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FINAL TIER II SAMPLING AND ANALYSIS PLAN EXPANDED SITE INSPECTION FOR SITE 9  
AREA OF CONCERN 1 ( AOC 1) AMMONIA SETTING PITS SUBAREA OF AREA OF  
CONCERN 6 (AOC 6) AND AREA OF CONCERN 7 (AOC 7) CHEATHAM ANNEX FISC  
WILLIAMSBURG VA  
10/1/2013  
CH2M HILL

# 1 Title and Approval Page

Final

## **Tier II Sampling and Analysis Plan Expanded Site Inspection – Site 9, AOC 1, Ammonia Settling Pits Subarea of AOC 6, and AOC 7**

**Naval Weapons Station Yorktown Cheatham Annex  
Williamsburg, Virginia**

**Contract Task Order WE02**

**October 2013**

Prepared for:

**Department of the Navy  
Naval Facilities Engineering Command  
Mid-Atlantic**

Under the

**NAVFAC CLEAN 8012 Program  
Contract N62470-11-D-8012**

Prepared by:



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## Signature Page

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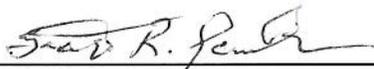
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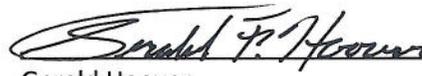
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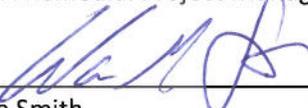
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# Executive Summary

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This Expanded Site Inspection (ESI) Sampling and Analysis Plan (SAP) was prepared under the United States Department of the Navy (Navy), Naval Facilities Engineering Command (NAVFAC) Mid-Atlantic, Comprehensive Long-term Environmental Action—Navy (CLEAN) 8012 Contract, Contract Task Order (CTO) WE02, for submittal to NAVFAC, United States Environmental Protection Agency (USEPA) Region III, and the Virginia Department of Environmental Quality (VDEQ). The Navy, USEPA, and VDEQ work jointly as the Naval Weapons Station (WPNSTA) Yorktown, Cheatham Annex (CAX) Partnering Team. This SAP was written in accordance with the Uniform Federal Policy (UFP) for Quality Assurance Project Plans guidance document (USEPA, 2004) using the modified Tier II format. Approval to prepare a Tier II SAP was provided via an email from Jan Nielsen (Navy) on January 20, 2012 (**Attachment 1**).

CAX is located in Williamsburg, Virginia, and encompasses 2,300 acres east of Williamsburg, between Interstate 64 and the York River on the York-James Peninsula (**Figure 1**). CAX is located on the site of the former DuPont Company Penniman Shell Loading Plant (PSLP) facility and is currently used to supply Atlantic Fleet ships and provide recreational opportunities to military and civilian personnel. The former PSLP was used as a powder and shell loading plant during World War I (WWI), was closed in 1918, and dismantled in the early 1920s. Currently, the majority of CAX is undeveloped and heavily wooded. Surface water features at CAX include Cheatham Pond, Jones Pond, and Penniman Lake, and the York River is adjacent to CAX's northeastern to eastern boundaries.

The objectives of the ESI are to characterize potential impacts from contaminant releases, evaluate potential risk to human health and the environment, and determine the need for further investigation or action at each site. This SAP details various aspects of the environmental investigation process that will serve as guidelines for the field sampling event to gather the required site data to conduct the ESI for each of the following sites:

- **Site 9** – Approximately 7,000 square feet in size, adjacent to the northwest corner of building Cheatham Annex Depot (CAD) 16, and used between 1973 and 1980 to store electrical transformers, some of which contained polychlorinated biphenyls (PCBs), prior to transfer or disposal. Site 9 is located approximately 900 feet east and upgradient of Cheatham Pond and approximately 2,500 feet west-southwest of the York River (**Figure 2**). An evaluation of the Site Inspection (SI) data indicated a localized surface soil polycyclic aromatic hydrocarbons (PAHs), Aroclor-1260, and metals “hot spot” area in the northern corner of the site (CAS09-SS02); therefore, additional surface soil data are needed to achieve the objectives of the ESI. While there were some site-related screening criteria exceedances detected in subsurface soil, subsurface soil samples from this area are not needed because the extent of site-related contamination in Site 9 subsurface soil was identified during the SI. In addition, the SI data indicated PAHs, pesticides, Aroclor-1260, and metals contamination within the drainage ditch, located across B Street from Site 9; however, in early 2010, the drainage ditch was reworked during utility installation activities. Therefore, new soil data from the drainage ditch area are needed to achieve the objectives of the SI, since surface runoff from Site 9 likely accumulated in the former drainage ditch.
- **Area of Concern (AOC) 1** – Comprised of two disposal areas located between Chapman Road and overhead utility lines running parallel to Chapman Road (AOC 1 North and AOC 1 South). AOC 1 North is approximately 0.5 acre in size, while AOC 1 South is approximately 1.5 acres in size. Both subareas are wooded with wood and metal debris outcropping from the banks of the drainage channels that run through each subarea. AOC 1 North and South are located approximately 1,000 feet east of Jones Pond (**Figure 3**). An evaluation of the SI soil data indicated a localized surface soil PAHs and metals “hot-spot” area (CAA01-SS04, CAA01-SS05, and CAA01-SS11) at AOC 1 North and a localized surface and subsurface soil PAHs and metals “hot-spot” area (a scrap metal pile) at AOC 1 South; therefore, additional surface soil data are needed at AOC 1 North and additional surface and subsurface soil data are needed at AOC 1 South to achieve the objectives of the ESI. While there were some screening criteria exceedances of select metals detected in subsurface soil and AOC 1 North, subsurface soil samples from this area are not needed because the extent of site-related

contamination in the AOC 1 North subsurface soil was identified during the SI. An evaluation of the SI groundwater data indicated elevated total metals concentrations (likely as a result of the high turbidity typically associated with direct-push technology [DPT] groundwater sampling) throughout both AOC 1 North and AOC 1 South; therefore, since the elevated total metals concentrations are not likely to be representative of actual groundwater conditions due to the effects of increased sample turbidity, metals data from permanent monitoring wells are needed to achieve the objectives of the ESI. Finally, since there is standing water within the drainage ditch of AOC 1 South, and no surface water or sediment samples have been collected, surface water and surface/subsurface sediment site-specific contaminant data (PAHs and metals) are needed from AOC 1 South to achieve the objectives of the ESI.

- AOC 6, Ammonia Settling Pits (ASP) subarea – One of five non-contiguous subareas (two being located within the same study area) located within the former Penniman shell loading area south of Sanda Avenue (formerly DuPont’s “G” plant), the AOC 6 ASP subarea is approximately 0.9 acre in size and is located adjacent to Penniman Lake (**Figure 4**). Other than the assumption that waste water from the Ammonia Finishing Building at this subarea discharged through the ASPs, no other information on the history of the AOC 6 ASP subarea is known. An evaluation of the SI soil data indicated elevated concentrations of select PAHs, explosives, and metals in surface or subsurface soil samples; however, since no surface or subsurface soil samples were collected from east and south of the Ammonia Evaporating and Ammonia Settling areas and since no information is known about the actual ammonia settling processes, additional PSLP-related contaminant surface and subsurface soil data (semivolatile organic compounds [SVOCs], explosives, and metals) are needed to fulfill the objectives of the ESI. An evaluation of the SI groundwater data indicated elevated total metals concentrations (likely as a result of the high turbidity typically associated with DPT groundwater sampling) throughout the AOC 6 ASP subarea; therefore, since the elevated total metals concentrations are not likely to be representative of actual groundwater conditions due to the effects of increased sample turbidity, metals data from permanent monitoring wells are needed to achieve the objectives of the ESI.
- AOC 7 – Approximately 1.5 acres in size and consisting of several small surface debris disposal areas containing 55-gallon drums (the former Drum Disposal Area) and numerous cans (the Can Pit), AOC 7 is located in a wooded area approximately 100 feet upgradient of Cheatham Pond (**Figure 5**). An evaluation of the SI groundwater data indicated elevated ethylbenzene (volatile organic compound [VOC]) and total metals concentrations (the elevated metals concentrations are likely a result of the high turbidity typically associated with DPT groundwater sampling) throughout AOC 7; therefore, due to the detected ethylbenzene (VOC) concentration and the likelihood that the total metals concentrations are not likely to be representative of actual groundwater conditions due to the effects of increased sample turbidity, VOCs and metals data from permanent monitoring wells are needed to achieve the objectives of the ESI. An evaluation of the SI soil data indicated elevated total metals concentrations at AOC 7; however, this media will be addressed separately as part of an interim removal action (Engineering Estimate/Cost Analysis submitted 08/14/13).

While this SAP and subsequent field work will be completed together, a separate ESI Report (including human health risk assessments [HHRAs] and ecological risk assessments [ERAs]) will be completed for each site.

This SAP will ensure that collected environmental data are scientifically sound, of known and documented quality, and suitable for intended uses. The laboratory information cited in this SAP is specific to the laboratories that were selected based on a competitive selection process and includes the necessary Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) certification for the analytical methods required by this project. In the event of changes, revisions will be submitted to the CAX Partnering Team prior to commencement of field work.

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# Acronyms and Abbreviations

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%R	percent recovery
°C	degree Celsius
µg/kg	microgram per kilogram
µg/L	microgram per liter
µm	micrometer
µmol/g	micromole per gram
AES	Atomic Emission Spectroscopy
AM	Activity Manager
AOC	Area of Concern
AQM	Activity Quality Manager
ASP	Ammonia Settling Pits
AVS	acid volatile sulfide
bgs	below ground surface
BHC	benzene hexachloride
BNA	base/neutral/acid
BTAG	Biological Technical Assistance Group
CA	corrective action
CAD	Cheatham Annex Depot
CAS	Chemical Analytical Services
CAX	Cheatham Annex
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-term Environmental Action—Navy
COC	constituent of concern
COPC	constituent of potential concern
CSM	conceptual site model
CTO	Contract Task Order
CVAA	cold vapor atomic absorption
DDD	dichlorodiphenyldichloroethane
DDE	dichlorodiphenyldichloroethylene
DDT	dichlorodiphenyltrichloroethane
DL	detection limit
DO	dissolved oxygen
DoD	Department of Defense
DPT	direct-push technology
DQI	data quality indicator
DUP	duplicate
DV	Data Validator
ECD	electron capture detector
ELAP	Environmental Laboratory Accreditation Program
ERA	ecological risk assessment
ESI	Expanded Site Inspection
ESV	Ecological Screening Value
FTL	Field Team Leader

g	gram
GC	gas chromatography
GC/MS	gas chromatography/mass spectrometry
GPS	global positioning system
HASP	Health and Safety Plan
HDPE	high-density polyethylene
HHRA	human health risk assessment
HMW	High Molecular Weight
HMX	octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
HPLC	High Performance Liquid Chromatography
HQ	hazard quotient
HSM	Health and Safety Manager
ICAL	initial calibration
ICP	inductively coupled plasma
ICPMS	inductively coupled plasma mass spectrometry
ID	identification
IDW	investigation-derived waste
IS	internal standards
L	liter
LCL	lower confidence limit
LCS	laboratory control sample
LMW	Low Molecular Weight
LOD	limit of detection
LOQ	limit of quantitation
MCL	Maximum Contaminant Level
mg/kg	milligram per kilogram
ml	milliliter
mm	millimeter
MPC	Measurement Performance Criteria
MS	matrix spike
MSA	method of standard additions
MSD	matrix spike duplicate
MTBE	methyl-tert-butyl ether
N/A	not applicable
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NC	no criterion
NOAA	National Oceanic and Atmospheric Administration
NTR	Navy Technical Representative
ORP	oxidation-reduction potential
oz	ounce
PAH	polycyclic aromatic hydrocarbon
PAL	Project Action Limit
PC	Project Chemist
PCB	polychlorinated biphenyl
PDS	post-digestion spike
PETN	pentaerythritol tetranitrate

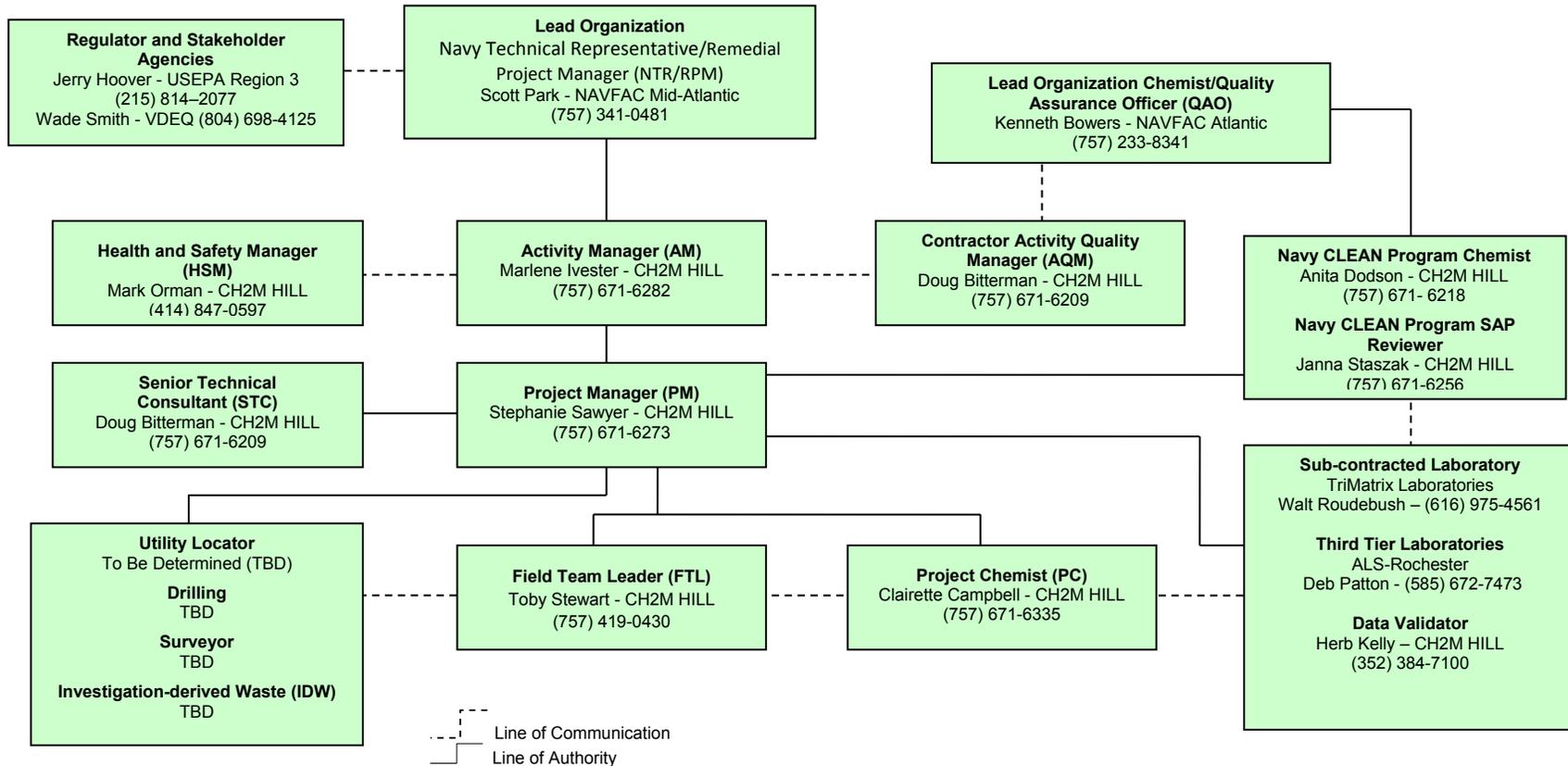
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PID	photoionization detector
PM	Project Manager
POC	point of contact
PPE	personal protective equipment
PQL	project quantitation limit
PSLP	Penniman Shell Loading Plant
PVC	polyvinyl chloride
QA	quality assurance
QAO	Quality Assurance Officer
QC	quality control
QL	quantitation limit
QSM	Quality Systems Manual
RA	risk assessor
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RL	reporting limit
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SEM	simultaneously extracted metals
SI	Site Inspection
SIM	selected ion monitoring
SOP	Standard Operating Procedure
STC	Senior Technical Consultant
SVOC	semivolatile organic compound
TBD	to be determined
TCLP	Toxicity Characteristic Leaching Procedure
TCMX	tetrachloro-m-xylene
Tetryl	methyl-2,4,6-trinitrophenylnitramine
TM	Technical Memorandum
TNT	trinitrotoluene
TOC	total organic carbon
UCL	upper confidence limit
UFP	Uniform Federal Policy
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
UTL	upper tolerance limit
UV	ultraviolet
VDEQ	Virginia Department of Environmental Quality
VOC	volatile organic compound
Weston	Roy F. Weston, Inc.
WPNSTA	Naval Weapons Station
WWI	World War I

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## 2 Project Organizational Chart

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



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### 3 Communication Pathways

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

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure, Pathway, etc.
Communication with Department of the Navy (Navy) (lead agency)	Naval Facilities Engineering Command (NAVFAC) Navy Technical Representative (NTR)/ Remedial Project Manager(RPM)	Scott Park	(757) 341-0481 <a href="mailto:scott.park@navy.mil">scott.park@navy.mil</a>	Primary point of contact (POC) for Navy; can delegate communication to other internal or external POCs. Any issues that may impact project work are to be reported to Scott immediately. NTR/RPM will notify the United States Environmental Protection Agency (USEPA) and Virginia Department of Environmental Quality (VDEQ) via e-mail or telephone within 24 hours of field changes affecting the scope or implementation of the work. Navy will have 30 days for Sampling and Analysis Plan (SAP) review.
Communication with USEPA Region III	USEPA RPM	Jerry Hoover	(215) 814-2077 <a href="mailto:Hoover.gerald@epa.gov">Hoover.gerald@epa.gov</a>	Primary POC for USEPA; can delegate communication to other internal or external POCs. Upon notification of field changes, USEPA will have 24 hours to approve or comment on the field changes. Responses will be communicated via e-mail or phone.
Communication with VDEQ	VDEQ RPM	Wade Smith	(804) 698-4125 <a href="mailto:wade.smith@deq.virginia.gov">wade.smith@deq.virginia.gov</a>	Primary POC for VDEQ; 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. Responses will be communicated via e-mail or phone.
Communication regarding overall project status and implementation and primary POC with Navy NTR/RPM, USEPA, and VDEQ	CH2M HILL Activity Manager (AM)	Marlene Ivester	(757) 671-6282 <a href="mailto:marlene.ivester@ch2m.com">marlene.ivester@ch2m.com</a>	Primary POC for stakeholder and agency managers; can delegate agency communication to other contract staff as appropriate. Oversees project and will be informed of project status by the Project Manager (PM). If field changes occur, the AM will work with the Navy NTR/RPM to communicate field changes to the USEPA and VDEQ via e-mail within 24 hours.
Communications regarding project management and implementation	CH2M HILL Deputy AM; PM	Stephanie Sawyer	(757) 671-6273 <a href="mailto:stephanie.sawyer@ch2m.com">stephanie.sawyer@ch2m.com</a>	Primary modes of communication are phone, e-mail, letter, document submittal; timing dependent on nature of communication and predefined schedule as applicable and as requested by stakeholder agencies. The PM will have 24 hours to respond to the request for field corrective actions (CAs). Responses will be communicated to the Field Team Leader (FTL) via phone. All information and materials about the project will be forwarded to the AM on a daily basis.
Technical communications for project implementation and data interpretation	CH2M HILL Senior Technical Consultant (STC) and Activity Quality Manager (AQM)	Doug Bitterman	(757) 671-6209 <a href="mailto:doug.bitterman@ch2m.com">doug.bitterman@ch2m.com</a>	Team members will contact the STC regarding questions/issues encountered in the field, input on data interpretation, and so forth, as needed. The STC will have 24 hours to respond to technical field questions as necessary. Responses will be communicated to the PM via e-mail or phone. In addition, the STC/AQM will review data and deliverables as necessary prior to Partnering Team discussion or distribution.

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-mail	Procedure, Pathway, etc.
SAP/Work Plan Changes prior to Field/Laboratory work	PM	Stephanie Sawyer	(757) 671-6273 <a href="mailto:stephanie.sawyer@ch2m.com">stephanie.sawyer@ch2m.com</a>	Notify the Cheatham Annex (CAX) Partnering Team by phone or e-mail of changes to the SAP made prior to beginning field work and the reasons within 24 hours.
Field Progress Reports	FTL	Toby Stewart	(757) 419-0430 <a href="mailto:toby.stewart@ch2m.com">toby.stewart@ch2m.com</a>	E-mail or fax daily field progress reports to contractor PMs on a weekly basis; telephone communication with PMs on an as-needed basis.
Stop Work due to Safety Issues	Site Safety Coordinator	Toby Stewart	(757) 419-0430 <a href="mailto:toby.stewart@ch2m.com">toby.stewart@ch2m.com</a>	Notify field personnel that work is to stop immediately if a safety issue is observed. Report all health and safety incidents and near-misses to PM and Health and Safety Manager (HSM) via e-mail or phone immediately if an incident occurred or within 24 hours if a near-miss occurred.
SAP/Work Plan Changes in the Field	FTL	Toby Stewart	(757) 419-0430 <a href="mailto:toby.stewart@ch2m.com">toby.stewart@ch2m.com</a>	Notify the PM by phone and e-mail of changes to the SAP made in the field and the reasons within 24 hours. Documentation of deviations from the SAP will be kept in the field logbook; deviations made only with the approval of the PM. Approvals will be made via e-mail or phone.
Field CAs	FTL	Toby Stewart	(757) 419-0430 <a href="mailto:toby.stewart@ch2m.com">toby.stewart@ch2m.com</a>	The need for CA for field or analytical issues will be determined by the FTL and/or senior risk assessors (RAs) and STC. Senior support will ensure SAP requirements are met by the field staff. The FTL will notify the PM via phone of any need for CA within 4 hours. The PM/AM may notify the Navy RPM of any field issues that would negatively affect schedule or the ability to meet project data quality objectives.
Reporting Laboratory Data Quality Issues	Laboratory PM	TriMatrix – Walt Roudebush ALS-Rochester – Deb Patton	(616) 975-4561 (585) 672-7473	All quality assurance (QA)/quality control (QC) issues with project field samples will be reported within 1 day to the Project Chemist (PC) by the laboratory.
Reporting Data Validation Issues	Data Validator (DV)	Herb Kelly	(352) 384-7100 <a href="mailto:herb.kelly@ch2m.com">herb.kelly@ch2m.com</a>	All completeness and data issues will be addressed with the laboratory. The DV should copy the CH2M HILL PC on all communications to the laboratory. The validated data package will be due within 14 calendar days of data receipt by the DV.
Sample Tracking, Laboratory Communication, Data Validation CAs	PC	Clairette Campbell	(757) 671-6335 <a href="mailto:clairette.campbell@ch2m.com">clairette.campbell@ch2m.com</a>	The PC tracks the data and informs the PM of potential problems or issues. The PM and AM are informed within 24 hours to pass on communications to Navy and regulators as appropriate. All issues discovered during data validation will be reported to the PC. CAs (revisions and additional information, if necessary) will be requested from the laboratory. The PC will review the data validation narrative and request CA from the DV if necessary.  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 NTR/RPM and Navy Quality Assurance Officer (QAO).

## 4 Project Planning Session Participants Sheets

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

### 4.1 Site 9 – Transformer Storage Area

#### 4.1.1 October 2011 Team Discussion

Project Name: Site 9 Expanded Site Inspection (ESI)			Site Name: Site 9	
Projected Date(s) of Sampling: Fall 2013			Site Location: CAX	
PM: Stephanie Sawyer				
Date of Session: 10/26/11				
Scoping Session Purpose: Discussion of the USEPA's perceived path forward presented in the various Site Inspection (SI) reports (including Site 9)				
Name	Title	Affiliation	Phone #	E-mail Address
John Burchette	RPM	USEPA Region III	(215) 814-3378	<a href="mailto:burchette.john@epa.gov">burchette.john@epa.gov</a>
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Marlene Ivester	AM	CH2M HILL	(757) 671-1634	<a href="mailto:marlene.iverster@ch2m.com">marlene.iverster@ch2m.com</a>
Stephanie Sawyer	Deputy AM/PM	CH2M HILL	(757) 671-6273	<a href="mailto:stephanie.sawyer@ch2m.com">stephanie.sawyer@ch2m.com</a>
Jennifer Corack	Human Health RA	Navy Marine Corps Health Center	(757) 953-0950	<a href="mailto:Jennifer.Corack@med.navy.mil">Jennifer.Corack@med.navy.mil</a>
Jennifer Wright	Ecological RA	NAVFAC Atlantic	(757) 322-8428	<a href="mailto:jennifer.h.wright@navy.mil">jennifer.h.wright@navy.mil</a>
Bruce Pluta	Biological Technical Assistance Group (BTAG) Coordinator	USEPA, Region III	(215) 814-2380	<a href="mailto:Pluta.Bruce@epa.gov">Pluta.Bruce@epa.gov</a>
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Peter Knight	Ecological RA	National Oceanic and Atmospheric Administration (NOAA) (USEPA BTAG)	(215) 814-3321	<a href="mailto:Peter.Knight@noaa.gov">Peter.Knight@noaa.gov</a>
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William Kappleman	Ecological RA	CH2M HILL	(703) 376-5152	<a href="mailto:William.kappleman@ch2m.com">William.kappleman@ch2m.com</a>
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#### Comments/Decisions

During the completion of three SI reports for CAX (including the SI for CAX Site 9), the CAX Partnering Team held a conference call with their associated technical support on October 26, 2011, to discuss the conclusions and recommendation of the SI reports. Two evaluations of the SI data were conducted and summarized in the reports. The first evaluation (Step 2a) included a comparison of detected constituents to the base background 95 percent upper tolerance limit (UTL) and the conservative screening criteria (residential Regional Screening Levels [RSLs] and Ecological Screening Values [ESVs]). Following the first evaluation, semi-quantitative human health and

ecological risk evaluations (Step 2b) were conducted to determine if those constituents identified in Step 2a likely pose a potential risk to human health and the environment. This evaluation was conducted in order to provide an indication of data gaps that would need to be filled by further investigative activities.

The USEPA provided comments on each of the three SI reports, expressing concerns about the two-stepped approach. They were concerned that constituents of potential concern (COPCs) would be eliminated from future investigations based on the results of the Step 2b evaluation. The USEPA felt that any constituent that exceeds a screening criterion (Step 2a) in the SI phase should be carried through for evaluation to the next phase.

During the October 26, 2011, Team call to discuss how to finalize the CAX Sites 4, 9, and Area of Concern (AOC) 3 SI report, the CAX Partnering Team agreed that the main focus of the SI process was to define site-related contaminants in order to focus the sampling plan for subsequent investigations since full-suite analysis is usually not needed. The Team clarified that individual site-related contaminants from both Steps 2a and 2b are discussed in the risk characterization section of the SI reports for those constituents that exceed background, regardless of whether site-related contamination was identified in the Step 2a or 2b list, and site-related contaminants, as analyte groups, would carry through to the next phase of the investigation.

Since many of the CAX sites (including Site 9) required follow-on investigations, the Team discussed what revisions would be made to the SI in order to ease the concerns of the USEPA. The Team agreed that in order to finalize the CAX Sites 4, 9, and AOC 3 SI report, the conclusions of the SI would include the following generic text:

Information regarding the number of samples, sampling locations, sampling analytes, and how the sample data will be used in the ESI will be agreed to by the CAX Partnering Team and documented in an ESI Uniform Federal Policy (UFP)-SAP, to be submitted under separate cover.

#### 4.1.2 January 2012 Scoping Session

Project Name: Site 9 ESI		Site Name: Site 9		
Projected Date(s) of Sampling: Fall 2013		Site Location: CAX		
PM: Stephanie Sawyer				
Date of Session: 1/19/12				
Scoping Session Purpose: To agree on a sampling plan to determine if there was a release of hazardous constituents at Site 9 that warrants further investigation or action.				
Name	Title	Affiliation	Phone #	E-mail Address
John Burchette	RPM	USEPA Region III	(215) 814-3378	<a href="mailto:burchette.john@epa.gov">burchette.john@epa.gov</a>
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Krista Parra	RPM	NAVFAC Mid-Atlantic	(757) 341-0395	<a href="mailto:krista.parra@navy.mil">krista.parra@navy.mil</a>
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#### Comments/Decisions

The Team reviewed the Step 2 (2a and 2b) results included in the SI report and the SI report recommendations. The Team discussed the objectives of the ESI (to determine if there has been a release of hazard constituents that warrants further investigation or action, and if there has, to determine if the hazardous constituent pose a potential risk to human health or ecological receptors).

The Team discussed the SI soil data analytical results and identified a “hot spot” in the northern corner of the site (CAS09-SS02). Due to the elevated polychlorinated biphenyl (PCB) and metals concentrations and the absence of soil samples surrounding CAS09-SS02, a data gap was identified and the Team agreed to collect additional surface

soil samples from Site 9. The Team discussed collecting three surface soil samples from the northern corner of the site (near CAS09-SS09) for PCBs and metals analysis, since constituents within these analytical groups were identified during the SI semi-quantitative human health and ecological risk evaluations as constituents that may pose a potential risk to human health and the environment. During this discussion, the USEPA asked, for those constituents not being proposed for surface soil analysis in the ESI (volatile organic compounds [VOCs], semivolatle organic compounds [SVOCs], pesticides, and explosives), whether any of them exceed any of the conservative screening criteria in the SI (Step 2a). CH2M HILL replied that only polycyclic aromatic hydrocarbons (PAHs) exceeded the residential RSLs and pesticides exceeded ESVs; however, pesticides at Site 9 did not appear to be related to a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) release. USEPA requested that PAHs be added to the analyte list since they were detected at the site at concentrations exceeding the residential RSLs. The Team agreed.

Based on the results of the SI groundwater analytical data, the Team discussed and agreed that no additional groundwater samples were needed from Site 9. However, because only a semi-quantitative risk evaluation was conducted (as opposed to a quantitative risk assessment), the existing SI groundwater data will be evaluated in the ESI risk assessments.

Following collection of the SI sediment samples from the drainage ditch, located across B Street from Site 9, overhead and underground utility lines were installed along B Street during an early 2010 utility installation project that resulted in the elimination of the drainage ditch. The results of the SI sediment analytical data indicated the presence of PAHs, PCBs, pesticides, and metals at concentrations above the conservative screening criteria (Step 2a). Therefore, since the drainage ditch no longer exists, the Team agreed to collect six surface and six subsurface soil samples from the area where the former drainage ditch used to be located in order to determine if there has been a release of hazard constituents that warrants further investigation or action, and if there has, to determine if the hazardous constituent pose a potential risk to human health or ecological receptors. In addition, due to the elevated chromium concentrations in the former drainage ditch before the utility installation project, the CAX Partnering Team agreed that four of the drainage ditch soil samples (two surface and two subsurface samples) will be analyzed for hexavalent chromium in order to refine the human health risk assessment [HHRA]).

The USEPA and VDEQ expressed their concerns that the sediment (identified in the SI as exceeding the conservative screening criteria) from within the former drainage ditch could have become soil outside the original footprint of the drainage ditch, thus the proposed drainage ditch soil samples (previously outlined) may not be representative of actual contamination or risk. To address the USEPA and VDEQ concerns, the Navy recommended collecting five-point composite samples from the vicinity of four of the six surface/subsurface drainage ditch samples previously outlined. The Team discussed and agreed that the five-point composite samples would be compared to the results of the proposed drainage ditch soil samples (previously outlined), to assist in determining if contaminated soil from within the former drainage ditch came to rest outside the original footprint of the drainage ditch. The samples would be collected from 0 to 2 feet below grade and analyzed for the same constituents as the surface/subsurface drainage ditch samples previously outlined (PAHs, pesticides, PCBs, and metals), since there were the constituent groups that exceeded the conservative screening criteria during the SI.

The USEPA and VDEQ then asked if any of the soil from the utility installation project had been removed (taken to a landfill or used as fill in another area of the base), as this could pose potential problems due to the screening criteria exceedances identified during the SI. Since no one knew the answer to this, Krista took an action to find out (results discussed as follows).

### **Action Items and Results**

Krista discussed the utility installation project with the Navy engineer to gather more information regarding how utilities were installed along B Street. *The Navy engineer informed Krista that the trenches were dug along B Street to install cable lines and that no soil was removed from the area during the trenching activities.*

### 4.1.3 February 2012 Scoping Session

Project Name: Site 9 ESI		Site Name: Site 9		
Projected Date(s) of Sampling: Fall 2013		Site Location: CAX		
PM: Stephanie Sawyer				
Date of Session: February 2012 (via e-mail)				
Scoping Session Purpose: To agree that full suite PCB analysis was not needed at Site 9				
Name	Title	Affiliation	Phone #	E-mail Address
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#### Comments/Decisions

The Team agreed, via e-mail, to not analyze the ESI soil samples for the full suite of PCBs. The site soil and drainage soil samples will be analyzed for Aroclor-1260 instead of the full suite of PCBs, since it was the only PCB detected during the SI. These samples would still be analyzed for PAHs, pesticides, and metals.

## 4.2 Area of Concern 1 – Scrap Metal Dump

### 4.2.1 January 2012 Scoping Session

Project Name: AOC 1 ESI		Site Name: AOC 1		
Projected Date(s) of Sampling: Fall 2013		Site Location: CAX		
PM: Stephanie Sawyer				
Date of Session: 1/19/12				
Scoping Session Purpose: To agree on a sampling plan to determine if there was a release of hazardous constituents at AOC 1 that warrants further investigation or action.				
Name	Title	Affiliation	Phone #	E-mail Address
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#### Comments/Decisions

##### ***AOC 1 North***

The Team reviewed the Step 2 (2a and 2b) results included in the SI report. The SI report recommended that an ESI at AOC 1 North be conducted to further verify and characterize the extent of SVOC (PAHs) and metals contamination in the localized surface soil “hot spot” areas and to install permanent monitoring wells to confirm the results of elevated metals (total and dissolved) concentrations (in particular upgradient of the site) detected in samples collected from direct-push technology (DPT) sample points and verify the groundwater flow directions; therefore, additional sampling activities were discussed.

Due to the elevated PAH and metals concentrations in the vicinity of CAA01-SS05 and CAA01-SS11, the Team agreed to collect six surface soil samples from the area surrounding these surface soil samples in order to determine the size of the “hot spot” area. The six surface soil samples were selected to provide an adequate number of soil samples surrounding the “hot spot” area. As recommended in the SI report, the Team agreed to analyze the surface soil samples for PAHs and metals. In addition, since the human health risk screening conducted during the SI assumed all the chromium detected in soil was in the hexavalent rather than trivalent form, which is highly unlikely, as recommended in the SI, the Team agreed to collect two surface soil samples, from the vicinity of where chromium concentrations were the highest, to be analyzed for total and hexavalent chromium. This data will be used to determine the speciation of chromium concentrations detected during the SI and determine if chromium concentrations in soil pose a potential risk to human health.

Since the SI report recommended the installation and sampling of permanent monitoring wells to confirm the elevated metals concentrations detected in samples collected from DPT sample points, the Team discussed and agreed to install five monitoring wells throughout the site. The Team selected the installation of five monitoring wells so statistical analyses could be completed on the data when completing the HHRA and ecological risk assessment (ERA).

##### ***AOC 1 South***

The Team reviewed the Step 2 (2a and 2b) results included in the SI report. The SI report recommended that an ESI at AOC 1 South be conducted to further verify and characterize the extent of SVOCs (PAHs) and metals contamination in the localized surface and subsurface soil “hot spot” areas, to install permanent monitoring wells

to confirm the results of elevated metals (total and dissolved) concentrations (in particular upgradient of the site) detected in samples collected from DPT sample points and verify the groundwater flow directions, and to collect surface water and sediment samples to evaluate potential transport of SVOCs (PAHs) and metals from the site to these media; therefore, additional sampling activities were discussed.

Due to the elevated PAH and metals concentrations in the vicinity of a scrap metal pile, the Team agreed to collect eight co-located surface/subsurface soil samples from the area surrounding these soil samples in order to determine the size of the “hot spot” area. The eight surface/subsurface soil samples were selected to provide an adequate number of soil samples surrounding the “hot spot” area. As recommended in the SI report, the Team agreed to analyze the surface/subsurface soil samples for PAHs and metals. Since the SI report recommended the installation and sampling of permanent monitoring wells to confirm the elevated metals concentrations detected in samples collected from DPT sample points, the Team discussed and agreed to install five monitoring wells throughout the site. The Team selected the installation of five monitoring wells so statistical analyses could be completed on the data when completing the HHRA and ERA.

Since no surface water or sediment (surface/subsurface) samples were collected from the site during the SI, the Team discussed and agreed to collect five co-located surface water and surface/subsurface sediment samples from the ravine located at AOC 1 South. The Team selected the collection of five samples so statistical analyses could be completed on the data when completing the HHRA and ERA.

## 4.3 AOC 6 – Ammonia Settling Pits Subarea of Penniman AOC

### 4.3.1 January 2012 Scoping Session

Project Name: AOC 6, Ammonia Settling Pits (ASP) subarea, ESI		Site Name: AOC 6		
Projected Date(s) of Sampling: Fall 2013		Site Location: CAX		
PM: Stephanie Sawyer				
Date of Session: 1/19/12				
Scoping Session Purpose: To agree on a sampling plan to determine if there was a release of hazardous constituents at the ASP subarea of AOC 6 that warrants further investigation or action.				
Name	Title	Affiliation	Phone #	E-mail Address
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#### Comments/Decisions

The Team reviewed the Step 2 (2a and 2b) results included in the SI report. The SI report recommended the installation of permanent monitoring wells to confirm the results of elevated metals (total and dissolved) concentrations detected in samples collected from DPT sample points and verify the groundwater flow directions; therefore, additional sampling activities were discussed. The Team discussed and agreed to install five monitoring wells throughout the site. The Team selected the installation of five monitoring wells so the statistical analyses could be completed on the data when completing the HHRA and ERA.

Following the groundwater sampling discussion, the VDEQ asked what the rationale behind collecting the SI soil samples was and why soil samples were not collected in the Ammonia Evaporating and Ammonia Settling areas. The Team was informed that it was assumed that the greatest potential concentrations of contaminants from the former ASP would have been directly east-northeast and north, where the SI soil samples were collected. In addition, during the 1999 Roy F. Weston, Inc. (Weston), investigation, it was believed that ammonia from the Ammonia Finishing Building was discharged through the settling pits (located north of the building) prior to being discharged to Penniman Lake; therefore, likely releases of contaminants would be expected within the settling pit.

### 4.3.2 March 2012 Scoping Session

Project Name: AOC 6, ASP subarea, ESI		Site Name: AOC 6		
Projected Date(s) of Sampling: Fall 2013		Site Location: CAX		
PM: Stephanie Sawyer				
Date of Session: 3/8/12				
Scoping Session Purpose: To agree on a sampling plan to determine if there was a release of hazardous constituents at the ASP subarea of AOC 6 that warrants further investigation or action.				
Name	Title	Affiliation	Phone #	E-mail Address
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Krista Parra	RPM	NAVFAC Mid-Atlantic	(757) 341-0395	<a href="mailto:krista.parra@navy.mil">krista.parra@navy.mil</a>
Marlene Ivester	AM	CH2M HILL	(757) 671-6282	<a href="mailto:marlene.ivester@ch2m.com">marlene.ivester@ch2m.com</a>
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#### Comments/Decisions

Based on the questions raised during the January 2012 scoping session, additional soil sampling was proposed with the objective to determine if there has been a release of hazardous constituents to the ASP subarea of AOC 6 soil that warrants further investigation or action, and if there has, to determine if the hazardous constituents pose a potential risk to human health or ecological receptors.

Since research into the processes of the ASP subarea of AOC 6 resulted in limited information, the Team agreed that additional soil samples were needed in the vicinity of the Ammonia Evaporating and Ammonia Settling areas of the site. Therefore, the Team discussed potential sample locations. Following the discussion, the Team agreed on the locations of three co-located surface and subsurface soil samples, east and south of the Ammonia Evaporating and Ammonia Settling areas for SVOCs, explosives, and metals analysis (Penniman Shell Loading Plant [PSLP]-related contaminants and the same constituents analyzed during the SI) since the ammonia settling process could not be confirmed.

## 4.4 AOC 7 – Drum and Can Disposal Area

### 4.4.1 January 2012 Scoping Session

Project Name: AOC 7		Site Name: AOC 7		
Projected Date(s) of Sampling: Fall 2013		Site Location: CAX		
PM: Stephanie Sawyer				
Date of Session: 1/19/12				
Scoping Session Purpose: To agree on a sampling plan to determine if there was a release of hazardous constituents at AOC 7 that warrants further investigation or action.				
Name	Title	Affiliation	Phone #	E-mail Address
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#### Comments/Decisions

The Team reviewed the Step 2 (2a and 2b) results included in the SI report. The SI report recommended the installation of permanent monitoring wells to confirm the results of the VOCs and metals concentrations and verify the groundwater flow directions; therefore, additional sampling activities were discussed. The Team discussed and agreed to install five monitoring wells throughout the site. The Team selected the installation of five monitoring wells so the statistical analyses could be completed on the data when completing the HHRA and ERA.

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## 5 Conceptual Site Model

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

### 5.1 Site 9 – Transformer Disposal Area

The conceptual site model (CSM) for Site 9 is based on data collected to complete the SI. This CSM presents the site background and history, physical setting, distribution of contamination, release history, potential migration pathways, and the potential exposure and receptor pathways. The CSM figure for Site 9 is provided as **Figure 6**.

#### 5.1.1 Site Background and History

Site 9 is approximately 900 feet east of Cheatham Pond and approximately 2,500 feet west-southwest of the York River. Site 9 is adjacent to the northwest corner of building Cheatham Annex Depot (CAD) 16 and covers approximately 7,000 square feet (**Figure 2**). Between 1973 and 1980, electrical transformers, some of which contained PCBs, were stored at Site 9 to await transfer or disposal (C. C. Johnson & Associates, Inc., and CH2M HILL, 1984). The storage area surface consisted of exposed soil enclosed by an earthen containment wall. While there is the potential that spills from the PCB-containing transformers occurred, there are no reports of releases from the transformers during storage. After 1980, when the transformers were removed, the area was graded and covered with gravel. Limited grassy cover now grows within the graveled area.

The following investigations have been conducted at Site 9:

- *Initial Assessment Study* (C. C. Johnson & Associates, Inc., and CH2M HILL, 1984)
- *Confirmation Study Step 1A (Verification), Round One* (Dames & Moore, 1986)
- *Remedial Investigation Interim Report* (Dames & Moore, 1991)
- *Draft Final No Further Response Action Planned Decision Document Site 9 - Transformer Storage Area* (Baker, 1999)
- *Screening Level Ecological Risk Assessment Report of Sites 4 and 9* (Baker, 2005)
- *Site Inspection Report, Site 4, Site 9, and Area of Concern 3* (CH2M HILL, 2011a)

#### 5.1.2 Physical Setting

The topography of Site 9 is relatively flat with the western part of the site draining west toward B Street and the eastern part of the site draining northeast towards a storm drain (**Figure 6**). Surface runoff from the western part of the site used to flow into a grassy drainage ditch along the western side of B Street, which flowed to the south. However, due to utility installation activities along B Street in early 2010 (after the SI field work was conducted), this drainage ditch was reworked and no longer exists. As a result, surface runoff from the western part of the site is expected to flow across B Street and infiltrate into the ground surface, close to the Site 9 study area. Surface runoff from the eastern part of the site flows northeast into a storm drain that discharges at Outfall 2 (located near Site 4) and flows as surface water in an unnamed drainage ditch through Site 4 and into Upstream Pond. Surface water in Upstream Pond flows through a culvert under D Street into Youth Pond and eventually discharges into the York River (inset of **Figure 2**).

Soil at Site 9 is predominantly yellowish-brown sandy clay and clay underlain by greenish-grey silty sand. The first encountered groundwater underlying Site 9 is the Yorktown-Eastover aquifer at a depth between 7.5 and 8.5 feet below ground surface (bgs). Groundwater on the eastern side of a groundwater divide in the vicinity of the site (**Figure 6**) is estimated to flow north-northeast towards Upstream Pond, while groundwater on the western side of the groundwater divide is estimated to flow south-southwest towards Cheatham Pond.

Site 9 is currently a gravel area with limited grass cover with no designated use. Site 9 is located within the CAD warehouse area, which is restricted to general CAX visitors (such as civilian employees and military personnel). Land use at Site 9 is not expected to change in the foreseeable future.

### 5.1.3 Release History

Although there are no reports of releases from PCB-containing transformers stored at Site 9 between 1973 and 1980, potential unreported spills from these transformers are the primary suspected sources of PCB contamination at Site 9. There are no other known CERCLA-related sources at Site 9 or any records of historical releases of VOCs, SVOCs, pesticides, or metals at Site 9. The findings of the SI indicate that detected pesticide concentrations in soil are likely related to normal, base-wide pesticide use, and not a site-related release. However, the origin of the low levels of detected VOCs, SVOCs, and metals detected in Site 9 soil is not known.

### 5.1.4 Distribution of Contamination

Select PAHs and metals were detected in groundwater at concentrations above their respective residential RSLs. The results of the semi-quantitative risk screening indicated they pose no potential unacceptable risk to human health or ecological receptors. However, since only a semi-quantitative risk screening was conducted during the SI, these groundwater results will need to be evaluated in the quantitative risk assessments to document the absence of risk to human health and ecological receptors.

While VOCs, PAHs, Aroclor-1260, pesticides, and metals were detected in surface and/or subsurface soil during the SI, only select PAHs, Aroclor-1260, pesticides, and metals were detected in surface and/or subsurface soil at concentrations exceeding the background 95 percent UTLs (where applicable) and either the adjusted USEPA residential RSLs or ESVs (CH2M HILL, 2011a).

The highest PAH and PCB concentrations and elevated metals concentrations in surface soil were detected in the northern corner of the Site 9 study area (CAS09-SS02). Therefore, additional surface soil samples from this area are needed to define the extent of PAH, Aroclor-1260, and metals contamination in this area and to determine if there has been a release of hazardous constituents that warrants further investigation or action. The low level pesticide concentrations indicate that their detections are not related to a CERCLA release. Additional subsurface soil samples from this area are not needed because the extent of PAH, Aroclor-1260 and metals contamination in Site 9 subsurface soil was identified during the SI.

While VOCs, PAHs, Aroclor-1260, pesticides, and metals were detected in surface/subsurface sediment samples from the drainage ditch, across B Street from Site 9, only select PAHs, Aroclor-1260, pesticides, and metals were detected at concentrations exceeding the base background 95 percent UTLs (where applicable) and either the adjusted USEPA residential RSLs or ESVs (CH2M HILL, 2011a). Following the SI sampling event, utility installation activities along B Street were conducted. As a result of the trenching activities conducted to install underground utility lines, the drainage ditch (where surface/subsurface sediment samples were collected during the SI) was eliminated. Since the sediment within the drainage ditch could not be evaluated further to characterize potential impacts from contaminate releases and there is a possibility that sediment (exceeding the previously listed screening criteria) from within the former drainage ditch could have ended up outside the original footprint of the drainage ditch, new surface and subsurface soil data are needed to characterize potential impacts from contaminant releases and determine the need for further investigation or action.

### 5.1.5 Potential Migration Pathways

The principal contaminant release and transport mechanisms from source areas include potential leaks (although none were ever reported) of contaminants from the transformers stored at Site 9 (or other unknown sources) and leaching from soil to groundwater as a result of rainwater infiltration. It has been reported that the transformers formerly stored at Site 9 were contained within an earthen berm (Baker, 1999); therefore, where contaminants were exposed at the ground surface, historical transport of contamination potentially occurred through infiltration into the soil and groundwater (although constituents detected in groundwater were not detected at concentrations that pose potentially unacceptable risk to human health). The earthen berm has since been removed (sometime in the 1980s) such that currently, where contaminants are potentially exposed at the ground

surface, transport could occur through stormwater runoff and eventual infiltration into the soil. This stormwater runoff either flows into an underground storm drain that discharges at Outfall 2 (from the eastern part of Site 9) or flows across B Street and infiltrates into the ground surface, close to the Site 9 study area (from the western part of Site 9). However prior to utility installation activities along B Street, stormwater runoff (and potential contaminants from Site 9 surface soil) from the western part of Site 9 would have been expected to flow southeast through the drainage channel before infiltrating into the ground.

### 5.1.6 Potential Exposure and Receptor Pathways

Potential human receptors exposed to soil and groundwater at Site 9 and offsite drainage ditch soil include:

- Current and future site visitors/trespassers/maintenance workers (site and drainage ditch surface and subsurface soil)
- Future industrial workers/residents (site and drainage ditch surface and subsurface soil and groundwater)
- Future construction workers (site and drainage ditch surface and subsurface soil and groundwater)

These potential receptors may be exposed to site-related contaminants through incidental ingestion of, inhalation of particulates from, and dermal contact with site and drainage ditch soil, and ingestion of and/or dermal contact with groundwater.

Potential ecological receptors exposed to surface soil and shallow subsurface soil at Site 9 and within the former drainage ditch area include lower trophic level terrestrial receptors (primarily plants and soil invertebrates). Due to the small size of potentially contaminated areas on the site (potential source areas), exposures to upper trophic level receptors (that is, birds and mammals) are not considered significant. The lower trophic level receptors may be exposed to site-related contaminants through root uptake from the soil and/or through direct exposure with soil both onsite and within the former drainage ditch. There is also the potential for groundwater transport of site-related contaminants to nearby surface water bodies (Cheatham Pond or Upstream Pond), at which point there may be potential exposures to aquatic receptors.

### 5.1.7 What are the environmental questions to be answered?

The following environmental questions will be answered to complete the ESI.

**Has there been a release of hazardous constituents to Site 9 soil that warrants further investigation or action?**

**There are 18 surface and five subsurface soil samples that were collected and evaluated in the 2009 SI (CH2M HILL, 2011a). However, due to some site-related screening criteria exceedances (select PAHs, Aroclor-1260, and metals) detected in a relatively isolated SI surface soil sample (CAS09-SS02), additional PAH, Aroclor-1260, and metals surface soil data (the constituent groups to exceed the conservative screening criteria during the SI) are warranted in this area to supplement the SI data in order to adequately characterize potential impacts of contaminant releases and determine the need for further investigation or action at Site 9. While there were some site-related screening criteria exceedances detected in subsurface soil, subsurface soil samples from this area are not needed because the extent of site-related contamination in Site 9 subsurface soil was identified during the SI. The following work is proposed to answer this environmental question:**

Three surface soil samples (0 to 6 inches bgs) will be collected from each side of CAS09-SS02 where there are no adjacent surface soil samples (**Figure 7**). Each soil sample will be analyzed for PAHs, Aroclor-1260, and metals to supplement the existing surface soil data. In addition, the three surface soil samples will also be analyzed for total organic carbon (TOC), pH, and grain size to collect physical parameter data needed to complete the ERA.

**Has there been a release of hazardous constituents to the former drainage ditch across B Street from Site 9 (considering its newly reworked soil profile) that warrants further investigation or action?**

There were three drainage ditch surface and subsurface sediment samples collected from the former drainage ditch across B Street during the SI (CH2M HILL, 2011a). The soil in and around the drainage ditch was reworked during recent utility installation activities along B Street in early 2010. Therefore, due to the screening criteria

exceedances (PAHs, Aroclor-1260, pesticides, and metals) and the fact that the SI samples are no longer reflective of current site conditions, additional PAHs, Aroclor-1260, pesticides, and metals surface and subsurface soil data (the constituent groups to exceed the conservative screening criteria during the SI) are needed to adequately characterize potential contaminant concentrations and determine the need for further investigation or action.

**The following work is proposed to answer this environmental question:**

Six surface (0 to 6 inches bgs) and six subsurface (6 to 24 inches bgs) soil samples will be collected along the alignment of the former drainage ditch across B Street (in the vicinity of, upgradient of, and downgradient of the samples collected during the SI [Figure 7]) and analyzed for PAHs, Aroclor-1260, pesticides, and metals to replace the SI drainage ditch data. The six surface soil samples will be analyzed for TOC, pH, and grain size, and the six subsurface soil samples will be analyzed for pH to collect physical parameter data needed complete the ERA. In addition, two of the surface and two of the subsurface drainage ditch samples (the locations were based on where the highest chromium concentrations were detected during the SI [Figure 7]) will be analyzed for hexavalent chromium in order to determine the valency of chromium concentrations in order to refine the HHRA.

Due to the uncertainty of where the soil from the drainage ditch ended up following the utility installation activities along B Street, five-point composite samples from the vicinity of four of the six surface/subsurface drainage ditch samples previously outlined and analyzed for the same constituents as the surface/subsurface drainage ditch samples previously outlined (PAH, pesticides, PCBs, and metals), since there were the constituent groups that exceeded the conservative screening criteria during the SI. The locations of three of the five-point composite are consistent with the location of the surface/subsurface sediment samples collected during the SI, while the remaining five-point composite sample location was selected as it is likely to be the farthest upgradient area where runoff from Site 9 could have entered the former drainage ditch.

**Do site and drainage ditch media pose a potentially unacceptable risk to human health and/or the environment?**

Quantitative risk assessments have not been conducted at Site 9; therefore, a quantitative HHRA and ERA will need to be conducted to determine if site media pose a potential unacceptable risk to human health and/or the environment.

**The following work is proposed to answer this environmental question:**

A baseline HHRA will be completed to determine if site contaminants potentially pose an unacceptable risk to human health. An ERA (through Step 3a) will be completed to determine if site contaminants in site soil and offsite former drainage ditch soil could pose an unacceptable risk to ecological receptors.

**Is further investigation or action (such as removal or remediation) warranted at Site 9 or the former drainage ditch?**

The results of the sampling activities and the HHRA and ERA are needed to determine if further investigation or action is warranted at Site 9.

**The following work is proposed to answer this environmental question:**

Recommendations regarding whether or not further investigation or action is warranted will be based on the results of the ESI, including the findings of the HHRAs and ERAs, and the expected future use of the site. The decision process used to evaluate the data and answer this question is presented on Figure 8. The recommended path forward for Site 9 will be presented in the ESI report.

## 5.2 AOC 1 – Scrap Metal Dump

The CSM for AOC 1 is based on data collected to complete the 2012 SI. This CSM presents the site background and history, physical setting, distribution of contamination, release history, potential migration pathways, and the potential exposure and receptor pathways. The CSM figure for AOC 1 is provided as Figure 9.

## 5.2.1 Site Background and History

AOC 1 is comprised of two debris disposal areas located between Chapman Road and overhead utility lines running parallel to Chapman Road. This site was identified as an AOC in 1998, following site visits by the Navy, USEPA, and VDEQ. Due to the distance between the most significant debris, which is centered around the site drainage channels, AOC 1 was divided into two distinct areas (AOC 1 North and AOC 1 South), which are evaluated separately (**Figure 3**).

Wood and metal debris outcrop from the banks of the ravines, with debris being more extensive within AOC 1 South. The date(s) of debris disposal at AOC 1 are unknown; however, it is possible some of this debris dates back to the World War I (WWI) era (Weston, 1999). The total volume of debris at AOC 1 North and AOC 1 South is estimated to be 3,000 cubic yards (Baker, 2001).

The following investigations have been conducted at AOC 1 North and AOC 1 South:

- *Site Inspection Narrative Report* (Weston, 1999)
- *Site Inspection Report, Site 4 and AOC 1* (Baker, 2001)
- *Site Inspection Report, Areas of Concern 1, 2, 6, 7, and 8* (CH2M HILL, 2012)

## 5.2.2 Physical Setting

AOC 1 North is approximately 0.5 acre in size, while AOC 1 South is about 1.5 acres in size; both areas are wooded. The topography of AOC 1 is characterized by the primary drainage channels located within the northern and southern subareas (AOC 1 North and AOC 1 South) (**Figures 10 and 11**). These two drainages merge west of the site, where runoff from both AOC 1 North and AOC 1 South flows approximately 1,000 feet west toward Jones Pond (**Figure 9**), a former source of potable water for CAX (Weston, 1999). Surface water is generally not observed in the AOC 1 North drainage channel; however, it is present in the AOC 1 South drainage channel.

In general, soil ranges from predominantly silt and clay at AOC 1 North to clay and sand at AOC 1 South. The first encountered groundwater underlying AOC 1 is the Cornwallis Cave aquifer at depths ranging between 4 and 32 and 4 and 28 feet bgs at AOC 1 North and AOC 1 South, respectively. Groundwater is expected to flow west toward Jones Pond, which is the nearest open-water body to AOC 1.

AOC 1 is currently a wooded area, restricted to the general public by a locked, chain-link fence; however, it is unrestricted to Navy personnel, who use Jones Pond for recreation, hiking, and fishing (Weston, 1999). Land use at AOC 1 is not expected to change in the foreseeable future.

## 5.2.3 Release History

Debris (surface and limited subsurface) including concrete, wood, metal, and empty drums at AOC 1 North and AOC 1 South are the primary known and suspected sources of PAHs and metals contamination at AOC 1 (CH2M HILL, 2012).

## 5.2.4 Distribution of Contamination

### AOC 1 North

While VOCs, PAHs, pesticides, and metals were detected in surface soil during the SI, only select PAHs, pesticides, and metals were detected in surface soil at concentrations exceeding the background 95 percent UTLs (where applicable) and either the adjusted USEPA residential RSLs or ESVs (CH2M HILL, 2012). No organic constituents and only select metals were detected in subsurface soil at concentrations exceeding the background 95 percent UTLs (where applicable) and either the adjusted USEPA residential RSLs or ESVs (CH2M HILL, 2012); however the detected metals concentrations only slightly exceeded the background 95 percent UTL indicating that their detected concentrations are not related to a CERCLA release.

The highest PAHs and metals concentrations were detected in surface soil in a localized “hot spot” area in the northeastern corner of the AOC 1 North study area (CAA01-SS04, CAA01-SS05, and CAA01-SS11 [**Figure 10**]). Therefore, additional surface soil samples from this area are needed to define the extent of PAHs and metals

contamination in this area and determine the need for further investigation or action. The low level pesticide concentrations indicate that their detections are not related to a CERCLA release.

While one VOC and total and dissolved metals were detected in groundwater during the SI, only total and dissolved metals were detected in groundwater at concentrations exceeding the base background 95 percent UTL and either the adjusted USEPA tap water RSLs or ESVs (CH2M HILL, 2012).

Elevated metals concentrations were detected in groundwater throughout the site; however, the groundwater samples were collected using DPT and may not be representative of current metals concentrations due to the effects of increased sample turbidity with DPT. Therefore, groundwater samples from permanent monitoring wells are needed to confirm the elevated metals concentrations.

### **AOC 1 South**

While VOCs, SVOCs (primarily PAHs), pesticides, and metals were detected in surface and/or subsurface soil during the SI, only select PAHs and metals were detected in surface and/or subsurface soil at concentrations exceeding the background 95 percent UTLs (where applicable) and either the adjusted USEPA residential RSLs or ESVs (CH2M HILL, 2012).

The highest PAHs and metals concentrations were detected in surface and/or subsurface soil in the vicinity of a scrap metal debris pile in the middle of the AOC 1 South study area (**Figure 11**). Therefore, additional surface and subsurface soil samples from this area are needed to define the extent of PAH and metals contamination in this area and determine the need for further investigation or action.

While one VOC, one SVOC, and total and dissolved metals were detected in groundwater during the SI, only total and dissolved metals were detected in groundwater at concentrations exceeding the base background 95 percent UTL and either the adjusted USEPA tap water RSLs or ESVs (CH2M HILL, 2012).

Elevated metals concentrations were detected in groundwater throughout the site; however, the groundwater samples were collected using DPT and may not be representative of current metals concentrations due to the effects of increased sample turbidity with DPT. Therefore, groundwater samples from permanent monitoring wells are needed to confirm the elevated metals concentrations.

## **5.2.5 Potential Migration Pathways**

The principal contaminant release and transport mechanisms from source areas include leaks and deterioration of debris materials and leaching of metals from soil to groundwater as a result of rainwater infiltration. Based on the results of the groundwater sampling conducted as part of the SI, site-related contaminants other than metals (PAHs) have not leached into the groundwater despite the several decades or more that have passed since debris placement; therefore, they are not expected to result in future impacts due to leaching. Where contaminants are exposed at the ground surface, transport could also occur through surface runoff, which is expected to flow through the drainage channels and may eventually reach Jones Pond, 1,000 feet west of the site.

## **5.2.6 Potential Exposure and Receptor Pathways**

Potential human receptors exposed to site media at AOC 1 include:

- Current and future site visitors/trespassers/recreational users/maintenance workers (surface/subsurface soil at both AOC 1 North and South and surface water and surface/subsurface sediment at AOC 1 South)
- Future construction/maintenance workers (surface/subsurface soil at both AOC 1 North and South and surface water and surface/subsurface sediment at AOC 1 South)
- Future industrial workers/residents (surface/subsurface soil and groundwater at both AOC 1 North and South)

These potential receptors may be exposed to site-related contaminants through incidental ingestion of, inhalation of particulates from, and dermal contact with site soil, and ingestion of and/or dermal contact with groundwater, surface water, and sediment.

Potential ecological receptors exposed to surface soil at AOC 1 include lower trophic level terrestrial receptors (plants and soil invertebrates). Due to the small size of areas on the site that contain debris (source areas), potential exposures to upper trophic level receptors (such as birds and mammals) are not considered significant. The lower trophic level receptors may be exposed to site-related contaminants through root uptake from the soil and/or through direct contact with the soil. There is also the potential for transport of site-related contaminants via surface flow and groundwater to nearby surface water bodies (Jones Pond and its tributaries), at which point there may be potential exposures (surface water and/or sediment) to lower trophic level aquatic receptors (plants and benthic invertebrates), as well as to upper trophic level aquatic receptors (amphibians, reptiles, fish, birds and mammals).

## 5.2.7 What are the environmental questions to be answered?

### AOC 1 North

#### **Has there been a release of hazardous constituents to AOC 1 North soil that warrants further investigation or action?**

There are 11 surface and 10 subsurface soil samples that were collected and evaluated in the SI (CH2M HILL, 2012). However, due to some site-site related surface soil screening criteria exceedances (PAHs and metals) detected in one localized “hot spot” area (CAA01-SS04, CAA01-SS05, and CAA01-SS11), as recommended in the SI, additional surface soil data are warranted in this area to supplement the existing SI data in order to define the extent of PAHs and metals (the constituent groups that exceeded the conservative screening criteria during the SI) contamination in this area and determine the need for further investigation or action and AOC 1 North. The SI did not recommend the collection of subsurface soil samples since no organic constituents and only select metals (at concentrations slightly exceeding the background 95 percent UTL) were detected at concentrations exceeding the conservative screening criteria during the SI.

#### **The following work is proposed to answer this environmental question:**

Six surface soil samples (0 to 6 inches bgs) will be collected to surround the “hot spot” area (**Figure 10**). Each surface soil sample will be analyzed for site-related contaminants (PAHs and metals) to supplement the existing surface soil data. The six surface soil samples will also be analyzed for TOC, pH, and grain size to collect physical parameter data need to complete the ERA. In addition, two of the surface soil samples (the locations were determined based on where the highest chromium concentrations were detected during the SI [**Figure 10**]) will be analyzed for hexavalent chromium in order to determine the valency of chromium concentrations in order to refine the HHRA.

#### **Has there been a release of hazardous constituents to AOC 1 North groundwater that warrants further investigation or action?**

There are three groundwater samples that were collected and evaluated in the SI (CH2M HILL, 2012). However, due to the elevated total metals concentrations, which are not likely to be representative of actual groundwater conditions due to the effects of increased sample turbidity from DPT sampling, as recommended in the SI, metals data (the only constituent group to exceed the conservative screening criteria during the SI) from permanent monitoring wells are necessary to adequately characterize potential impacts of releases and determine the need for further investigation or action at AOC 1 North.

#### **The following work is proposed to answer this environmental question:**

Five permanent groundwater monitoring wells will be installed throughout the site to collect groundwater samples for metals (total and dissolved, to account for the different human health and ecological exposure scenarios) analysis (**Figure 10**). In addition, the water levels in the monitoring wells will be gauged in order to determine the groundwater flow direction.

**Do site media pose a potentially unacceptable risk to human health and/or the environment?**

Quantitative risk assessments have not been conducted at AOC 1 North; therefore, a quantitative HHRA and ERA will need to be conducted to determine if soil and groundwater pose a potential unacceptable risk to human health and/or the environment.

**The following work is proposed to answer this environmental question:**

A baseline HHRA will be completed to determine if site contaminants potentially pose an unacceptable risk to human health. An ERA (through Step 3a) will be completed to determine if site contaminants at AOC 1 North could potentially pose an unacceptable risk to ecological receptors. Groundwater data will also be compared to Maximum Contaminant Levels (MCLs).

**Is further investigation or action (such as removal or remediation) warranted at AOC 1 North?**

The results of the sampling activities and the HHRA and ERA are needed to determine if further investigation or action is warranted at AOC 1 North.

**The following work is proposed to answer this environmental question:**

Recommendations regarding whether or not further action is warranted will be based on the results of the ESI, including the findings of the HHRAs and ERAs, exceedances of groundwater MCLs, and the expected future use of the site. The decision process used to evaluate the data and answer this question is presented on **Figure 12**. The recommended path forward for AOC 1 North will be presented in the ESI report.

**AOC 1 South**

**Has there been a release of hazardous constituents to AOC 1 South soil that warrants further investigation or action?**

There are eight existing surface and subsurface soil samples that were previously collected and evaluated in the SI (CH2M HILL, 2012). However, due to some surface and subsurface soil screening criteria exceedances observed in the vicinity of a scrap metal pile (PAHs and metals), as recommended in the SI, additional surface and subsurface soil data are warranted in this area to supplement the existing SI PAH and metals data (the constituent groups to exceed the conservative screening criteria during the SI) in order to adequately characterize potential impacts of contaminant releases and determine the need for further investigation or action at AOC 1 South.

**The following work is proposed to answer this environmental question:**

Eight surface soil samples (0 to 6 inches bgs) and eight subsurface soil samples (6 to 24 inches bgs) will be collected to surround the “hot spot” area (**Figure 11**). Each surface and subsurface soil sample will be analyzed for PAHs and metals to supplement the existing surface and subsurface soil data. In addition, the eight surface soil samples will also be analyzed for TOC, pH, and grain size to collect the physical parameter data need to complete the ERA.

**Has there been a release of hazardous constituents to AOC 1 South groundwater that warrants further investigation or action?**

There are four groundwater samples that were collected and evaluated in the SI (CH2M HILL, 2012). However, due to the elevated total metals concentrations, which are not likely to be representative of actual groundwater conditions due to the effects of increased sample turbidity from DPT sampling, as recommended in the SI, metals data (the only constituent group to exceed the conservative screening criteria during the SI) from permanent monitoring wells are necessary to adequately characterize potential impacts of releases and determine the need for further investigation or action at AOC 1 South.

**The following work is proposed to answer this environmental question:**

Five permanent groundwater monitoring wells will be installed throughout the site to collect groundwater samples for metals (total and dissolved, to account for the different human health and ecological exposure

scenarios) analysis (**Figure 11**). In addition, the water levels in the monitoring wells will be gauged in order to determine the groundwater flow direction.

**Has there been a release of hazardous constituents to AOC 1 South surface water or sediment that warrants further investigation or action?**

While there is typically standing water in the drainage channel at AOC 1 South, no surface water or sediment samples have been collected; therefore, as recommended in the SI, sediment data are needed to characterize potential impacts from site-related contaminant releases (PAHs and metals, the constituent groups to exceed the conservative screening criteria in soil during the SI) and determine the need for further investigation or action at AOC 1 South.

**The following work is proposed to answer this environmental question:**

Five co-located surface water, surface sediment (0 to 4 inches bgs), and subsurface sediment (4 to 8 inches bgs) samples will be collected from throughout the drainage channel at AOC 1 South (**Figure 11**) and analyzed for the site-related contaminants (PAHs and metals). In addition, the surface water samples will be analyzed for hardness and the sediment samples will be analyzed for TOC, pH, grain size, and acid volatile sulfide (AVS)/simultaneously extracted metals (SEM) to collect physical parameter data need to complete the ERA.

**Do site media pose a potentially unacceptable risk to human health and/or the environment?**

Quantitative risk assessments have not been conducted at AOC 1 South; therefore, a quantitative HHRA and ERA will need to be conducted to determine if soil, groundwater, surface water, and sediment pose a potential unacceptable risk to human health and/or the environment.

**The following work is proposed to answer this environmental question:**

A baseline HHRA will be completed to determine if site contaminants potentially pose an unacceptable risk to human health. An ERA (through Step 3a) will be completed to determine if site contaminants at AOC 1 South could potentially pose an unacceptable risk to ecological receptors. Groundwater data will also be compared to MCLs.

**Is further investigation or action (such as removal or remediation) warranted at AOC 1 South?**

The results of the sampling activities and the HHRA and ERA are needed to determine if further investigation or action is warranted at AOC 1 South.

**The following work is proposed to answer this environmental question:**

Recommendations regarding whether or not further action is warranted will be based on the results of the ESI, including the findings of the HHRAs and ERAs, exceedances of groundwater MCLs, and the expected future use of the site. The decision process used to evaluate the data and answer this question is presented on **Figure 12**. The recommended path forward for AOC 1 South will be presented in the ESI report.

## **5.3 AOC 6 – Ammonia Settling Pits Subarea of Penniman AOC**

The CSM for the AOC 6 ASP subarea is based on data collected as part of the SI. This CSM presents the site background and known history, physical setting, distribution of contamination, release history, potential migration pathways, and the potential exposure and receptor pathways. The CSM figure for the ASP subarea of AOC 6 is provided as **Figure 13**.

### **5.3.1 Site Background and History**

The AOC 6 ASP subarea is one of the five non-contiguous subareas of the PSLP that make up AOC 6 (**Figure 4**). The PSLP was an explosives manufacturing facility operated during WWI by the DuPont de Nemours Company on what is now CAX and adjacent properties. This facility operated as a trinitrotoluene (TNT) manufacturing plant

beginning in approximately 1916, and subsequently began loading artillery shells for the war effort in 1918. The ASP subarea is the only subarea being investigated as part of this ESI; the other four AOC 6 subareas are being evaluated as part of other projects.

The AOC 6 ASP subarea was originally identified as a potential waste source by Weston through reviews of historical aerial photographs and engineering drawings and site reconnaissance visits (Weston, 1999). While the history of the ASP subarea is unknown, Weston assumed that wastewater from an Ammonia Finishing Building was discharged through these settling pits into Penniman Lake. Currently, this subarea is wooded with remnants of what may be the Ammonia Finishing Building still onsite.

The following investigations have been conducted at the AOC 6 ASP subarea:

- *Final Site Inspection Report, Areas of Concern 1, 2, 6, 7, and 8* (Weston, 1999)
- *Final Site Inspection Narrative Report* (CH2M HILL, 2012)

### 5.3.2 Physical Setting

The AOC 6 ASP subarea is less than 1 acre in size. The topography in the vicinity of the AOC 6 ASP subarea is gently undulating with a somewhat abrupt topographic descent along the shoreline of Penniman Lake. Stormwater runoff from the site flows primarily east toward Penniman Lake. Based on the findings of the SI, in general, soil at the ASP subarea is predominantly brown silt and olive-brown clay, underlain by yellow sand. The first encountered groundwater underlying the site is the Yorktown-Eastover aquifer at a depth between 8 to 11 feet bgs. Groundwater is expected to flow to the east toward Penniman Lake, which is the nearest open-water body to the AOC 6 ASP subarea.

The AOC 6 ASP subarea is currently wooded and within the confines of CAX, where site access is restricted for the general public. However, the site is currently accessible to Navy and Department of Defense (DoD) personnel for recreational activities such as jogging, hunting, and fishing. Land use at the ASP subarea is not expected to change and will likely continue as recreational for the foreseeable future.

### 5.3.3 Distribution of Contamination

Select SVOCs, explosives, and metals were detected in surface soil and only aluminum was detected in subsurface soil during the SI at concentrations exceeding the background 95 percent UTL (where applicable) and either the adjusted USEPA residential RSLs or ESVs (CH2M HILL, 2012) in the vicinity of the former Ammonia Finishing Building. However no soil samples were collected from east and south of the Ammonia Evaporating or Ammonia Settling areas. Therefore, since no information is known about the actual ammonia processes, additional surface and subsurface soil samples from these areas are needed to determine if there has been a release of hazardous constituents that warrants further investigation or action.

No SVOCs or explosives were detected in groundwater; however, metals concentrations were detected at concentrations exceeding the base background 95 percent UTLs and either the adjusted USEPA tap water RSL, ESV, or MCL. Elevated metals concentrations were detected in groundwater throughout the site; however, the groundwater samples were collected using DPT and may not be representative of current metals concentrations due to the effects of increased sample turbidity with DPT. Therefore, groundwater samples from permanent monitoring wells are needed to confirm the elevated metals concentrations.

### 5.3.4 Release History

While the history of the AOC 6 ASP subarea and its function within the PSLP cannot be confirmed, potential releases from the ammonia settling, evaporation, and finishing processes are the primary suspected sources of potential contamination.

### 5.3.5 Potential Migration Pathways

The principal contaminant release and transport mechanisms from source areas include potential historical releases from the ammonia setting, evaporation, and finishing process and potential leaching from soil to groundwater as a result of rainwater infiltration (although constituents detected in groundwater were not

detected at concentrations that may pose risk to human health or ecological receptors). Based on the results of the groundwater sampling conducted as part of the SI, SVOCs and explosives have not leached into groundwater despite the many decades since potential releases occurred; therefore, they are not expected to impact groundwater in the future due to leaching. Where contaminants are potentially exposed at the ground surface, transport could also occur through stormwater runoff, which is expected to either infiltrate into the ground within the site boundary or flow into Penniman Lake. Any evaluation of stormwater runoff to Penniman Lake will be evaluated as part of the ongoing Penniman Lake investigation, the results of which will be submitted under a separate cover.

### 5.3.6 Potential Exposure and Receptor Pathways

Potential human receptors exposed to site soil and groundwater at the ASP subarea include:

- Current and future site visitors/trespassers/recreational users/maintenance workers (surface and subsurface soil)
- Future construction/maintenance workers (surface and subsurface soil)
- Future industrial workers/residents (surface and subsurface soil and groundwater)

These potential receptors may be exposed to site-related contaminants through incidental ingestion of, inhalation of particulates from, and dermal contact with site soil, and ingestion of and/or dermal contact with groundwater.

Potential ecological receptors exposed to surface soil at the ASP subarea include lower trophic level terrestrial receptors (primarily plants and soil invertebrates). Due to the small size of areas on the site that have the potential to contain contamination (source areas), exposures to upper trophic level receptors (such as birds and mammals) are not considered significant. The lower trophic level receptors may be exposed to site-related contaminants through root uptake from the soil and/or through direct exposure with soil. There is also the potential for transport of site-related contaminants via groundwater and surface runoff to nearby Penniman Lake, at which point there may be potential exposures to aquatic receptors; these potential exposures will not be evaluated in the ESI, as they will be addressed separately as part of the Penniman Lake investigation.

### 5.3.7 What Are The Environmental Questions To Be Answered?

The following environmental questions will be answered to complete the ESI.

#### **Has there been a release of hazardous constituents to the ASP subarea of AOC 6 soil that warrants further investigation or action?**

There were a total of six surface and subsurface soil samples that were collected and evaluated in either the SI (CH2M HILL, 2012) or the 2013 Technical Memorandum (TM) (CH2M HILL, 2013). However, due to some site-related surface or subsurface soil screening criteria exceedances and the absence of surface and subsurface soil samples east and south of the Ammonia Evaporating and Ammonia Settling areas, additional PSLP-related contaminant surface and subsurface soil data (SVOCs, explosives, and metals) are warranted in this area to supplement the SI data in order to adequately characterize potential impacts of contaminant releases and determine the need for further investigation or action at the AOC 6 ASP subarea.

#### **The following work is proposed to answer this environmental question:**

Three co-located surface (0 to 6 inches bgs) and subsurface (6 to 24 inches bgs) soil samples will be collected from the AOC 6 ASP subarea (**Figure 14**) and analyzed for the PSLP-related contaminants (SVOCs, explosives, and metals) to supplement the existing soil data. In addition, surface soil samples will be analyzed for TOC, pH, and grain size, and subsurface soil samples will be analyzed for pH to collect physical parameter data to complete the ERA.

**Has there been a release of hazardous constituents to the ASP subarea of AOC 6 groundwater that warrants further investigation or action?**

There were a total of four groundwater samples that were collected and evaluated in either the SI (CH2M HILL, 2012) or the 2013 TM (CH2M HILL, 2013). However, due to the elevated total metals concentrations, which are not likely to be representative of actual metals concentrations due to the effects of increased sample turbidity from DPT sampling, as recommended in the SI, metals (the only constituent group to exceed the conservative screening criteria during the SI) data from permanent monitoring wells are necessary to characterize impacts of potential releases and determine the need for further investigation or action at the AOC 6 ASP subarea.

**The following work is proposed to answer this environmental question:**

Five permanent groundwater monitoring wells will be installed throughout the site to collect groundwater samples for metals (total and dissolved, to account for the different human health and ecological exposure scenarios) analysis (**Figure 14**). In addition, water levels in the monitoring wells will be gauged in order to determine the groundwater flow direction.

**Do site media pose a potentially unacceptable risk to human health and/or ecological receptors?**

Quantitative risk assessments have not been conducted at the AOC 6 ASP subarea; therefore, a quantitative HHRA and ERA will need to be conducted to determine if soil and groundwater pose a potential unacceptable risk to human health and/or the environment.

**The following work is proposed to answer this environmental question:**

A baseline HHRA will be completed to determine if site contaminants potentially pose an unacceptable risk to human health. An ERA (through Step 3a) will be completed to determine if site contaminants in soil could potentially pose an unacceptable risk to ecological receptors. Groundwater data will also be compared to MCLs.

**Is further investigation or action (such as removal or remediation) warranted at the ASP subarea of AOC 6?**

The results of the sampling activities and the HHRA and ERA are needed to determine if further investigation or action is warranted at the AOC 6 ASP subarea.

**The following work is proposed to answer this environmental question:**

Recommendations regarding whether or not further action is warranted will be based on the results of the ESI, including the findings of the HHRAs and ERAs, exceedances of groundwater MCLs, and the expected future use of the site. The decision process used to evaluate the data and answer this question is presented on **Figure 15**. The recommended path forward for the ASP subarea will be presented in the ESI report.

## **5.4 AOC 7 – Drum and Can Disposal Area**

The CSM for AOC 7 is based on data collected as part of the SI. This CSM presents the site background and history, physical setting, distribution of contamination, release history, potential migration pathways, and the potential exposure and receptor pathways. The CSM figure for AOC 7 is provided as **Figure 16**.

### **5.4.1 Site Background and History**

AOC 7 consists of several small debris disposal areas containing empty 55-gallon drums (the former Drum Disposal Area) and numerous cans (the Can Pit) (**Figure 5**). In April 2004, the Navy identified this area of potential concern north of CAD Building 14 and Environmental Restoration Site 8 and named it AOC 7. The former Drum Disposal Area was a localized area where several rusty pails and two empty 55-gallon drums were found discarded on the ground surface. The Can Pit is an area that was measured to be approximately 30-by-20 feet and 4 feet deep and contained approximately forty 10-gallon rusted cans with labeling containing the word “tetrachloroethane.” With the exception of the trail created during the completion of the 2006 housekeeping effort (currently used as a hiking trail), this area is heavily vegetated with shrubs and trees.

The following action and investigations have been conducted at the AOC 6 ASP subarea:

- Housekeeping (Shaw, 2006)
- *Final Site Inspection Narrative Report* (CH2M HILL, 2012)

### 5.4.2 Physical Setting

AOC 7 is approximately 1.5 acres in size and, with the exception of the Can Pit and a pile of excavated soil beside it, is relatively flat with a gentle slope northeast towards the southern fingers of Cheatham Pond (**Figure 5**). There are no wetlands or surface water bodies located within AOC 7. Surface runoff as a result of heavy rain events is expected to flow toward the northeast to Cheatham Pond.

Based on the SI, in general, the uppermost soil within the vicinity of AOC 7 is predominantly olive and brown silt with varying degrees of sand and clay. A thin layer of organic material (0.5 foot thick) was observed between 7 and 10 feet bgs. Below this layer, olive-yellow and yellowish-brown sands were observed. The first encountered groundwater underlying AOC 7 is the Yorktown-Eastover aquifer. During the SI, groundwater was encountered at depths ranging between approximately 9 feet bgs and 20 feet bgs. Groundwater is expected to flow northwest (from the former Drum Disposal Area) and northeast (from the Can Pit) toward Cheatham Pond.

AOC 7 is currently a wooded area within the confines of CAX and access is restricted for the general public. However, Navy and DoD personnel have access to AOC 7, as it is a wooded area located along a popular hiking trail. Future land use at AOC 7 is not expected to change and will likely continue as a wooded recreational area in the foreseeable future.

### 5.4.3 Distribution of Contamination

Select PAHs and metals were detected in soil during the SI; however, this media will be addressed separately as part of an interim removal action.

No SVOCs, pesticides, or explosives were detected in groundwater during the SI. Only one VOC (ethylbenzene) and select total and dissolved metals were detected in groundwater at concentrations exceeding the base background 95 percent UTL (where applicable) and the adjusted tap water RSL, ESVs, or MCLs.

The one ethylbenzene concentration was detected to the southeast, outside the site study area. Elevated metals concentrations were detected in groundwater throughout the site; however, the groundwater samples were collected using DPT and may not be representative of current metals concentrations due to the effects of increased sample turbidity with DPT. Therefore, groundwater samples from permanent monitoring wells are needed to confirm the elevated metals concentrations.

### 5.4.4 Release History

Empty surface drums at the former Drum Disposal Area and metal cans within the Can Pit (rusted cans and metal shards) are the primary known and suspected sources of metals contamination at AOC 7. Buried material (such as empty glass bottles) within the Can Pit may also be a source of contamination. However, the origin of the low levels of ethylbenzene detected in AOC 7 groundwater is unknown.

### 5.4.5 Potential Migration Pathways

The principal contaminant release and transport mechanisms from source areas include leaks and deterioration of surface and subsurface debris materials and leaching of metals from soil to groundwater as a result of rainwater infiltration.

### 5.4.6 Potential Exposure and Receptor Pathways

Potential human receptors exposed to site groundwater at AOC 7 include:

- Future industrial workers
- Future residents
- Future construction workers

These potential receptors may be exposed to site-related contaminants through ingestion of groundwater, and inhalation and dermal contact with the groundwater while bathing/showering.

There is the potential for groundwater transport of site-related contaminants to Cheatham Pond, at which point there may be potential exposures to aquatic receptors.

#### **5.4.7 What are the environmental questions to be answered?**

The following environmental questions will be answered to complete the ESI. Soil data from previous investigations will not be evaluated, as they will be addressed separately as part of an interim removal action.

##### **Has there been a release of hazardous constituents to AOC 7 groundwater that warrants further investigation or action?**

There were four groundwater samples that were previously collected and evaluated in the SI (CH2M HILL, 2012). However, due to the detected VOC and elevated metals concentrations (which are not likely to be representative of actual groundwater due to the effects of increased sample turbidity with DPT sampling), as recommended in the SI, VOCs and metals (the constituent groups to exceed the conservative screening criteria during the SI) data from permanent monitoring wells are necessary to characterize potential impacts of releases and determine the need for further investigation or action at the AOC 7.

##### **The following work is proposed to answer this environmental question:**

Five permanent groundwater monitoring wells will be installed throughout the site to collect groundwater samples for VOCs and metals (total and dissolved, to account for the different human health and ecological exposure scenarios) analysis (**Figure 17**). In addition, water levels in the monitoring wells will be gauged in order to determine the groundwater flow direction.

##### **Do site media pose a potentially unacceptable risk to human health and/or ecological receptors?**

Quantitative risk assessments have not been conducted at the AOC 7; therefore, a quantitative HHRA and ERA will need to be conducted to determine if groundwater poses a potential unacceptable risk to human health and/or the environment.

##### **The following work is proposed to answer this environmental question:**

A baseline HHRA will be completed to determine if site contaminants in groundwater potentially pose an unacceptable risk to human health. Although ecological receptors do not typically have direct exposure to groundwater, the proposed groundwater data will be used in the ERA (through Step 3a) in order to provide a conservative evaluation of potential ecological risks should contaminated groundwater discharge to nearby surface water bodies. Groundwater data will also be compared to MCLs.

##### **Is further investigation or action (such as removal or remediation) warranted at AOC 7?**

The results of the sampling activities and the HHRA and ERA are needed to determine if further investigation or action is warranted at AOC 7.

##### **The following work is proposed to answer this environmental question:**

Recommendations regarding whether or not further action is warranted will be based on the results of the ESI, including the findings of the HHRAs and ERAs, exceedances of groundwater MCLs, and the expected future use of the site. The decision process used to evaluate the data and answer this question is presented on **Figure 18**. The recommended path forward for groundwater at AOC 7 will be presented in the ESI report.

## 6 Data Quality Objectives/Systematic Planning Process Statements

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

### 6.1 Project Statement and Objectives

The objective of the ESIs are to collect additional data to supplement the current Site 9, AOC 1, AOC 6 ASP subarea, and AOC 7 SI datasets to characterize potential impacts of contaminant releases, determine the need for further investigation or action, and evaluate potential risks to human health and ecological receptors at each site. Field activities will include collecting additional soil, groundwater, surface water, and/or sediment samples, depending on the site. The following data will be evaluated as part of the site-specific ESIs and will be used to support site-specific HHRAs and ERAs:

- Site 9 – Surface soil, subsurface soil, and groundwater data evaluated during the SI, and surface soil and surface and subsurface drainage ditch soil collected as part of the ESI (although no additional groundwater data are being collected, because only a semi-quantitative risk evaluation was previously conducted, the existing SI groundwater data will be re-evaluated in the ESI risk assessments). Data previously collected from the drainage ditch across B Street during the SI will not be evaluated because soil in and around the drainage ditch was reworked/excavated during utility installation activities along B Street; therefore, the earlier sample results are not representative of current site conditions.
- AOC 1 North – Surface and subsurface soil data evaluated during the SI, and surface soil and groundwater data collected as part of the ESI. Groundwater data collected during the SI will not be evaluated in the ESI because these samples were collected from temporary well points using DPT and may not be representative of actual groundwater conditions due to the effects of increased sample turbidity and aquifer disturbance from DPT sampling.
- AOC 1 South – Surface and subsurface soil data evaluated during the SI, and surface soil, subsurface soil, surface water, sediment (surface and subsurface), and groundwater data collected as part of the ESI. Groundwater data collected during the SI will not be evaluated in the ESI because these samples were collected from temporary well points using DPT and may not be representative of actual groundwater conditions due to the effects of increased sample turbidity and aquifer disturbance from DPT sampling.
- AOC 6, ASP subarea – Surface and subsurface soil evaluated during the SI and 2013 TM, and surface soil, subsurface soil, and groundwater data collected as part of the ESI (groundwater will not be evaluated in the ERA; this pathway will be included in the Penniman Lake investigation). Groundwater data collected during the SI and for the 2013 TM will not be evaluated in the ESI because these samples were collected from temporary well points using DPT and may not be representative of actual groundwater conditions due to the effects of increased sample turbidity and aquifer disturbance from DPT sampling.
- AOC 7 – Groundwater data collected as part of the ESI. Groundwater data collected during the SI will not be evaluated in the ESI because these samples were collected from temporary well points using DPT and may not be representative of actual groundwater conditions due to the effects of increased sample turbidity and aquifer disturbance from DPT sampling. Soil data from the SI will also not be evaluated, as soil at AOC 7 will be addressed separately as part of an interim removal action.

#### 6.1.1 Data Quality Objectives

Quantifiable analytical results will be the primary basis for project decisions. The limit of quantitation (LOQ), which is defined as the minimum concentration or quantity of a target analyte that can be reported with accurate quantitation, will be the metric to define whether an analytical result is quantifiable.

If an analyte is undetected or if any detected analytes are below the Project Action Limits (PALs), then it will be assumed that the nature and concentrations of these constituents do not pose an unacceptable risk and no further action for them will be necessary.

If the analytical results of samples determine that analytes are detected above the project-specific PALs, then a quantitative HHRA and ERA will be conducted to identify COPCs as follows:

### **Human Health Risk Decision Logic**

As applicable, the results of the ESI soil sampling will be combined with the earlier soil sample data evaluated in the SI to determine if there may be unacceptable risks to potential human receptors:

- Soil concentrations will be compared to the adjusted USEPA residential soil RSLs (adjusted meaning that RSLs based on non-noncarcinogenic effects are divided by 10 to account for exposure to more than one constituent that affects the same target organ; RSLs based on carcinogenic endpoints are not adjusted). If the maximum detected concentration of a constituent exceeds the applicable RSL, the constituent will be identified as a COPC.
- Human health risks will be evaluated for exposure to the COPCs identified in soil for all potential human receptors (such as current visitors/trespassers and maintenance worker and future visitors/trespassers, maintenance/industrial workers, residents, and construction workers). The 95 percent upper confidence limit (UCL) of the mean soil concentration will be used as the exposure concentration for the risk calculations. If all risks are within acceptable USEPA risk levels, no further action/assessment based on human health will be required for soil.
- If potentially unacceptable risks are identified associated with metals, the metals data will be compared to the base background 95 percent UTLs (CH2M HILL, 2011b) to determine if the risks are associated with the site or background conditions. If all risks are associated with background conditions, no further action/assessment based on human health will be required for soil. If risks are not associated with background conditions, the constituent will be identified as an initial constituent of concern (COC) and recommendations for additional investigation and/or action will be made in the ESI report.

Results of the ESI groundwater sampling (or the SI groundwater sampling in the case of Site 9) will be evaluated to determine if there may be unacceptable risks to potential human receptors:

- Groundwater concentrations from monitoring well samples will be compared to the adjusted tap water RSLs (adjusted meaning that RSLs based on non-noncarcinogenic effects are divided by 10 to account for exposure to more than one constituent that affects the same target organ; RSLs based on carcinogenic endpoints are not adjusted). If the maximum detected concentration of a constituent exceeds the applicable RSL, the constituent will be identified as a COPC.
- Human health risks will be evaluated for exposure to the COPCs identified in groundwater for future industrial workers, residents, and construction workers. The 95 percent UCL of the mean groundwater concentration from the wells located within the most contaminated portion of the groundwater plume (if a plume is identified) will be used as the exposure concentration for the risk calculations. If all risks are within acceptable USEPA risk levels, no further action/assessment based on human health will be required for groundwater.
- If potentially unacceptable risks are identified associated with metals, the metals data will be compared to the base background 95 percent UTLs to determine if the risks are associated with the site or background conditions. If all risks are associated with background conditions, no further action/assessment based on human health will be required for groundwater. If risks are not associated with background conditions, the constituent will be identified as an initial COC and recommendations for additional investigation and/or action will be made in the ESI report.

Results of the ESI sediment sampling at AOC 1 South will be evaluated to determine if there may be unacceptable risks to potential human receptors:

- Analyte concentrations from ESI sediment sample data will be compared to 10 times the adjusted residential soil RSLs (adjusted meaning that RSLs based on non-noncarcinogenic effects are divided by 10 to account for exposure to more than one constituent that affects the same target organ; RSLs based on carcinogenic endpoints are not adjusted). If the maximum detected concentration of a constituent exceeds the applicable RSL, the constituent will be identified as a COPC.
- If a constituent is identified as a COPC, human health risks will be evaluated for exposure to the COPCs identified in sediment for current/future trespassers/visitors/recreational users/maintenance workers, and future construction workers. The 95 percent UCL of the mean sediment concentration will be used as the exposure concentration for the risk calculations. If all risks are within acceptable USEPA risk levels, no further action/assessment based on human health will be required for sediment. If the risks are greater than acceptable USEPA risk levels, the constituent will be identified as an initial COC and recommendations for additional investigation and/or action will be made in the ESI report.

Results of the surface water sample data at AOC 1 South will be used to determine if there may be unacceptable risks to potential human receptors:

- Contaminant concentrations from the ESI surface water sample data will be compared to 10 times the adjusted tap water RSLs (adjusted meaning that RSLs based on non-noncarcinogenic effects are divided by 10 to account for exposure to more than one constituent that affects the same target organ; RSLs based on carcinogenic endpoints are not adjusted). If the maximum detected concentration of a constituent exceeds the applicable RSL, the constituent will be identified as a COPC.
- If a constituent is identified as a COPC, human health risks will be evaluated for exposure to the COPCs identified in surface water for current/future trespassers/visitors/recreational users/maintenance workers, and future construction workers. The 95 percent UCL of the mean surface water concentration will be used as the exposure concentration for the risk calculations. If all risks are within acceptable USEPA risk levels, no further action/assessment based on human health will be required for surface water. If the risks are greater than acceptable USEPA risk levels, the constituent will be identified as an initial COC and recommendations for additional investigation and/or action will be made in the ESI report.

### **Ecological Risk Decision Logic**

As applicable, the results of the ESI soil sampling will be combined with the earlier soil sample data evaluated in the SI to determine if potential risks to terrestrial receptors may be occurring:

- Soil constituent concentrations from each site sample (with a sample depth less than 24 inches bgs) will be compared to literature-based soil screening values for plants and/or soil invertebrates (surface [0 to 6 inches bgs] and shallow subsurface [6 to 24 inches bgs] data will be screened separately). Initial (Step 2) COPCs will include all constituents with a maximum hazard quotient (HQ) exceeding 1 based upon a detected concentration and all detected constituents lacking screening values. Mean soil concentrations will also be compared with soil screening values (samples may be partitioned by spatial area when calculating means). If mean concentrations exceed soil screening values, then the contaminant will be considered a refined (Step 3a) COPC. If it is below the soil screening values, the constituent will not generally be considered a COPC (the magnitude of the maximum HQ and the exceedance frequency will also be considered when making this determination) and no further action will be necessary for that constituent.
- If the ERA (through Step 3a) identifies soil COPCs, the COPC concentrations will be compared to the base soil background 95 percent UTLs (if available) to determine if the detected concentrations are consistent with the base background concentrations. If all potential risks are associated with background conditions, no further action/assessment based on ecological receptors will be required for soil. If risks are not associated with base

background conditions, the constituent will be identified as a Step 3a COPC and recommendations for additional investigation and/or action will be made in the ESI report.

Results of the AOC 1 and AOC 7 ESI groundwater sampling, and the Site 9 2009 SI groundwater sampling, will be evaluated as follows to provide a conservative evaluation of the potential for significant contaminant transport via groundwater to nearby surface water bodies:

- Groundwater concentrations from each site sample will be compared to literature-based freshwater surface water screening values and BTAG Region III freshwater screening values. Initial (Step 2) COPCs will include all constituents with a maximum HQ exceeding 1 based upon a detected concentration and all detected constituents lacking screening values. For metals, COPC selection will be based upon the results from filtered samples. Mean groundwater concentrations will also be compared with surface water screening values (samples may be partitioned by spatial area when calculating means). If mean concentrations exceed screening values, then the constituent will be considered a refined (Step 3a) COPC. If it is below the screening values, the constituent will not generally be considered a COPC (the magnitude of the maximum HQ and the exceedance frequency will also be considered when making this determination) and no further action will be necessary for that constituent. Dilution factors may also be considered during the refined (Step 3a) assessment.
- If the ERA identifies groundwater COPCs, the COPC concentrations will be compared to the base groundwater background 95 percent UTLs (if available) to determine if the detected concentrations are consistent with the base background concentrations. If all potential risks are associated with background conditions, no further action/assessment based on ecological receptors will be required for groundwater. If risks are not associated with base background conditions, the constituent will be identified as a Step 3a COPC and recommendations for additional investigation and/or action will be made in the ESI report.

Results of the surface water and sediment analytical sampling at AOC 1 South will be evaluated as follows to determine if potential risks to aquatic receptors may be occurring:

- Concentrations from each site sediment sample will be compared to literature-based freshwater sediment screening values and BTAG Region III freshwater sediment screening values. Initial (Step 2) COPCs will include all constituents with a maximum HQ exceeding 1 based upon a detected concentration and all detected constituents lacking screening values. Mean sediment concentrations will also be compared with screening values (samples may be partitioned by spatial area when calculating means). If the mean concentration exceeds screening values, and the maximum concentration exceeds reference concentrations (if available), then the constituent will be considered a refined (Step 3a) COPC. If it is below the screening value, the constituent will not generally be considered a COPC (the magnitude of the maximum HQ and the exceedance frequency will also be considered when making this determination) and no further action will be necessary for that constituent.
- Concentrations from each site surface water sample will be compared to literature-based freshwater screening values and BTAG Region III freshwater screening values. Initial (Step 2) COPCs will include all constituents with a maximum HQ exceeding 1 based upon a detected concentration and all detected constituents lacking screening values. For metals, COPC selection will be based upon the results from filtered samples. Mean surface water concentrations will also be compared with screening values (samples may be partitioned by spatial area when calculating means). If the mean concentration exceeds screening values, and the maximum concentration exceeds reference concentrations (if available), then the constituent will be considered a refined (Step 3a) COPC. If it is below the screening value, the constituent will not generally be considered a COPC (the magnitude of the maximum HQ and the exceedance frequency will also be considered when making this determination) and no further action will be necessary for that constituent.

## 6.2 Project Action Limits

PALs are media-specific standards and criteria chosen for evaluation to help provide a conservative assessment of site conditions and determine if action is needed to address concentrations of chemicals present at the site. The detected data will be compared to the lower value of the following PALs to identify COPCs (PAL values are included in **Section 10**):

- **Surface Soil:** USEPA Adjusted Residential Soil RSLs and literature-based ESVs for plants and soil invertebrates.
- **Subsurface Soil:** USEPA Adjusted Residential Soil RSLs and literature-based ESVs for plants and soil invertebrates (if sample collected less than 2 feet bgs).
- **Groundwater:** USEPA Adjusted Tap Water RSLs, federal MCLs, literature-based fresh surface water screening values (for Site 9, AOC 1 North, and AOC 7, to conservatively evaluate potential risks to ecological receptors from groundwater discharge to surface water), and Region III BTAG freshwater screening values.
- **Sediment:** USEPA Adjusted Residential Soil RSLs multiplied by 10 to adjust soil RSL to sediment, literature-based freshwater ESVs, and Region III BTAG freshwater sediment screening values.
- **Surface Water:** USEPA Adjusted Tap Water RSLs multiplied by 10, literature-based freshwater ESVs, and Region III BTAG freshwater screening values.

A quantitative HHRA (conducted in accordance with USEPA guidance and as previously described) and an ERA (through Step 3a) will be conducted to identify the initial human health COCs and ecological COPCs for each medium.

Specific PAL values and laboratory detection and quantitation limits (QLs) are included in the Reference Limits and Evaluation Tables (**Section 10**).

### 6.2.1 How will the data be used?

The lithologic data will be used to identify the aquifer encountered and potential geotechnical properties of soils. Groundwater data (such as static water-level data) will be used to determine the general groundwater conditions, including depth-to-water, rate of groundwater flow, and directions of groundwater flow. This information will be incorporated into the CSM for each site.

The soil and groundwater chemical data will be used to characterize potential impacts of contaminant releases, to assess potential human health and ecological risks at each site, and determine the need for further investigation or action, as applicable. The HHRAs will estimate the likelihood of adverse impacts to current and potential future users of the sites. The ERAs will estimate the likelihood of potential risks to ecological receptors at the sites and the potential for ecologically significant transport of site-related constituents to nearby surface water bodies (where applicable).

Wet chemistry soil data (TOC, pH, and grain size) and sediment data (TOC, pH, grain size, and AVS/SEM) will be collected for physical parameter data needed to complete the ERA; water hardness will also be measured in surface water samples (as will water depth and standard field parameters, such as water temperature) to have physical parameter data needed to complete the ERA.

### 6.2.2 What types of data are needed?

**Section 8.1** contains detailed information on the types of data needed for this project, including sample locations and sample depth intervals. In general, soil, groundwater, sediment, and surface water sample analytical data are required on a site-specific basis to characterize potential impacts of contaminant releases, to complete the HHRAs and ERAs, and to determine the need for further investigation. All analytical samples will be submitted to an offsite subcontracted laboratory for analysis. Refer to **Section 8.1** and **Section 9** for sample locations, numbers, rationale, and methodology. Sample locations are provided on **Figures 7, 10, 11, 14, and 17**.

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

The data will be used in HHRAs and ERAs to make further investigation/action decisions; therefore, the DV will qualify data according to the Measurement Performance Criteria (MPC) outlined in **Section 7.1** for field QC samples and the Laboratory QC Samples Table in **Section 10** for laboratory QC samples. These MPC are consistent with the DoD Quality Systems Manual (QSM), as applicable, and laboratory in-house limits where the QSM does not apply.

The data collected from each site will be validated by CH2M HILL. This process is outlined in **Section 6.2.5**.

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

Detailed information on where, when, and how the data will be collected is provided in **Section 9**. Data generated at the subcontract laboratory (or laboratories) will be reported in a data package equivalent to a USEPA Contract Laboratory Program Level IV deliverable. This data package includes a case narrative, all field sample results, QC forms, and raw data. An electronic data deliverable will also be required.

### 6.2.5 How will the data be evaluated?

Data will undergo an evaluation for quality and completeness at the laboratory and will be validated by CH2M HILL. Specific verification and validation steps are detailed in **Table 13-1, Data Verification and Validation (Steps I and IIa/IIb) Process Table (Section 13)**. In general:

- Deviations from the SAP will be reviewed to assess whether CA is warranted and to assess impacts to the achievement of project objectives.
- To assess whether sufficient quantities of acceptable data are available for decision-making, the data will be reconciled with MPC following validation and review of data quality indicators (DQIs).
- For field duplicate sample results, the most conservative value will be used for project decisions.
- Field and laboratory precision will be compared as Relative Percent Difference (RPD) between the two results.
- For statistical calculations in the ERAs, non-detect values will be represented by a concentration equal to one-half the sample reporting limit (RL).

### 6.2.6 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 CAX Partnering Team who, as a whole, will evaluate the data usability according to project objectives. Any qualifications made to the data during data validation will be included for consideration; possible qualifications that may be applied to the data during validation are as follows:

- When major QC deficiencies are encountered, data will be qualified with an R, and in most cases considered not 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 ESI report. The R-qualifier is defined as follows:
  - R = Rejected result. Result not reliable.
- For minor QC deficiencies that will not affect the usability of the data, data may be qualified as estimated with the following qualifiers: J, UJ, K, L, or UL. These qualifiers are defined as follows:
  - J = Analyte present. Reported value may or may not be accurate or precise.
  - UJ = Analyte not detected. QL may be inaccurate or imprecise.
  - K = Analyte present. 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.

- Additional qualifiers that may be applied to data by the DV are:
  - B = Not detected substantially above the level reported in laboratory or field blanks. This detection is attributed to blank contamination and is to be treated as a non-detect.
  - N = Tentative identification (ID). The analyte is considered present, though special methods may be needed to confirm its presence or absence in future sampling efforts.
  - NJ = Qualitative ID is questionable due to poor resolution. Presumptively present at approximate quantity.
  - U = Not detected.

Data usability will be documented in data tables and discussed in the data quality evaluation, both of which will be provided as part of the ESI reports. Data tables will reflect the reported concentration of analytes, whether the analyte was detected, and what, if any, data qualifiers accompany the result. The data quality evaluation will discuss the use of specific data qualifiers and their impact on decision-making, the overall quality of the data set, and any data usability limitations determined by the CAX Partnering Team.

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# 7 Field Quality Control Samples

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

## 7.1 Field Quality Control Samples

Field QC samples will be collected to assist in evaluating whether the results reported from the field effort meet the precision, accuracy, and representativeness requirements for this project. Presented in **Tables 7-1 through 7-5** as follows are details about the frequency at which each QC sample will be collected, what constitutes acceptable field QC results, and what aspect of data quality is indicated by the outcome of each QC sample.

TABLE 7-1  
 Measurement Performance Criteria Table for Field QC Samples

Matrix: Groundwater  
 Analytical Group: VOCs  
 Concentration Level: Medium

QC Sample	Analytical Group	Frequency	DQIs	MPC
Trip Blank	VOCs	1 per cooler sent to laboratory	Bias/Contamination	No target analytes detected > 1/2 LOQ
Equipment Blank		1 per day of sampling for decontaminated equipment, 1 per lot of disposable equipment	Bias/Contamination	
Field Duplicate		1 per 10 field samples of similar matrix	Precision	RPD ≤ 30%
Cooler Temperature Indicator		1 per cooler sent to laboratory	Representativeness	Temperature ≤ 6 degrees Celsius (°C)

TABLE 7-2  
 Measurement Performance Criteria Table for Field QC Samples

Matrix: Surface Soil, Subsurface Soil, Composite Soil, Groundwater, Surface Sediment, Subsurface Sediment, or Surface Water  
 Analytical Group: SVOCs, PAHs, Pesticides, PCBs, or Explosives  
 Concentration Level: Low/Medium

QC Sample	Analytical Group	Frequency	DQIs	MPC
Field Duplicate	SVOCs, PAHs, Pesticides, PCBs, or Explosives	1 per 10 field samples of similar matrix <sup>1</sup>	Precision	RPD ≤ 30%
Equipment Blank		1 per day of sampling for decontaminated equipment, 1 per lot of disposable equipment	Bias/Contamination	No target analytes detected > 1/2 LOQ
Cooler Temperature Indicator		1 per cooler to the laboratory	Representativeness	Temperature ≤ 6°C

Notes:

<sup>1</sup> Separate field duplicates will be collected for all media, except surface soil and composite soil will be considered "similar matrix."

TABLE 7-3  
 Measurement Performance Criteria Table for Field QC Samples

Matrix: Surface Soil, Subsurface Soil, Composite Soil, Groundwater, Surface Sediment, Subsurface Sediment, or Surface Water  
 Analytical Group: Total Metals, Dissolved Metals, Cyanide, or Hexavalent Chromium  
 Concentration Level: Medium/Low

QC Sample	Analytical Group	Frequency	DQIs	MPC
Field Duplicate	Total Metals, Dissolved Metals, Cyanide, or Hexavalent Chromium	1 per 10 field samples of similar matrix <sup>1</sup>	Precision	RPD ≤ 20%
Equipment Blank		1 per day of sampling for decontaminated equipment, 1 per lot of disposable equipment	Bias/Contamination	No target analytes detected > 1/2 LOQ
Cooler Temperature Indicator		1 per cooler to the laboratory	Representativeness	Temperature ≤ 6°C

Notes:

<sup>1</sup> Separate field duplicates will be collected for all media, except surface soil and composite soil will be considered "similar matrix."

TABLE 7-4  
 Measurement Performance Criteria Table for Field QC Samples

Matrix: Surface Soil, Subsurface Soil, Composite Soil, Groundwater, Surface Sediment, Subsurface Sediment, or Surface Water  
 Analytical Group: Wet Chemistry, or AVS/SEM  
 Concentration Level: Low/Medium

QC Sample	Analytical Group	Frequency	DQIs	MPC
Cooler Temperature Indicator	Wet Chemistry, AVS/SEM	1 per cooler to the laboratory	Representativeness	Temperature ≤ 6°C

TABLE 7-5  
 Measurement Performance Criteria Table for Field QC Samples

Matrix: Surface Soil, Subsurface Soil, Surface Sediment, Subsurface Sediment  
 Analytical Group: Grain size  
 Concentration Level: Not applicable (N/A)

QC Sample	Analytical Group	Frequency	DQIs	MPC
None				

## 8 Sampling Design and Rationale

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

### 8.1 Sampling Design and Rationale

The CAX Partnering Team met to scope the investigations outlined in **Section 4**. During these meetings, the Team discussed and agreed to the proposed sampling rationale for Site 9, AOC 1, AOC 6 ASP subarea, and AOC 7.

**Figures 7, 10, 11, 14, and 17** present the proposed sample locations for each site and medium to be evaluated, including the proposed soil sample and monitoring wells locations. Exact sample locations will ultimately be field-determined based on actual site conditions at the time of the field effort, but will be in close proximity to the proposed sample locations.

The proposed sampling schemes and associated rationale for Site 9, AOC 1, AOC 6, ASP subarea, and AOC 7 are included in **Table 8-1**.

QC samples will be collected as described in **Section 7.1**.

Analytical methods to be employed by the laboratory for each analyte and their respective PALs are listed in **Section 10**.

**Section 9** provides a detailed outline of the field methods to be performed.

TABLE 8-1  
 Proposed Sampling Design and Rationale

Site	Media	Sample Count	Analysis	Rationale
Site 9	Surface Soil	3	PAHs, Aroclor-1260, metals, TOC, pH, and grain size	Collected to characterize potential impacts of contaminant releases (those constituent groups with one or more analyte exceeding the conservative screening criteria in the SI) from the vicinity of SI Sample SS02 and determine the need for further investigation or action (no samples were previously collected from the north, east, and west of this sample; therefore, there is a spatial data gap in this area). These data will also be used to evaluate potential risks to human health and ecological receptors.
	Surface Drainage Ditch Soil	6	PAHs, Aroclor-1260, pesticides, metals, TOC, pH, and grain size	Collected to characterize potential impacts of contaminant releases (those constituent groups with one or more analyte exceeding the conservative screening criteria in the SI) in current soil, along the alignment of the former drainage ditch area across B Street from the site, to determine the need for further investigation or action (contamination was identified in the drainage ditch; however, during utility installation activities in 2010, the drainage ditch was eliminated and no current data exists from this area; therefore, there is a spatial data gap in this area). Samples will be collected in the vicinity of, upgradient of, and downgradient of the drainage ditch samples collected during the SI. These data will also be used to evaluate potential risks to human health and ecological receptors.
		2	Hexavalent chromium	Collected to determine the valence state of chromium concentrations within the former drainage ditch surface soil in order to refine the HHRA. Will be used with total chromium concentrations to calculate a ratio of hexavalent chromium to total chromium that will then be applied to the rest of the samples from the site.
		4	PAHs, Aroclor-1260, pesticides, and metals	Five-point composite samples collected to help determine if contamination, previously identified within the former drainage ditch, ended up outside the footprint of the former drainage ditch, during utility installation activities in 2010 (no information is available confirming exactly where former drainage ditch soil currently exists; therefore, there is an uncertainty in this area). Samples will be collected from the area of the SI drainage ditch sampling activities, and the farthest upgradient area where runoff from Site 9 could have entered the former drainage ditch.
	Subsurface Drainage Ditch Soil	6	PAHs, Aroclor-1260, pesticides, metals, TOC, pH, and grain size	Collected to characterize potential impacts of contaminant releases (those constituent groups with one or more analyte exceeding the conservative screening criteria in the SI) in current soil, along the alignment of the former drainage ditch area across B Street from the site, to determine the need for further investigation or action (contamination was identified in the drainage ditch; however during utility installation activities in 2010, the drainage ditch was eliminated and no current data exists from this area; therefore, there is a spatial data gap in this area). Samples will be collected in the vicinity of, upgradient of, and downgradient of the drainage ditch samples collected during the SI. These data will also be used to evaluate potential risks to human health and ecological receptors.
		2	Hexavalent chromium	Collected to determine the valence state of chromium concentrations within the former drainage ditch subsurface soil in order to refine the HHRA. Will be used with total chromium concentrations to calculate a ratio of hexavalent chromium to total chromium that will then be applied to the rest of the samples from the site.

TABLE 8-1  
 Proposed Sampling Design and Rationale

Site	Media	Sample Count	Analysis	Rationale
AOC 1 North	Surface Soil	6	PAHs, metals, TOC, pH, and grain size	As recommended in the SI, collected to define the extent of PAH and metals contamination in the vicinity of the SI surface soil “hotspot” area to determine the need for further investigation or action (only one sample was previously collected from the vicinity of this “hotspot” area; therefore, additional samples surrounding the area are needed to determine the extent of contamination). These data will also be used to evaluate potential risks to human health and ecological receptors.
		2 (of the 6 listed above)	Hexavalent chromium	Collected to determine the valence state of chromium concentrations detected during the SI in order to refine the HHRA. Will be used with total chromium concentrations to calculate a ratio of hexavalent chromium to total chromium that will then be applied to the rest of the samples from the site.
	Groundwater	5	Total and dissolved metals	As recommended in the SI, collected to characterize potential impacts of contaminant releases to the groundwater throughout the site (metals data from permanent monitoring wells have not been collected; therefore, there is a data gap at the site). Five samples will be collected so statistical analyses could be completed during an evaluation of potential risks to human health (total and dissolved metals depending on the potential receptor) and a conservative evaluation of potential ecological risks (dissolved metals; should contaminated groundwater discharge to nearby surface water bodies).
AOC 1 South	Surface Soil	8	PAHs, metals, TOC, pH, and grain size	As recommended in the SI, collected to define the extent of PAH and metals contamination in the vicinity of the scrap metal debris pile to determine the need for further investigation or action (few samples were previously collected from the vicinity of this scrap metal pile therefore, additional samples surrounding the area are needed to determine the extent of contamination). These data will also be used to evaluate potential risks to human health and ecological receptors.
	Subsurface Soil	8	PAHs, metals, and pH	As recommended in the SI, collected to define the extent of PAH and metals contamination in the vicinity of the scrap metal debris pile to determine the need for further investigation or action (few samples were previously collected from the vicinity of this scrap metal pile therefore, additional samples surrounding the area are needed to determine the extent of contamination). These data will also be used to evaluate potential risks to human health and ecological receptors.
	Groundwater	5	Total and dissolved metals	As recommended in the SI, collected to characterize potential impacts of contaminant releases to the groundwater throughout the site (metals data from permanent monitoring wells have not been collected; therefore, there is a data gap at the site). Five samples will be collected so statistical analyses could be completed during an evaluation of potential risks to human health (total and dissolved metals depending on the potential receptor).
	Surface Sediment	5	PAHs, metals, TOC, pH, grain size, and AVS/SEM	As recommended in the SI, collected to characterize potential impacts of site-related contaminant releases to the surface sediment throughout the drainage ditch at the site (no samples were previously collected from the drainage ditch; therefore, this is a data gap). These data will also be used to evaluate potential risks to human health and ecological receptors.

TABLE 8-1  
 Proposed Sampling Design and Rationale

Site	Media	Sample Count	Analysis	Rationale
AOC 1 South (cont.)	Subsurface Sediment	5	PAHs, metals, TOC, pH, and grain size	As recommended in the SI, collected to characterize potential impacts of site-related contaminant releases to the subsurface sediment throughout the drainage ditch at the site (no samples were previously collected from the drainage ditch; therefore, this is a data gap). These data will also be used to evaluate potential risks to human health and ecological receptors.
	Surface Water	5	PAHs, total and dissolved metals, and hardness	As recommended in the SI, collected to characterize potential impacts of site-related contaminant releases to the surface water throughout the drainage ditch at the site (no samples were previously collected from the drainage ditch; therefore, this is a data gap). These data will also be used to evaluate potential risks to human health and ecological receptors.
AOC 6, ASP subarea	Surface Soil	3	SVOCs, explosives, metals, TOC, pH, and grain size	Due to the uncertainty of the ammonia settling process and the absence of soil samples in the vicinity of the Ammonia Evaporating and Ammonia Settling areas, collected to characterize potential impacts of contaminant releases from the vicinity of the Ammonia Evaporating and Ammonia Settling Areas to determine the need for further investigation or action (no samples were previously collected from this area; therefore, there is a spatial data gap in this area). These data will also be used to evaluate potential risks to human health and ecological receptors.
	Subsurface Soil	3	SVOCs, explosives, metals, and, pH	Due to the uncertainty of the ammonia settling process and the absence of soil samples in the vicinity of the Ammonia Evaporating and Ammonia Settling areas, collected to characterize potential impacts of contaminant releases from the vicinity of the Ammonia Evaporating and Ammonia Settling Areas to determine the need for further investigation or action (no samples were previously collected from this area; therefore, there is a spatial data gap in this area). These data will also be used to evaluate potential risks to human health and ecological receptors.
	Groundwater	5	Total and dissolved metals	As recommended in the SI, collected to characterize potential impacts of contaminant releases to the groundwater throughout the site (metals data from permanent monitoring wells have not been collected; therefore, there is a data gap at the site). Five samples will be collected so statistical analyses could be completed during an evaluation of potential risks to human health (total and dissolved metals depending on the potential receptor).
AOC 7	Groundwater	5	VOCs and total and dissolved metals	As recommended in the SI, collected to characterize potential impacts of contaminant releases to the groundwater throughout the site (VOCs and metals data from permanent monitoring wells have not been collected; therefore, there is a data gap at the site). Five samples will be collected so statistical analyses could be completed during an evaluation of potential risks to human health (total and dissolved metals depending on the potential receptor) and a conservative evaluation of potential ecological risks (dissolved metals; should contaminated groundwater discharge to nearby surface water bodies).

## 9 Field Project Implementation

### 9.1 Field Project Tasks

The following sections provide a summary of field activities.

#### 9.1.1 Project Logistics

Prior to mobilization, NAVFAC Mid-Atlantic, USEPA, and VDEQ will be notified to allow for appropriate oversight and coordination. In addition, CH2M HILL will procure the following subcontractors to support investigation activities:

- Analytical laboratories
- Utility Locator
- Drillers (including vegetation clearing)
- Investigation-derived waste (IDW) handler

In general, work will be performed in Level D personal protective equipment (PPE), which includes hard hat, safety glasses, safety-toed boots, hearing protection, and impermeable gloves. The criteria for upgrades to higher levels of PPE will be presented in the Health and Safety Plan (HASP), which will be prepared as part of mobilization efforts and available to all field personnel during field activities. In addition, a photoionization detector (PID) will be used for monitoring sample locations for VOCs in the breathing zone as a health and safety precaution, which will be discussed in the HASP.

All field activities will be conducted during normal working hours unless requested otherwise by the Navy. Following monitoring well installation activities, the site will be restored to its original condition.

#### 9.1.2 Field Project Tasks

Applicable Standard Operating Procedures (SOPs) for project tasks outlined in this section are listed in **Section 9.2**.

##### **Utility Clearance**

Utility clearance at each site will be performed prior to the start of subsurface investigation activities. The CH2M HILL field staff will coordinate subsurface utility clearance with Miss Utility of Virginia ([800] 552-7001 or 811) and obtain available utility maps from CAX (Mr. James Michener at [757] 636-4084). In addition, a third-party utility clearance subcontractor will be procured by CH2M HILL to clearly mark utilities in the vicinity of all sampling locations. Any sampling location in close proximity to utility locations will be relocated to avoid impact to utilities while continuing to meet the intent of the sampling rationale. Proposed monitoring wells located within 5 feet of a marked, subsurface utility will be relocated. If a monitoring well needs to be relocated, the field team will use their best judgment in relocating the well and notifying the PM of its new location.

##### **Mobilization**

Following approval of the SAP, CH2M HILL will begin mobilization activities. Before mobilization, all field team members will review this SAP and the project-specific HASP. A field team kickoff meeting will be held to ensure that personnel are familiar with the scope of the field activities and discuss any safety issues. Mobilization activities include coordination with base personnel and preparation of field equipment.

##### **Vegetation Clearance**

AOC 1, the AOC 6 ASP subarea, and AOC 7 are located in wooded areas and some locations may require vegetation clearing to gain access. If required, prior to sampling activities, vegetation will be cleared in a manner that minimally impacts the site. Trees less than 3 inches in diameter will be cut and/or low-hanging tree limbs will be removed. All cut vegetation will remain onsite. Cutting will be accomplished through either manual or mechanical methods. Selection of the appropriate land-clearing strategy will be based on the type and density of

vegetation, topography, drainage patterns, terrain and soil conditions, and the level of effort required to maintain environmental and natural resource protection.

### **Soil Sampling**

The number of soil samples and laboratory analyses varies by site, as outlined in **Tables 8-1 and 9-2**. All soil samples will be collected using a stainless steel hand auger. Any relevant information pertaining to evidence of contamination or visual observations will be recorded in the sample log book. Samples will be homogenized prior to placement in the laboratory-prepared sample container. The SOPs to be used are referenced in **Section 9.2**.

### **Drainage Ditch Sampling**

At Site 9, six surface drainage ditch (0 to 6 inches bgs) and six subsurface drainage ditch (6 to 24 inches bgs) soil samples (two of which will be co-located with the former drainage ditch samples collected as part of the 2009 SI) will be collected and analyzed as outlined in **Table 9-2**. In addition, in the vicinity of four of the surface/subsurface drainage ditch soil samples, a five-point composite sample will be collected from within a 2-foot radius around the associated surface/subsurface drainage ditch soil sample (**Figure 7**). All soil samples will be collected using a stainless steel hand auger. Any relevant information pertaining to evidence of contamination or visual observations will be recorded in the sample log book. Samples will be homogenized prior to placement in the laboratory-prepared sample container. The SOPs to be used are referenced in **Section 9.2**.

### **Monitoring Well Installation and Development**

The number of monitoring wells to be installed varies by site, as outlined in **Tables 8-1 and 9-2**. During soil boring advancement prior to monitoring well installation, soil samples will be collected and logged for lithologic characterization at each location in accordance with Unified Soil Classification System (USCS) standards, and field screening of sample headspace will be conducted using a PID as the boreholes are advanced. Soil samples will be collected continuously from the ground surface to the final depth of the borehole using either DPT or split-spoon sampling.

Monitoring wells will be installed using 4.25-inch-inner-diameter hollow-stem auger drilling methods. Each monitoring well will be constructed with 2-inch-inner-diameter Schedule 40 polyvinyl chloride (PVC) screen and installed at an anticipated maximum depth of 40 feet bgs. The monitoring well screens will be machine-slotted 0.010-inch PVC.

A silica sand filter pack will be placed around the annular space of the well screen from the bottom of the boring extending to a depth of 2 feet above the top of the screen. A 2-foot bentonite layer will be placed above the top of the sand pack. After the bentonite has been hydrated, a cement-bentonite grout will be placed in the remaining annular space to the ground surface. The monitoring wells will be completed with a steel protective casing finished above grade. A locking watertight cap will be placed on the PVC pipe and the wells will be clearly marked.

Following installation, each monitoring well will be developed by the drilling subcontractor using a submersible pump. Each monitoring well will be developed using a combination of surging and pumping throughout the well screen. During monitoring well development, CH2M HILL will measure water quality parameters (pH, oxidation-reduction potential [ORP], temperature, conductivity, turbidity, and dissolved oxygen [DO]) approximately every 5 minutes with a Horiba U-22 or similar water quality meter and record data in the field logbook. In addition, the water quality meter will be calibrated daily (at a minimum) with the calibration documented in the field logbook. At least three well volumes of water will be removed in addition to the amount of any water added during the installation process. Development will continue until the water is clear and free of sediment or until 2 hours of development have passed, whichever comes first. Development information, including ORP, temperature, conductivity, turbidity, DO, and gallons removed will be recorded in the field logbook.

## Water-Level Survey

Following monitoring well installation and development, and prior to the start of groundwater sampling, the depth to groundwater to the nearest 0.01 foot will be measured from all monitoring wells. Measurements will be made from the surveyed point on the lip of the PVC riser, which will be marked with an indelible marker. If during removal of the locking well cap, the well demonstrates signs of being under pressure (such as escaping air sounds or cap being pushed off by pressure), then the depth to water in that monitoring well will not be measured for a period of 1 hour in order to allow for the water level to equilibrate. Measurements of depth to water and time will be recorded in the field logbook.

## Groundwater Sampling

Each newly installed monitoring well will be sampled with a Monsoon pump (or similar) using low-flow sampling protocol, and the samples will be analyzed for site-specific analytes as outlined in **Tables 8-1 and 9-2**. All groundwater samples will be collected by placing the sample tubing intake in the middle of the vertical screen interval. During purging prior to sampling, water quality parameters (pH, ORP, temperature, conductivity, turbidity, and DO) will be measured with a water quality meter and data will be recorded in the field logbook approximately every 5 minutes. In addition, the water quality meter will be calibrated daily (at a minimum) and the calibration documented in the field logbook.

DO will be field-verified using CHEMetrics test kits. Sampling will begin when water quality parameters have stabilized during purging over three consecutive readings (that is, when consecutive measurements agree as follows):

- pH within 0.1 pH unit
- Conductivity within 3 percent
- DO within 10 percent
- ORP within 10 millivolts
- Turbidity measurements within 10 percent or turbidity is minimized to the extent practical for the well

If the recharge rate of the well is so low that the well goes dry despite a flow rate of 0.1 liter per minute, purging will stop and the well will be allowed to recharge before purging continues. Sampling will be conducted once at least one well volume has been removed.

## Sediment Sampling

Surface (0 to 4 inches bgs) and subsurface (4 to 8 inches bgs) sediment samples will be collected using a hand-corer and analyzed as outlined in **Tables 8-1 and 9-2**. Any relevant information pertaining to visual observations (color, texture, and so forth) will be recorded in the sample log book. Samples will be collected in accordance with the SOPs referenced in **Section 9.2**.

All sample locations will be approached from downstream to avoid disturbance of bottom sediments as much as possible. Prior to sample collection, water quality data will be measured using a water quality meter (pH, conductivity, turbidity, DO, temperature, salinity, and ORP). Water depth and flow rate (if applicable) will also be measured. Sediment cores, approximately 12 inches in length, will be collected at each location using a sediment/sludge sampler and cores will be logged according to the USCS.

With the exception of AVS/SEM samples, sediment will be homogenized in stainless steel bowls prior to placement in laboratory-prepared sample containers. Samples collected for AVS/SEM analysis will be placed directly into sample containers. Following sample collection, horizontal coordinates of sample locations will be surveyed to the nearest 1 meter using a hand-held global positioning system (GPS) unit.

## Surface Water Sampling

Sample locations will be co-located with corresponding sediment samples. Prior to sample collection, water quality data will be measured using a water quality meter (pH, conductivity, turbidity, DO, temperature, salinity,

and ORP). Water depth and flow rate (if applicable) will also be measured. Surface water samples will be collected in accordance with the SOPs referenced in **Section 9.2**. Samples will be collected just below the water surface; however, if the water depth exceeds 4 feet, the sample will be collected at mid-depth. Samples will be collected using a decontaminated collection sampler such as an unpreserved laboratory jar. The collected surface water will then be decanted into the laboratory-provided sample containers. The GPS coordinates of surface water sampling locations will be surveyed to the nearest 1 meter. Surface water samples will be collected and analyzed for as outlined in **Tables 8-1 and 9-2**.

### **Equipment Decontamination**

All non-disposable sampling equipment will be decontaminated before and immediately after each use, as described in the applicable SOPs referenced in **Section 9.2**. Equipment will be decontaminated with Liquinox (or equivalent solution) and allowed to dry between each use. The water-level indicator will be scrubbed with deionized water between each measurement. All decontamination liquids will be containerized and handled according to the following IDW handling section. Disposable equipment (such as tubing for low-flow sampling, filters, paper towels, and disposable PPE) will be disposed as solid waste.

Heavy equipment such as drill rig equipment (augers, rods, or split spoons) will be high-temperature pressure washed before use at each new monitoring well location. A decontamination pad will be set up onsite to prevent runoff of the decontamination wash water and to allow easy collection of decontamination fluids into a 55-gallon drum for treatment as IDW.

### **Investigation-derived Waste Handling**

All IDW generated during this project is anticipated to be non-hazardous; however, it will be characterized in order to ensure it is transported and disposed in accordance with all pertinent regulations.

The IDW generated during monitoring well installation and sampling will be soil cuttings, monitoring well development water, purge water, and solutions used to decontaminate non-disposable sampling equipment. Solid and aqueous IDW will be containerized separately in Department of Transportation-approved 55-gallon drums, which will be stored onsite. Secondary containment for IDW storage will be large enough to contain 10 percent of the volume of containers or the volume of the largest container, whichever is greater. The IDW storage area will be covered with a tarp to minimize potential exposure to the drums and to prevent rain water from accumulating in the secondary containment. It is anticipated that 20 drums of solid IDW and 15 drums of aqueous IDW will be generated.

Unless there is evidence of gross contamination, one composite soil sample and one composite groundwater sample will be collected for the purpose of IDW characterization. These samples will be analyzed for the full Toxicity Characteristic Leaching Procedure (TCLP) list and ignitability, corrosivity, and reactivity. All drums will be removed from the site within 90 days of generation (with Navy approval).

Disposable equipment, including PPE and paper towels, will be disposed as ordinary trash.

### **Surveying**

Following sample collection, soil sample locations will be marked in the field using pin flags, with the sample station clearly labeled. All soil sample locations will be horizontally located and all monitoring wells will be horizontally and vertically located by a Virginia-licensed surveyor. The surveyor will provide coordinates of all horizontal points X and Y to the nearest 0.5 foot and vertical points Z to the nearest 0.01 foot (0.1 foot for unpaved ground surface elevations).

### **Quality Control**

QC samples will be collected as outlined in **Section 12**. Field and laboratory activities will be implemented following the applicable SOPs, as referenced in **Section 9.2 and Section 11**.

## 9.2 Field SOPs Reference Table

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

Applicable SOPs for project tasks are listed in **Table 9-1** and the SOPs are included as **Appendix A**.

TABLE 9-1  
 Field SOPs Reference Table

SOP Reference Number	Title/Author	Revision Date or Version Number	Location of SOP	Any planned deviation for Project Work	Comments
001_BlankPrep	Equipment Blank and Field Blank Preparation	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Sample Preparation and Handling	N/A	N/A
002_COC	Chain of Custody	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Sample Preparation and Handling	N/A	N/A
003_Decon	Decontamination of Personnel and Equipment	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Decontamination	N/A	N/A
004_DeconRig	Decontamination of Drilling Rigs and Equipment	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Decontamination	N/A	N/A
005_DrumSamp	Sampling Contents of Tanks and Drums	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Other	N/A	N/A
006_Disposal	Disposal of Waste Fluids and Solids	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Decontamination	N/A	N/A
007_GPS	Global Positioning System	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Other	N/A	N/A
008_HomoSamp	Homogenization of Soil and Sediment Samples	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Sample Preparation and Handling	N/A	N/A
009_FieldLog	Preparing Field Log Books	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Log Books	N/A	N/A
010_LowFlowSamp	Low-Flow Groundwater Sampling from Monitoring Wells	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Groundwater Sampling	N/A	N/A
011_MiniRAE	Mini RAE Photoionization Detector (PID)	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Health and Safety	N/A	N/A
012_MWInstall	General Guidance for Monitoring Well Installation	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Hydrogeology	N/A	N/A
013_GWSamp	Groundwater Sampling from Monitoring Wells	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Groundwater Sampling	N/A	N/A

TABLE 9-1  
 Field SOPs Reference Table

SOP Reference Number	Title/Author	Revision Date or Version Number	Location of SOP	Any planned deviation for Project Work	Comments
014_InstallMWSshallow	Installation of Shallow Monitoring Wells	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Hydrogeology	N/A	N/A
015_SBLog	Logging of Soil Borings	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Soil Sampling	N/A	N/A
016_SedSamp	Sediment Sampling	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Surface-Water and Sediment Sampling	N/A	N/A
017_SWSamp	Surface Water Sampling	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Surface-Water and Sediment Sampling	N/A	N/A
018_Ship	Packaging and Shipping Procedures for Low-Concentration Samples	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Sample Preparation and Handling	N/A	N/A
019_SoilSamp	Soil Sampling	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Soil Sampling	N/A	N/A
020_UtilLoc	Locating and Clearing Underground Utilities	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Utility Location	N/A	N/A
021_VOC SampGW	VOC Sampling-Water	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Sample Preparation and Handling	N/A	N/A
022_WaterLevel	Water Level Measurements	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Hydrogeology	N/A	N/A
023_FieldParam	Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature Using a Water Quality Parameter Meter with Flow-through Cell	8/2012	\\orion\proj\CLEANII\SOPS\1 - MASTER\Field Parameters	N/A	N/A



Table 9-2 Sample Details Table				Soil and Sediment										Aqueous Samples												
Analysis Group				PAHs	SVOCS	Explo	Metals	Hex Chrom	PCBs	Pest	TOC	pH	Grainsize	AVS/SE M	VOCs	PAHs	SVOCS	Explo	Metals	Dissolved Metals	Hex Chrom	PCBs	Pest	Hardness		
Preparation and Analytical Method				SW-846 3550C/8270C-SIM	SW-846 3550C/8270C	SW-846 8330B	SW-846 3050B/6010C/6020A, 7471A	SW-846 7199	SW-846 3550C/8082A	SW-846 3550C/8081B	Lloyd Kahn	SW-846 9045C	ASTM D422	EPA 821-R-91-100	SW-846 8260B	SW-846 3510C/8270C-SIM	SW-846 3510C/8270C	SW-846 8330B	SW-846 3010A/6010C, 3020A/6020A, 7470A	SW-846 3010A/6010C, 3020A/6020A, 7470A	SW-846 7199	SW-846 3550C/8082A	SW-846 3550C/8081B	SM 2340B		
Analytical Laboratory/ Analytical SOP Reference				TriMatrix/GR-04-103		ALS-Rochester / HPLC-8330	TriMatrix/GR-01-100, GR-01-129, GR-01-123	ALS-Rochester/GE N-7199	TriMatrix/GR-03-128	TriMatrix/GR-03-120	TriMatrix/GR-05-132	TriMatrix/GR-07-113	TriMatrix/GR-16-119	TriMatrix/GR-19-100	TriMatrix/GR-04-104	TriMatrix / GR-04-103		ALS-Rochester / HPLC-8330	TriMatrix/GR-01-100, GR-01-129, GR-01-123	TriMatrix/GR-01-100, GR-01-129, GR-01-123	ALS-Rochester / GEN-7199	TriMatrix / GR-03-128	TriMatrix / GR-03-120	TriMatrix / GR-06-104		
Data Package Turnaround Time				28 Calendar Days																						
Container Type/ Volume required (if different than container volume)				8-ounce (oz) Wide-mouth glass/30 grams (g)	1-4-oz. Wide-mouth/ 20 g	4-oz Wide-mouth High-density polyethylene (HDPE) / 20 g	1-4-oz. Wide-mouth/ 2.5 g	8-oz Wide-mouth glass/60 g	8-oz Wide-mouth HDPE/150 g	1 32-oz Wide-mouth HDPE/1,000 g	14 days for AVS, 28 days for Hg, 180 days for other SEM metals	Three '40-milliliter (ml)' clear glass vials/44 ml	Two 1,000 ml Narrow-mouth amber glass/1,000 ml	Two 1000ml Narrow-mouth amber glass / 1,000 ml	2, 1-liter (L) amber glass/1 L	500-ml Narrow-mouth HDPE/100 ml	500-ml Narrow-mouth HDPE/100 ml	250-ml HDPE/10 ml	1-L amber glass/0.5 L	1-L amber glass/0.5 L	500-ml Narrow-mouth HDPE / 100 ml					
Preservative				Cool to <6 °C										pH <2 w/HCl, Cool to <6 °C	Cool to <6 °C				pH <2 w/HNO3, Cool to <6 °C	pH <2 w/HNO3, Cool to <6 °C	Cool to <6°C		pH <2 w/HNO3, Cool to <6 °C			
Holding Time (Preparation/ Analysis)				14 days extraction, 40 days for analysis from date of extraction		180 days, 28 days for Hg	30 days to extraction/ 7 days from extraction to analysis	14 days extraction, 40 days for analysis from date of extraction	7 days (TriMatrix-specified)	14 days	28 days	14 days for AVS, 28 days for Hg, 180 days for other SEM metals	14 days	7 days extraction, 40 days for analysis from date of extraction		180 days, 28 days for Hg	180 days, 28 days for Hg	<u>24 hours</u>	7 days to extraction/40 days to analysis		28 days					
Matrix	Station ID	Sample ID	Sampling Depth																							
SS	CAS09-SO09	CAS09-SS09-MMY	0-0.5 foot bgs	X		X			PCB-1260 only	X	X	X	X													
SB		CAS09-SB09-TDBD	0.5-1 foot bgs	X		X			PCB-1260 only	X		X														
SS	CAS09-SO10	CAS09-SS10-MMY	0-0.5 foot bgs	X		X	X		PCB-1260 only	X	X	X	X													
SB		CAS09-SB10-TDBD	0.5-1 foot bgs	X		X	X		PCB-1260 only	X		X														
Site 9 Drainage Ditch - Surface (SS) and Subsurface Soil (SB) Samples, continued, and Soil Composite (SO) Samples																										
SS	CAS09-SO11	CAS09-SS11-MMY	0-0.5 foot bgs	X		X	X		PCB-1260 only	X	X	X	X													
SB		CAS09-SB11-TDBD	0.5-1 foot bgs	X		X	X		PCB-1260 only	X		X														
SO-5 pt-Composite	CAS09-SO12	CAS09-SO12-MMY	0-0.5 foot bgs	X		X			PCB-1260 only	X																
SO-5 pt-Composite	CAS09-SO13	CAS09-SO13-MMY	0-0.5 foot bgs	X		X			PCB-1260 only	X																
SO-5 pt-Composite	CAS09-SO14	CAS09-SO14-MMY	0-0.5 foot bgs	X		X			PCB-1260 only	X																
SO-5 pt-Composite	CAS09-SO15	CAS09-SO15-MMY	0-0.5 foot bgs	X		X			PCB-1260 only	X																
QA/QC	CAA06-QC	CAS09-EBMDDYY	N/A												X			X		X	PCB-1260 only	X				
AOC 1-N Surface Soil (SS) and Groundwater (GW) Samples																										
SS	CAA01-SS20	CAA01-SS20-MMY	0-0.5 foot bgs	X		X					X	X	X													
SS	CAA01-SS21	CAA01-SS21-MMY	0-0.5 foot bgs	X		X					X	X	X													
SS	CAA01-SS22	CAA01-SS22-MMY	0-0.5 foot bgs	X		X					X	X	X													
SS	CAA01-SS23	CAA01-SS23-MMY	0-0.5 foot bgs	X		X					X	X	X													
SS	CAA01-SS24	CAA01-SS24-MMY	0-0.5 foot bgs	X		X	X				X	X	X													
SS		CAA01-SS24P-MMY		X		X	X																			
SS	CAA01-SS25	CAA01-SS25-MMY	0-0.5 foot bgs	X		X	X				X	X	X													
SS		CAA01-SS25-MMYY-MS		X		X	X																			
SS		CAA01-SS25-MMYY-SD		X		X	X																			
GW	CAA01-MW01	CAA01-GW01-MMY	To be determined (TBD)															X	X							
GW	CAA01-MW01	CAA01-GW01P-MMY	TBD															X	X							
GW	CAA01-MW02	CAA01-GW02-MMY	TBD															X	X							
GW	CAA01-MW03	CAA01-GW03-MMY	TBD															X	X							
GW		CAA01-GW03-MMYY-MS	TBD															X	X							
GW		CAA01-GW03-MMYY-SD	TBD															X	X							







Table 9-2 Sample Details Table				Soil and Sediment									Aqueous Samples														
Analysis Group				PAHs	SVOCS	Explo	Metals	Hex Chrom	PCBs	Pest	TOC	pH	Grainsize	AVS/SE M	VOCs	PAHs	SVOCS	Explo	Metals	Dissolved Metals	Hex Chrom	PCBs	Pest	Hardness			
Contract Task Order (CTO)-WE02 CAX Site 9 and AOCs 1, 6, and 7 - ESI Sampling - Winter 2012, tentative  Main Laboratory* TriMatrix Laboratories 5560 Corporate Exchange Ct. SE Grand Rapids, MI 49512 Walt Roudebush - (616) 975-4561  Explosives and Hexavalent Chromium Laboratory* ALS-Rochester 1565 Jefferson Road, Building 300, Suite 360 Rochester, NY 14623 Deb Patton - (585) 672-7473  *Samples will be shipped to the analytical laboratory performing analysis				Preparation and Analytical Method	SW-846 3550C/8270C-SIM	SW-846 3550C/8270C	SW-846 8330B	SW-846 3050B/6010C/6020A, 7471A	SW-846 7199	SW-846 3550C/8082A	SW-846 3550C/8081B	Lloyd Kahn	SW-846 9045C	ASTM D422	EPA 821-R-91-100	SW-846 8260B	SW-846 3510C/8270C-SIM	SW-846 3510C/8270C	SW-846 8330B	SW-846 3010A/6010C, 3020A/6020A, 7470A	SW-846 3010A/6010C, 3020A/6020A, 7470A	SW-846 7199	SW-846 3550C/8082A	SW-846 3550C/8081B	SM 2340B		
				Analytical Laboratory/ Analytical SOP Reference	TriMatrix/GR-04-103		ALS-Rochester / HPLC-8330	TriMatrix/GR-01-100, GR-01-129, GR-01-123	ALS-Rochester/GE N-7199	TriMatrix/GR-03-128	TriMatrix/GR-03-120	TriMatrix / GR-05-132	TriMatrix / GR-07-113	TriMatrix / GR-16-119	TriMatrix / GR-19-100	TriMatrix / GR-04-104	TriMatrix / GR-04-103		ALS-Rochester / HPLC-8330	TriMatrix/GR-01-100, GR-01-129, GR-01-123	TriMatrix/GR-01-100, GR-01-129, GR-01-123	ALS-Rochester / GEN-7199	TriMatrix / GR-03-128	TriMatrix / GR-03-120	TriMatrix / GR-06-104		
				Data Package Turnaround Time	28 Calendar Days																						
				Container Type/ Volume required (if different than container volume)	8-ounce (oz) Wide-mouth glass/30 grams (g)	1-4-oz. Wide-mouth/ 20 g	4-oz Wide-mouth High-density polyethylene (HDPE) / 20 g	1-4-oz. Wide-mouth/ 2.5 g	8-oz Wide-mouth glass/60 g	8-oz Wide-mouth HDPE/150 g	1 32-oz Wide-mouth HDPE/1,000 g	14 days for AVS, 28 days for Hg, 180 days for other SEM metals	Three '40-milliliter (ml)' clear glass vials/44 ml	Two 1,000 ml Narrow-mouth amber glass/1,000 ml	Two 1000ml Narrow-mouth amber glass / 1,000 ml	2, 1-liter (L) amber glass/1 L	500-ml Narrow-mouth HDPE/100 ml	500-ml Narrow-mouth HDPE/100 ml	250-ml HDPE/10 ml	1-L amber glass/0.5 L	1-L amber glass/0.5 L	500-ml Narrow-mouth HDPE / 100 ml					
				Preservative	Cool to <6 °C											pH <2 w/HCl, Cool to <6 °C	Cool to <6 °C				pH <2 w/HNO3, Cool to <6 °C	pH <2 w/HNO3, Cool to <6 °C	Cool to <6°C		pH <2 w/HNO3, Cool to <6 °C		
				Holding Time (Preparation/ Analysis)	14 days extraction, 40 days for analysis from date of extraction			180 days, 28 days for Hg	30 days to extraction/ 7 days from extraction to analysis	14 days extraction, 40 days for analysis from date of extraction	7 days (TriMatrix-specified)	14 days	28 days	14 days for AVS, 28 days for Hg, 180 days for other SEM metals	14 days	7 days extraction, 40 days for analysis from date of extraction		180 days, 28 days for Hg	180 days, 28 days for Hg	<u>24 hours</u>	7 days to extraction/40 days to analysis		28 days				
Matrix	Station ID	Sample ID	Sampling Depth																								
GW	CAA07-MW05	CAA07-GW05-MMY	TBD																								
QA/QC	CAA07-QC	CASS07-EBMDDYY	N/A																								
		CASS07-TBMDDYY	N/A																								
Total Number of Samples to the Laboratory:				68	12	12	68	6	26	26	50	74	50	13	11	11	2	2	44	35	3	1	1	10			

Notes:  
<sup>1</sup> For a complete reference of laboratory SOPs, see the Analytical SOP References Table.  
<sup>2</sup> Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/analyzed.  
<sup>3</sup> Field QC counts may change depending on the duration of field event. Frequency of QA/QC sample collection is noted on the MPC Table in Section 6 of the Uniform Federal Policy (UFP)-SAP and is as follows :  
 Field Duplicate - One per 10 field samples  
 Matrix spike (MS)/matrix spike duplicate (MSD) - One pair per 20 field samples of similar matrix (including field duplicates)  
 Equipment Blank- For disposable equipment, one per week of sampling; for decontaminated equipment, one per type of sampling equipment, per day of sampling  
 Trip Blanks - One per cooler to the laboratory containing samples for VOC analysis.  
 Field Blank- No field blanks will be collected for this project  
 MMY - 2 digit month and 2 digit year  
 MMDDYY - 2 digit month then 2 digit year followed by 2 digit year

# 10 Reference Limits and Evaluation Tables

(UFP-QAPP Manual Section 2.8.1 – Worksheet # 15)

Samples will be collected and analyzed for the analytical groups and methods detailed in **Table 9-2, Sample Details Table**. The PALs and laboratory RLs for each analyte from these samples are provided in *Reference Limits and Evaluation Tables (Tables 10-1A through 10-4D)*.

TABLE 10-1A  
 Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil  
 Analytical Group: SVOCs or PAHs<sup>1</sup>

Analyte	Chemical Analytical Services (CAS) Number	SW-846 8270C Method	PAL <sup>2,4</sup> (milligrams per kilogram [mg/kg])		Project Quantitation Limit (PQL) Goal <sup>3,4</sup> (mg/kg)	Laboratory-Specific (mg/kg)			Laboratory Control Sample (LCS), MS/MSD Percent Recovery (%R) and RPD Limits <sup>6</sup>		
			Adjusted Residential Soil RSL (Nov 2012)	Soil ESV <sup>5</sup>		LOQ	Limit of Detection (LOD)	Detection Limit (DL)	Lower Confidence Limit (LCL)	UCL	%RPD
1,1-Biphenyl	92-52-4	Full Scan	5.1	13.6	2.55	0.017	0.0033	0.00091	60	131	30
1,2,4,5-Tetrachlorobenzene	95-94-3	Full Scan	1.8	No criteria (NC)	0.9	0.0333	0.00167	0.00123	30	150	
2,2'-Oxybis(1-chloropropane)	108-60-1	Full Scan	4.6	NC	2.3	0.017	0.0033	0.00225	20	115	
2,3,4,6-Tetrachlorophenol	58-90-2	Full Scan	180	NC	90	0.0333	0.00333	0.00146	30	150	
2,4,5-Trichlorophenol	95-95-4	Full Scan	610	1.35	0.675	0.017	0.0033	0.00242	50	110	
2,4,6-Trichlorophenol	88-06-2	Full Scan	6.1	0.58	0.29	0.017	0.0033	0.00218	45	110	
2,4-Dichlorophenol	120-83-2	Full Scan	18	0.5	0.25	0.033	0.017	0.0162	45	110	
2,4-Dimethylphenol	105-67-9	Full Scan	120	1	0.5	0.17	0.17	0.0593	30	105	
2,4-Dinitrophenol	51-28-5	Full Scan	12	20	6	0.17	0.17	0.0881	15	130	
2,4-Dinitrotoluene	121-14-2	Full Scan	1.6	11	0.8	0.033	0.033	0.0198	50	115	
2,6-Dinitrotoluene	606-20-2	Full Scan	6.1	8.5	3.05	0.017	0.017	0.00812	50	110	
2-Chloronaphthalene	91-58-7	Full Scan	630	Low Molecular Weight (LMW) PAH	315	0.017	0.0033	0.00106	45	105	
2-Chlorophenol	95-57-8	Full Scan	39	0.5	0.25	0.017	0.0033	0.00108	45	105	
2-Methylnaphthalene	91-57-6	Selected Ion Monitoring (SIM)	23	LMW PAH	12.5	0.0017	0.0017	0.000316	45	105	
2-Methylphenol	95-48-7	Full Scan	310	1	0.5	0.017	0.017	0.00654	40	105	
2-Nitroaniline	88-74-4	Full Scan	61	NC	30.5	0.017	0.017	0.00534	45	120	
2-Nitrophenol	88-75-5	Full Scan	39	1	0.5	0.017	0.0033	0.00298	40	110	
3,3'-Dichlorobenzidine	91-94-1	Full Scan	1.1	NC	0.55	0.83	0.33	0.104	10	130	
3-Nitroaniline	99-09-2	Full Scan	NC	NC	Lab LOD	0.033	0.033	0.0134	25	110	
4,6-Dinitro-2-methylphenol	534-52-1	Full Scan	0.49	1	0.245	0.17	0.033	0.0287	30	135	
4-Bromophenyl-phenylether	101-55-3	Full Scan	NC	NC	Lab LOD	0.017	0.0033	0.00154	45	115	
4-Chloro-3-methylphenol	59-50-7	Full Scan	610	0.5	0.25	0.017	0.0033	0.00133	45	115	
4-Chloroaniline	106-47-8	Full Scan	2.4	0.5	0.25	0.067	0.033	0.0333	10	100	
4-Chlorophenyl-phenylether	7005-72-3	Full Scan	31	NC	15.5	0.017	0.0033	0.00333	45	110	

TABLE 10-1A  
 Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil  
 Analytical Group: SVOCs or PAHs<sup>1</sup>

Analyte	Chemical Analytical Services (CAS) Number	SW-846 8270C Method	PAL <sup>2,4</sup> (milligrams per kilogram [mg/kg])		Project Quantitation Limit (PQL) Goal <sup>3,4</sup> (mg/kg)	Laboratory-Specific (mg/kg)			Laboratory Control Sample (LCS), MS/MSD Percent Recovery (%R) and RPD Limits <sup>6</sup>		
			Adjusted Residential Soil RSL (Nov 2012)	Soil ESV <sup>5</sup>		LOQ	Limit of Detection (LOD)	Detection Limit (DL)	Lower Confidence Limit (LCL)	UCL	%RPD
4-Methylphenol	106-44-5	Full Scan	610	1	0.5	0.017	0.017	0.00422	40	105	
4-Nitroaniline	100-01-6	Full Scan	24	NC	12	0.033	0.033	0.0333	35	115	
4-Nitrophenol	100-02-7	Full Scan	4.8	0.38	0.19	0.67	0.17	0.0597	15	140	
Acenaphthene	83-32-9	SIM	340	LMW PAH	170	0.0017	0.0017	0.000251	45	110	
Acenaphthylene	208-96-8	SIM	340	LMW PAH	170	0.0017	0.0017	0.000353	45	105	
Acetophenone	98-86-2	Full Scan	780	NC	390	0.017	0.0033	0.00333	50	150	
Anthracene	120-12-7	SIM	1700	LMW PAH	850	0.0017	0.0017	0.000168	55	105	
Atrazine	1912-24-9	Full Scan	2.1	0.0119	0.00595	0.017	0.0033	0.00266	61	146	
Benzaldehyde	100-52-7	Full Scan	780	NC	390	0.085	0.0033	0.00257	50	150	
Benzo(a)anthracene	56-55-3	SIM	0.15	High Molecular Weight (HMW) PAH	0.075	0.0017	0.0017	0.000374	50	110	
Benzo(a)pyrene	50-32-8	SIM	0.015	HMW PAH	0.0075	0.0017	0.0017	0.000366	50	110	
Benzo(b)fluoranthene	205-99-2	SIM	0.15	HMW PAH	0.075	0.0017	0.0017	0.000778	45	115	
Benzo(g,h,i)perylene	191-24-2	SIM	170	HMW PAH	85	0.0017	0.0017	0.000367	40	125	
Benzo(k)fluoranthene	207-08-9	SIM	1.5	HMW PAH	0.75	0.0017	0.0017	0.000212	45	125	
bis(2-Chloroethoxy)methane	111-91-1	Full Scan	18	NC	9	0.017	0.0033	0.001	45	110	
bis(2-Chloroethyl)ether	111-44-4	Full Scan	0.21	NC	0.105	0.017	0.0033	0.00088	40	105	
bis(2-Ethylhexyl)phthalate	117-81-7	Full Scan	35	30	15	0.033	0.017	0.00759	45	125	
Butylbenzylphthalate	85-68-7	Full Scan	260	30	15	0.033	0.0033	0.00191	50	125	
Caprolactam	105-60-2	Full Scan	3100	NC	1550	0.085	0.033	0.0131	62	112	
Carbazole	86-74-8	Full Scan	NC	NC	Lab LOD	0.17	0.017	0.00575	45	115	
Chrysene	218-01-9	SIM	15	HMW PAH	7.5	0.0017	0.0017	0.000472	55	110	
Dibenz(a,h)anthracene	53-70-3	SIM	0.015	HMW PAH	0.0075	0.0017	0.0017	0.000404	40	125	
Dibenzofuran	132-64-9	Full Scan	7.8	NC	3.9	0.017	0.0033	0.00333	50	105	
Diethylphthalate	84-66-2	Full Scan	4900	26.8	13.4	0.017	0.017	0.00937	50	115	
Dimethyl phthalate	131-11-3	Full Scan	NC	10.64	5.32	0.017	0.0033	0.00152	50	110	
Di-n-butylphthalate	84-74-2	Full Scan	610	40	20	0.067	0.033	0.0333	55	110	
Di-n-octylphthalate	117-84-0	Full Scan	73	30	15	0.017	0.0033	0.00105	40	130	
Fluoranthene	206-44-0	SIM	230	LMW PAH	115	0.0017	0.0017	0.000364	55	115	

TABLE 10-1A  
 Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil  
 Analytical Group: SVOCs or PAHs<sup>1</sup>

Analyte	Chemical Analytical Services (CAS) Number	SW-846 8270C Method	PAL <sup>2,4</sup> (milligrams per kilogram [mg/kg])		Project Quantitation Limit (PQL) Goal <sup>3,4</sup> (mg/kg)	Laboratory-Specific (mg/kg)			Laboratory Control Sample (LCS), MS/MSD Percent Recovery (%R) and RPD Limits <sup>6</sup>		
			Adjusted Residential Soil RSL (Nov 2012)	Soil ESV <sup>5</sup>		LOQ	Limit of Detection (LOD)	Detection Limit (DL)	Lower Confidence Limit (LCL)	UCL	%RPD
Fluorene	86-73-7	SIM	230	LMW PAH	115	0.0017	0.0017	0.000379	50	110	
Hexachlorobenzene	118-74-1	Full Scan	0.3	1	0.15	0.017	0.0033	0.00186	45	120	
Hexachlorobutadiene	87-68-3	Full Scan	6.1	NC	3.05	0.017	0.0033	0.00212	40	115	
Hexachlorocyclopentadiene	77-47-4	Full Scan	37	2	1	0.017	0.0033	0.00143	10	113	
Hexachloroethane	67-72-1	Full Scan	4.3	NC	2.15	0.017	0.0033	0.00236	35	110	
Indeno(1,2,3-cd)pyrene	193-39-5	SIM	0.15	HMW PAH	0.075	0.0017	0.0017	0.000451	40	120	
Isophorone	78-59-1	Full Scan	510	NC	255	0.017	0.0033	0.00146	45	110	
Naphthalene	91-20-3	SIM	3.6	LMW PAH	1.8	0.0017	0.0017	0.000474	40	105	
Nitrobenzene	98-95-3	Full Scan	4.8	2.26	1.13	0.017	0.017	0.0103	40	115	
n-Nitroso-di-n-propylamine	621-64-7	Full Scan	0.069	NC	0.0345	0.017	0.0033	0.00153	40	115	
n-Nitrosodiphenylamine	86-30-6	Full Scan	99	1.09	0.545	0.017	0.017	0.005	50	115	
Pentachlorophenol	87-86-5	Full Scan	0.89	5	0.445	0.17	0.033	0.027	25	120	
Phenanthrene	85-01-8	SIM	1700	LMW PAH	850	0.0017	0.0017	0.000402	50	110	
Phenol	108-95-2	Full Scan	1800	1.88	0.94	0.17	0.0033	0.00202	40	100	
Pyrene	129-00-0	SIM	170	HMW PAH	85	0.0017	0.0017	0.000316	45	125	

Notes:

<sup>1</sup> This table lists all analytes that are considered SVOCs. PAHs are a subset of 17 SVOCs, which will be analyzed by the SIM method. Samples for some sites will be analyzed for all SVOCs, some will only be analyzed for only the PAHs.

<sup>2</sup> The PAL for each analyte is the lower of the criteria shown. Refer to Section 6.2 for a detailed discussion on PALs by matrix. No 95 percent UTL background values have been established for SVOCs in soil at CAX.

<sup>3</sup> PQL goals are equal to half of the minimum applicable PALs.

<sup>4</sup> PALs and PQL Goals assume dry weight basis.

<sup>5</sup> Site-Specific ESVs for PAHs are based on whether they are LMW or HMW. The cumulative LMW ESV is 29 mg/kg and the cumulative HMW ESV is 18 mg/kg.

<sup>6</sup> DoD QSM v.4.1 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where statistical in-house limits are used.

TABLE 10-1B  
 Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil  
 Analytical Group: Pesticides

Analyte <sup>4</sup>	CAS Number	PAL <sup>1,3</sup> (micrograms per kilogram [µg/kg])		PQL Goal <sup>2</sup> (µg/kg)	Laboratory-Specific (µg/kg)			LCS, MS/MSD %R and RPD Limits <sup>4</sup>		
		Adjusted Residential Soil RSL (Nov 2012)	Soil ESV		LOQ	LOD	DL	LCL	UCL	%RPD
4,4'- DDD	72-54-8	2000	583	291.5	17	0.267	0.11	30	135	30
4,4'- DDE	72-55-9	1400	114	57	17	0.267	0.13	70	125	
4,4'- DDT	50-29-3	1700	100	50	17	0.267	0.14	45	140	
Aldrin	309-00-2	29	3.63	1.815	17	0.267	0.1	45	140	
alpha- BHC	319-84-6	77	226	38.5	17	0.267	0.08	60	125	
alpha-Chlordane	5103-71-9	1600	11	5.5	17	0.267	0.13	65	120	
beta-BHC	319-85-7	270	342	135	17	0.267	0.21	60	125	
delta-BHC	319-86-8	270	226	113	17	0.267	0.1	55	130	
Dieldrin	60-57-1	30	10.5	5.25	17	0.267	0.13	65	125	
Endosulfan I	959-98-8	37000	6.32	3.16	17	0.267	0.12	15	135	
Endosulfan II	33213-65-9	37000	6.32	3.16	17	0.267	0.14	35	140	
Endosulfan sulfate	1031-07-8	37000	6.32	3.16	17	0.267	0.12	60	135	
Endrin	72-20-8	1800	1.95	0.975	17	0.267	0.17	60	135	
Endrin aldehyde	7421-93-4	1800	1.95	0.975	17	0.267	0.14	35	145	
Endrin ketone	53494-70-5	1800	1.95	0.975	17	0.267	0.11	65	135	
gamma-BHC (Lindane)	58-89-9	520	7.75	3.875	17	0.267	0.11	60	125	
gamma-Chlordane	5103-74-2	1600	11	5.5	17	0.267	0.14	65	125	
Heptachlor	76-44-8	110	52.9	26.45	17	0.267	0.12	50	140	
Heptachlor epoxide	1024-57-3	53	52.9	26.45	17	0.267	0.12	65	130	
Methoxychlor	72-43-5	31000	500	250	17	0.267	0.17	55	145	
Toxaphene	8001-35-2	440	500	220	170	33.3	33.3	40	150	

Notes:

<sup>1</sup> The PAL for each analyte is the lower of the criteria shown. Refer to Section 6.2 for a detailed discussion on PALs by matrix. No 95 percent UTL background values have been established for pesticides in soil at CAX.

<sup>2</sup> PQL goals are equal to half of the minimum applicable PAL.

<sup>3</sup> PALs and PQL Goals assume dry weight basis.

<sup>4</sup> DoD QSM v.4.1 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where statistical in-house limits are used.

N/A indicates that criteria are not applicable.

TABLE 10-1C  
 Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil  
 Analytical Group: PCBs

Analyte	CAS Number	PAL <sup>1,3</sup> (µg/kg)		PQL Goal <sup>2,3</sup> (µg/kg)	Laboratory-Specific (µg/kg)			LCS, MS/MSD %R and RPD Limits <sup>4</sup>		
		Adjusted Residential Soil RSL (Nov 2012)	Soil ESV		LOQ	LOD	DL	LCL	UCL	%RPD
Aroclor-1260	11096-82-5	220	8,000	110	17	17	4.9	60	130	30

Notes:

<sup>1</sup> The PAL for each analyte is the lower of the criteria shown. Refer to Section 6.2 for a detailed discussion on PALs by matrix. No 95 percent UTL background values have been established for PCBs in soil at CAX.

<sup>2</sup> PQL goals are equal to half of the minimum applicable PAL.

<sup>3</sup> PALs and PQL Goals assume dry weight basis.

<sup>4</sup> DoD QSM v.4.1 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where statistical in-house limits are used.

N/A indicates that criteria are not applicable.

TABLE 10-1D  
 Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil  
 Analytical Group: Metals

Analyte <sup>4</sup>	CAS Number	Analytical Method	PAL <sup>1,3</sup> (mg/kg)		CAX Surface Soil Background <sup>1</sup> (mg/kg)	CAX Subsurface Soil Background <sup>1</sup> (mg/kg)	PQL Goal <sup>2</sup> (mg/kg)	Laboratory-Specific (mg/kg)			LCS, MS/MSD %R and RPD Limits <sup>5</sup>		
			Adjusted Residential Soil RSL (Nov 2012)	Soil ESV				LOQ	LOD	DL	LCL	UCL	%RPD
Aluminum	7429-90-5	6010C	7700	pH < 5.5	12200	13000	3850	10	5	1.36	80	120	20
Antimony	7440-36-0	6020A	3.1	78	NE	NE	1.55	0.2	0.05	0.0243			
Arsenic	7440-38-2	6020A	0.39	18	6.36	5.54	0.195	0.5	0.05	0.0163			
Barium	7440-39-3	6020A	1500	330	52.9	84.5	26.45	0.1	0.02	0.0122			
Beryllium	7440-41-7	6020A	16	40	0.587	NE	0.2935	0.1	0.05	0.0195			
Cadmium	7440-43-9	6020A	7	32	NE	NE	3.5	0.05	0.05	0.0033			
Calcium	7440-70-2	6010C	NC	NC	2290	2380	1145	50	50	20.2			
Chromium	7440-47-3	6020A	0.29	64	18.2	33.7	0.145	0.2	0.05	0.0139			
Chromium VI (Hexavalent) <sup>4</sup>	18540-29-9	7199	0.29	NC	NC	NC	0.145	0.4	0.2	0.065	LCS 80 MS 75	LCS 120 MS 125	20
Cobalt	7440-48-4	6020A	2.3	13	9.93	5.18	1.15	0.1	0.02	0.0064	80	20	20
Copper	7440-50-8	6020A	310	70	4.25	3.17	1.585	0.2	0.1	0.0254	80	120	
Cyanide	57-12-5	9014	2.2	15.8	NE	NE	1.1	0.1	0.05	0.0208	80	120	
Iron	7439-89-6	6010C	5500	5 < pH > 8	19900	32000	2750	5	1	0.619	80	120	
Lead	7439-92-1	6020A	400	120	17.4	8.79	4.395	0.1	0.02	0.0066			
Magnesium	7439-95-4	6010C	NC	NC	1070	1120	535	50	25	7.1			
Manganese	7439-96-5	6020A	180	220	324	176	88	0.2	0.1	0.0234			
Mercury	7439-97-6	7471	2.3	0.1	0.111	NE	0.05	0.05	0.017	0.0061			
Nickel	7440-02-0	6020A	150	38	9.52	17.6	4.76	0.2	0.05	0.0161			
Potassium	7440-09-7	6010C	NC	NC	708	901	354	50	10	7.13			
Selenium	7782-49-2	6020A	39	0.52	0.51	NE	0.255	0.5	0.1	0.0327			
Silver	7440-22-4	6020A	39	560	NE	NE	19.5	0.1	0.01	0.0039	75	80	
Sodium	7440-23-5	6010C	NC	NC	521	811	260.5	50	25	6.03			
Thallium	7440-28-0	6020A	0.078	1	NC	NC	0.039	0.1	0.01	0.0026			
Vanadium	7440-62-2	6020A	39	130	27.9	48.3	13.95	0.1	0.04	0.0097			
Zinc	7440-66-6	6020A	2300	120	26.5	28	13.25	2	1	0.28	80		

Notes:

<sup>1</sup> The PAL for each analyte is the lower of the criteria shown. Refer to Section 6.2 for a detailed discussion on PALs by matrix.

<sup>2</sup> PQL goals are equal to half of the minimum applicable PAL.

<sup>3</sup> PALs and PQL Goals assume dry weight basis.

<sup>4</sup> Not all soils will be analyzed for hexavalent chromium. Refer to Sample Details Table in Section 7.3 for specifics.

<sup>5</sup> DoD QSM v.4.1 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where statistical in-house limits are used.

NC indicates that there is no criterion for an analyte.

NE indicates that the 95 percent UTL was not evaluated for this analyte.

TABLE 10-1E  
 Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil  
 Analytical Group: Explosives

Analyte Name	CAS No.	PAL <sup>1,3</sup> (mg/kg)		PQL Goal <sup>2,3</sup> (mg/kg)	Laboratory Limits (mg/kg)			LCS and MS/MSD Recovery and RPD Limits <sup>4</sup> (%)		
		Adjusted Residential Soil RSL (Nov 2012)	Soil ESV		LOQ	LOD	DL	LCL	UCL	RPD
1,3,5-Trinitrobenzene	99-35-4	220	NC	110	0.4	0.2	0.017	<b>40</b>	<b>140</b>	<b>20</b>
1,3-Dinitrobenzene	99-65-0	0.61	NC	0.305	0.4	0.2	0.016			
2,4,6-TNT	118-96-7	3.6	10	1.8	0.4	0.2	0.022			
2,4-Dinitrotoluene	121-14-2	1.6	11	0.8	0.4	0.2	0.025			
2,6-Dinitrotoluene	606-20-2	6.1	8.5	3.05	0.4	0.2	0.056			
2-Amino-4,6-Dinitrotoluene	35572-78-2	15	80	7.5	0.4	0.2	0.033			
2-Nitrotoluene	88-72-2	2.9	NC	1.45	0.4	0.2	0.058			
3,5-Dinitroaniline	618-87-1	NC	NC	Lab LOD	0.4	0.2	0.031			
3-Nitrotoluene	99-08-1	0.61	NC	0.305	0.4	0.2	0.049			
4-Amino-2,6-dinitrotoluene	19406-51-0	15	80	7.5	0.4	0.2	0.043			
4-Nitrotoluene	99-99-0	24	NC	12	0.4	0.2	0.126			
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	5.6	10	2.8	0.4	0.2	0.091			
Methyl-2,4,6-trinitrophenyl nitramine (Tetryl)	479-45-8	24	10	5	0.4	0.2	0.056			
Nitrobenzene	98-95-3	4.8	2.26	1.13	0.4	0.2	0.013			
Nitroglycerin	55-63-0	0.61	NC	0.305	0.4	0.2	0.103			
HMX	2691-41-0	380	10	5	0.4	0.2	0.018			
Pentaerythritol tetranitrate (PETN)	78-11-5	12	NC	6	0.4	0.2	0.104			

Notes:

- <sup>1</sup> The PAL for each analyte is the lower of the criteria shown. Refer to Section 6.2 for a detailed discussion on PALs by matrix.
  - <sup>2</sup> PQL goals are equal to half of the minimum applicable PAL.
  - <sup>3</sup> PALs and PQL Goals assume dry weight basis.
  - <sup>4</sup> DoD QSM v.4.1 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where statistical in-house limits are used.
- NC indicates that there is no criterion for an analyte.

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TABLE 10-1F  
 Reference Limits and Evaluation Table

Matrix: Surface Soil, Subsurface Soil  
 Analytical Group: Wet Chemistry

Analyte <sup>2</sup>	CAS Number <sup>3</sup>	Units	Project Indicator Limit (PIL) <sup>1</sup>	Laboratory-Specific			LCS, MS/MSD %R and RPD Limits <sup>3</sup>		
				LOQ	LOD	DL	LCL	UCL	%RPD
TOC	TOC	mg/kg	N/A	1000	1000	225	75	125	20
pH	PH	pH	5, 8	N/A	N/A	N/A	NC	NC	20

Notes:

There are no action limits for wet chemistry analytes because they are screening data.

<sup>1</sup> PILs are approximate threshold values for results that will help support the ERA.

<sup>2</sup> TOC data will be used to help evaluate fate, transport, and bioavailability. Data for pH will be used as the soil ESV for select metals (aluminum and iron).

<sup>3</sup> In some instances a contractor-specific identifier is used.

NC indicates that there is no criterion for an analyte.

TABLE 10-1G  
 Reference Limits and Evaluation Table

Matrix: Surface Soil, Surface Sediment, Subsurface Sediment

Analytical Group: Grain size<sup>1,2</sup>

Analyte	CAS Number <sup>3</sup>	Units
GS03 Sieve 3 inches (75 millimeter [mm])	SIEVE75.0	% Passing
GS05 Sieve 2 inches (50 mm)	SIEVE50.0	% Passing
GS06 Sieve 1.5 inches (37.5 mm)	SIEVE37.5	% Passing
GS07 Sieve 1 inch (25.0 mm)	SIEVE25.0	% Passing
GS08 Sieve 0.75 inch (19.0 mm)	SIEVE19.0	% Passing
GS10 Sieve 0.375 inch (9.5 mm)	SIEVE9.5	% Passing
Sieve No. 004 (4.75 mm)	SIEVE4.75	% Passing
Sieve No. 010 (2.00 mm)	SIEVE2.0	% Passing
Sieve No. 020 (850 micrometers [µm])	SIEVE850	% Passing
Sieve No. 040 (425 µm)	SIEVE425	% Passing
Sieve No. 060 (250 µm)	SIEVE250	% Passing
Sieve No. 080 (180 µm)	SIEVE180	% Passing
Sieve No. 100 (150 µm)	SIEVE150	% Passing
Sieve No. 200 (75 µm)	SIEVE75	% Passing
Gravel (%)	GRAVEL	%
Sand (%)	14808-60-7	%
Coarse Sand (%)	COARSE SAND	%
Medium Sand (%)	MEDIUM SAND	%
Fine Sand (%)	FINE SAND	%
Fines (%)	FINES	%

Notes:

- <sup>1</sup> There are no action limits, laboratory RLs, or LCS recovery limits for grain-size analytes because they are screening data.
- <sup>2</sup> Grain-size data will be used to characterize sediment and soil conditions in terms of habitat for certain invertebrates, and to help evaluate fate, transport, and bioavailability.
- <sup>3</sup> In some instances a contractor-specific identifier is used.

TABLE 10-2A  
 Reference Limits and Evaluation Table

Matrix: Sediment (surface and subsurface)  
 Analytical Group: PAHs

Analyte	CAS Number	SW-846 8270C Method	Adjusted Residential Soil RSL x10 for Sediment (Nov 2012) <sup>1,3</sup> (mg/kg)	Sediment ESV <sup>1,3</sup> (mg/kg)	Sediment BTAG <sup>1,3</sup> (mg/kg)	PQL Goal <sup>2,3</sup> (mg/kg)	Laboratory-Specific (mg/kg)			LCS, MS/MSD %R and RPD Limits <sup>4</sup>		
							LOQ	LOD	DL	LCL	UCL	%RPD
2-Methylnaphthalene	91-57-6	SIM	230	NC	0.0202	0.0101	0.0017	0.0017	0.00032	45	105	30
Acenaphthene	83-32-9	SIM	3400	0.29	0.0067	0.00335	0.0017	0.0017	0.00025	45	110	
Acenaphthylene	208-96-8	SIM	3400	0.16	0.0059	0.00295	0.0017	0.0017	0.00035	45	105	
Anthracene	120-12-7	SIM	17000	0.0572	0.00572	0.00286	0.0017	0.0017	0.00017	55	105	
Benzo(a)anthracene	56-55-3	SIM	1.5	0.108	0.108	0.054	0.0017	0.0017	0.00037	50	110	
Benzo(a)pyrene	50-32-8	SIM	0.15	0.15	0.15	0.075	0.0017	0.0017	0.00037	50	110	
Benzo(b)fluoranthene	205-99-2	SIM	1.5	0.24	0.0272	0.0136	0.0017	0.0017	0.00078	45	115	
Benzo(g,h,i)perylene	191-24-2	SIM	1700	0.17	0.17	0.085	0.0017	0.0017	0.00037	40	125	
Benzo(k)fluoranthene	207-08-9	SIM	15	0.24	0.24	0.12	0.0017	0.0017	0.00021	45	125	
Chrysene	218-01-9	SIM	150	0.166	0.166	0.083	0.0017	0.0017	0.00047	55	110	
Dibenz(a,h)anthracene	53-70-3	SIM	0.15	0.033	0.033	0.0165	0.0017	0.0017	0.0004	40	125	
Fluoranthene	206-44-0	SIM	2300	0.423	0.423	0.2115	0.0017	0.0017	0.00036	55	115	
Fluorene	86-73-7	SIM	2300	0.0774	0.0774	0.0387	0.0017	0.0017	0.00038	50	110	
Indeno(1,2,3-cd)pyrene	193-39-5	SIM	1.5	0.2	0.017	0.0085	0.0017	0.0017	0.00045	40	120	
Naphthalene	91-20-3	SIM	36	0.176	0.176	0.088	0.0017	0.0017	0.00047	40	105	
Phenanthrene	85-01-8	SIM	17000	0.204	0.204	0.102	0.0017	0.0017	0.0004	50	110	
Pyrene	129-00-0	SIM	1700	0.195	0.195	0.0975	0.0017	0.0017	0.00032	45	125	

Notes:

<sup>1</sup> The PAL for each analyte is the lower of the criteria shown. Refer to Section 6.2 for a detailed discussion on PALs by matrix. No 95 percent UTL background values have been established for SVOCs in soil at CAX.

<sup>2</sup> PQL goals are equal to half of the minimum applicable PALs.

<sup>3</sup> PALs and PQL Goals assume dry weight basis.

<sup>4</sup> DoD QSM v.4.1 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where statistical in-house limits are used.

TABLE 10-2B  
 Reference Limits and Evaluation Table

Matrix: Sediment (surface and subsurface)  
 Analytical Group: Metals

Analyte <sup>4</sup>	CAS Number	Analytical Method	Adjusted Residential Soil RSL x10 for Sediment (Nov 2012) <sup>1,3</sup> (mg/kg)	Sediment ESV <sup>1,3</sup> (mg/kg)	Sediment BTAG <sup>1,3</sup> (mg/kg)	PQL Goal <sup>2,3</sup> (mg/kg)	Laboratory-Specific (mg/kg)			LCS, MS/MSD %R and RPD Limits <sup>4</sup>		
							LOQ	LOD	DL	LCL	UCL	%RPD
Aluminum	7429-90-5	6010C	77000	25500	NC	12750	10	5	1.36	80	120	20
Antimony	7440-36-0	6020A	31	3	2	1	0.2	0.05	0.0243			
Arsenic	7440-38-2	6020A	3.9	9.79	9.8	1.95	0.5	0.05	0.0163			
Barium	7440-39-3	6020A	15000	20	NC	10	0.1	0.02	0.0122			
Beryllium	7440-41-7	6020A	160	NC	NC	80	0.1	0.05	0.0195			
Cadmium	7440-43-9	6020A	70	0.99	0.99	0.495	0.05	0.05	0.0033			
Calcium	7440-70-2	6010C	NC	NC	NC	Lab LOD	50	50	20.2			
Chromium	7440-47-3	6020A	2.9	43.4	43.4	1.45	0.2	0.05	0.0139			
Cobalt	7440-48-4	6020A	23	50	50	11.5	0.1	0.02	0.0064			
Copper	7440-50-8	6020A	3100	31.6	31.6	15.8	0.2	0.1	0.0254			
Iron	7439-89-6	6010C	55000	20000	20000	10000	5	1	0.619			
Lead	7439-92-1	6020A	4000	35.8	35.8	17.9	0.1	0.02	0.0066			
Magnesium	7439-95-4	6010C	NC	NC	NC	Lab LOD	50	25	7.1			
Manganese	7439-96-5	6020A	1800	460	460	230	0.2	0.1	0.0234			
Mercury	7439-97-6	7471	23	0.18	0.18	0.09	0.05	0.017	0.0061			
Nickel	7440-02-0	6020A	1500	22.7	22.7	11.35	0.2	0.05	0.0161			
Potassium	7440-09-7	6010C	NC	NC	NC	Lab LOD	50	10	7.13			
Selenium	7782-49-2	6020A	390	2	2	1	0.5	0.1	0.0327			
Silver	7440-22-4	6020A	390	1	1	0.5	0.1	0.01	0.0039	75		
Sodium	7440-23-5	6010C	NC	NC	NC	Lab LOD	50	25	6.03	80		
Thallium	7440-28-0	6020A	0.78	NC	NC	0.39	0.1	0.01	0.0026			
Vanadium	7440-62-2	6020A	390	NC	NC	195	0.1	0.04	0.0097			
Zinc	7440-66-6	6020A	23000	121	121	60.5	2	1	0.28	80		
Cyanide	57-12-5	9014	22	NC	0.1	0.05	0.1	0.05	0.0208		80	120

Notes:

- <sup>1</sup> The PAL for each analyte is the lower of the criteria shown. Refer to Section 6.2 for a detailed discussion on PALs by matrix.
  - <sup>2</sup> PQL goals are equal to half of the minimum applicable PAL.
  - <sup>3</sup> PALs and PQL Goals assume dry weight basis.
  - <sup>4</sup> DoD QSM v.4.1 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where statistical in-house limits are used.
- NC indicates that there is no criterion for an analyte.

TABLE 10-2C  
 Reference Limits and Evaluation Table

Matrix: Sediment (surface and subsurface)  
 Analytical Group: Wet Chemistry

Analyte	CAS Number <sup>3</sup>	Units	PIL <sup>1,2</sup>	Laboratory-Specific			LCS, MS/MSD %R and RPD Limits <sup>4</sup>		
				LOQ	LOD	DL	LCL	UCL	%RPD
TOC	TOC	mg/kg	2000	1000	1000	225	75	125	20
pH	PH	pH	NA	N/A	N/A	N/A	NC	NC	20

Notes:

- <sup>1</sup> There are no action limits for wet chemistry analytes because they are screening data. PILs are approximate threshold values for results that will help support the ERA.
- <sup>2</sup> TOC data in sediment will be used to adjust equilibrium partitioning-based ESVs and to evaluate habitat conditions. Data for pH will be used to evaluate habitat conditions.
- <sup>3</sup> In some instances a contractor-specific identifier is used.
- <sup>4</sup> DoD QSM v.4.1 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where statistical in-house limits are used.

Table 10-2D

Reference Limits and Evaluation Table

Matrix: Sediment (surface and subsurface)

Analytical Group: Wet Chemistry (AVS/SEM)

Analyte	CAS Number <sup>3</sup>	Units	PIL <sup>1,2</sup>	Laboratory-Specific			LCS, MS/MSD %R and RPD Limits <sup>4</sup>		
				LOQ	LOD	DL	LCL	UCL	%RPD
AVS	ACIDSO2	Micromole per gram (µmol/g)	N/A	0.068	0.0184	0.0082	<b>10</b>	<b>183</b>	<b>30</b>
Cadmium	7440-43-9	µmol/g	N/A	0.0022	0.0011	0.000452	<b>LCS: 80 MS: 75</b>	<b>LCS: 120 MS: 125</b>	<b>20</b>
Copper	7440-50-8	µmol/g	N/A	0.0039	0.0039	0.00152			
Lead	7439-92-1	µmol/g	N/A	0.006	0.006	0.00176			
Mercury	7439-97-6	µmol/g	N/A	0.000025	1.25E-05	6.9E-06			
Nickel	7440-02-0	µmol/g	N/A	0.0043	0.0043	0.00162			
Silver	7440-22-4	µmol/g	N/A	0.0023	0.0023	0.000946			
Zinc	7440-66-6	µmol/g	N/A	0.0076	0.0038	0.00187			

Notes:

- <sup>1</sup> There are no action limits for wet chemistry analytes because they are screening data. PILs are approximate threshold values for results that will help support the ERA.
- <sup>2</sup> The ratio of AVS/SEM will be used to evaluate the potential bioavailability of certain metals in sediment.
- <sup>3</sup> In some instances a contractor-specific identifier is used.
- <sup>4</sup> DoD QSM v.4.1 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where statistical in-house limits are used.

TABLE 10-3A  
 Reference Limits and Evaluation Table

Matrix: Groundwater  
 Analytical Group: VOCs

Analyte	CAS Number	Adjusted Tapwater RSL <sup>1</sup> (Nov 2012) (micrograms per liter [µg/L])	MCL <sup>1</sup> (µg/L)	ESV <sup>1</sup> (µg/L)	BTAG Values <sup>1</sup> (µg/L)	PQL Goal <sup>2</sup> (µg/L)	Laboratory-Specific (µg/L)			LCS, MS, and MSD %R Limits <sup>3</sup>		
							LOQ	LOD	DL	LCL	UCL	%RPD
Dichlorodifluoromethane (Freon-12)	75-71-8	19	NC	NC	NC	9.5	1	0.5	0.25	30	155	30
Chloromethane	74-87-3	19	NC	5500	NC	9.5	1	0.5	0.179	40	125	
Vinyl chloride	75-01-4	0.015	2	930	930	0.0075	1	0.5	0.238	50	145	
Bromomethane	74-83-9	0.7	NC	110	NC	0.35	1	0.5	0.279	30	145	
Chloroethane	75-00-3	2100	NC	NC	NC	1050	1	0.5	0.15	60	135	
Trichlorofluoromethane (Freon-11)	75-69-4	110	NC	NC	NC	55	1	0.5	0.179	60	145	
1,1-Dichloroethene	75-35-4	26	7	25	25	3.5	1	0.5	0.173	70	130	
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)	76-13-1	5300	NC	NC	NC	2650	1	0.5	0.225	70	130	
Acetone	67-64-1	1200	NC	1500	1500	600	10	1	0.655	40	140	
Carbon disulfide	75-15-0	72	NC	0.92	0.92	0.46	5	0.5	0.187	35	160	
Methyl acetate	79-20-9	1600	NC	NC	NC	800	5	0.5	0.273	70	130	
Methylene chloride	75-09-2	8.4	5	2200	98.1	2.5	1	0.5	0.347	55	140	
trans-1,2-Dichloroethene	156-60-5	8.6	100	590	970	4.3	1	0.5	0.114	60	140	
Methyl-tert-butyl ether (MTBE)	1634-04-4	12	NC	11070	11070	6	1	0.5	0.128	65	125	
1,1-Dichloroethane	75-34-3	2.4	NC	47	47	1.2	1	0.5	0.194	70	135	
cis-1,2-Dichloroethene	156-59-2	2.8	70	590	590	1.4	1	0.5	0.171	70	125	
2-Butanone	78-93-3	490	NC	14000	14000	245	5	0.5	0.281	30	150	
Chloroform	67-66-3	0.19	80	28	1.8	0.095	1	0.5	0.161	65	135	
1,1,1-Trichloroethane	71-55-6	750	200	11	11	5.5	1	0.5	0.143	65	130	
Cyclohexane	110-82-7	1300	NC	NC	NC	650	5	0.5	0.288	70	130	
Carbon tetrachloride	56-23-5	0.39	5	240	13.3	0.195	1	0.5	0.144	65	140	
Benzene	71-43-2	0.39	5	130	370	0.195	1	0.5	0.116	80	120	
1,2-Dichloroethane	107-06-2	0.15	5	910	100	0.075	1	0.5	0.122	70	130	
Trichloroethene	79-01-6	0.26	5	47	21	0.13	1	0.5	0.183	70	125	
Methylcyclohexane	108-87-2	NC	NC	NC	NC	0	5	0.5	0.234	70	130	
1,2-Dichloropropane	78-87-5	0.38	5	525	NC	0.19	1	0.5	0.146	75	125	
Bromodichloromethane	75-27-4	0.12	80	NC	NC	0.06	1	0.5	0.134	75	120	
cis-1,3-Dichloropropene	10061-01-5	0.41	NC	24.4	0.055	0.0275	1	0.1	0.0504	70	130	
4-Methyl-2-pentanone	108-10-1	100	NC	170	170	50	5	0.5	0.234	60	135	
Toluene	108-88-3	86	1000	9.8	2	1	1	0.1	0.057	75	120	
trans-1,3-Dichloropropene	10061-02-6	0.41	NC	24.4	0.055	0.0275	1	0.25	0.109	55	140	

TABLE 10-3A  
 Reference Limits and Evaluation Table

Matrix: Groundwater  
 Analytical Group: VOCs

Analyte	CAS Number	Adjusted Tapwater RSL <sup>1</sup> (Nov 2012) (µg/L)	MCL <sup>1</sup> (µg/L)	ESV <sup>1</sup> (µg/L)	BTAG Values <sup>1</sup> (µg/L)	PQL Goal <sup>2</sup> (µg/L)	Laboratory-Specific (µg/L)			LCS, MS, and MSD %R Limits <sup>3</sup>		
							LOQ	LOD	DL	LCL	UCL	%RPD
1,1,2-Trichloroethane	79-00-5	0.041	5	1200	1200	0.0205	1	0.5	0.152	75	125	
Tetrachloroethene	127-18-4	3.5	5	98	111	1.7	1	0.5	0.165	45	150	
2-Hexanone	591-78-6	3.4	NC	99	99	1.7	5	0.5	0.239	55	130	
Dibromochloromethane	124-48-1	0.15	80	NC	NC	0.075	1	0.25	0.0943	60	135	
1,2-Dibromoethane	106-93-4	0.0065	0.05	NC	NC	0.00325	1	0.25	0.107	80	120	
Chlorobenzene	108-90-7	7.2	100	64	1.3	0.65	1	0.5	0.128	80	120	
Ethylbenzene	100-41-4	1.3	700	290	90	0.65	1	0.25	0.107	75	125	
o-Xylene	95-47-6	19	10000	13	13	6.5	1	0.25	0.104	80	120	
m- and p-Xylene	m&pXYLENE	19	10000	13	13	6.5	2	0.5	0.286	75	130	
Styrene	100-42-5	110	100	72	72	36	1	0.1	0.0557	65	135	
Bromoform	75-25-2	7.9	80	320	320	3.95	1	0.25	0.102	70	130	
Isopropylbenzene	98-82-8	39	NC	2.6	2.6	1.3	1	0.5	0.169	75	125	
1,1,2,2-Tetrachloroethane	79-34-5	0.066	NC	610	610	0.033	1	0.5	0.12	65	130	
1,3-Dichlorobenzene	541-73-1	NC	NC	71	150	35.5	1	0.25	0.106	75	125	
1,4-Dichlorobenzene	106-46-7	0.42	75	15	26	0.21	1	0.5	0.156	75	125	
1,2-Dichlorobenzene	95-50-1	28	600	14	0.7	0.35	1	0.5	0.154	70	120	
1,2-Dibromo-3-chloropropane	96-12-8	0.00032	0.2	NC	NC	0.00016	2	0.5	0.251	50	130	
1,2,4-Trichlorobenzene	120-82-1	0.39	70	110	24	0.195	2	0.5	0.147	65	135	
Bromochloromethane	74-97-5	8.3	NC	NC	NC	4.15	1	0.5	0.157	65	130	
1,2,3-Trichlorobenzene	87-61-6	0.52	NC	8	8	0.26	2	0.5	0.138	55	140	

Notes:

<sup>1</sup> The PAL for each analyte is the lower of the criteria shown. Refer to Section 6.2 for a detailed discussion on PALs by matrix. No 95 percent UTL background values have been established for VOCs in groundwater at CAX.

<sup>2</sup> PQL goals are equal to half of the minimum applicable PALs.

<sup>3</sup> DoD QSM v.4.1 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where statistical in-house limits are used.

NC indicates that there is no criterion for an analyte.

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

TABLE 10-3B  
 Reference Limits and Evaluation Table

Matrix: Groundwater  
 Analytical Group: Total Metals

Analyte	CAS Number	Analytical Method	Adjusted Tapwater RSL <sup>1</sup> (Nov 2012) (µg/L)	MCL <sup>1</sup> (µg/L)	ESV <sup>1</sup> (µg/L)	BTAG Values <sup>1</sup> (µg/L)	Cornwallis Cave Aquifer 95% UTL background <sup>1</sup> (µg/L)	Yorktown Eastover Aquifer 95% UTL Background <sup>1</sup> (µg/L)	PQL Goal <sup>2</sup> (µg/L)	Laboratory-Specific (µg/L)			LCS, MS/MSD %R and RPD Limits <sup>3</sup>		
										LOQ	LOD	DL	LCL	UCL	%RPD
Aluminum	7429-90-5	6010C	1600	NC	87	87	2230	2230	43.5	100	50	13.1	80	120	20
Antimony	7440-36-0	6020A	0.6	6	30	30	NE	NE	0.3	2	0.5	0.148			
Arsenic	7440-38-2	6020A	0.045	10	150	5	2.28	2.28	0.0225	5	0.5	0.177			
Barium	7440-39-3	6020A	290	2000	4	4	118	118	2	2	0.5	0.136			
Beryllium	7440-41-7	6020A	1.6	4	0.66	0.66	2.45	2.45	0.33	1	0.4	0.111			
Cadmium	7440-43-9	6020A	0.69	5	0.27	NC	0.605	0.605	0.135	0.2	0.1	0.0385			
Calcium	7440-70-2	6010C	NC	NC	NC	NC	158000	169000	79000	500	500	230			
Chromium	7440-47-3	6020A	0.031	100	11.4	NC	15.1	15.1	0.0155	1	0.5	0.195			
Cobalt	7440-48-4	6020A	0.47	NC	23	23	20.6	20.6	0.235	1	0.2	0.0501			
Copper	7440-50-8	6020A	62	1300	9.33	NC	NE	NE	4.665	1	0.5	0.127			
Cyanide	57-12-5	9014	0.14	200	5.2	5	NE	NE	0.07	10	5	2.9	80	120	
Iron	7439-89-6	6010C	1100	NC	1000	300	3590	894	150	20	10	6.53	80	120	
Lead	7439-92-1	6020A	15	15	3.18	NC	NE	NE	1.59	1	0.5	0.152			
Magnesium	7439-95-4	6010C	NC	NC	NC	NC	3600	11500	1800	500	500	143			
Manganese	7439-96-5	6020A	32	NC	120	120	57.9	57.9	16	2	0.5	0.141			
Mercury	7439-97-6	7470A	0.43	2	0.91	0.026	NE	NE	0.013	0.2	0.1	0.0551			
Nickel	7440-02-0	6020A	30	NC	52.16	NC	11.4	11.4	5.7	1	0.5	0.171			
Potassium	7440-09-7	6010C	NC	NC	NC	NC	3490	12700	1745	100	100	32.9			
Selenium	7782-49-2	6020A	7.8	50	5	1	NE	NE	0.5	5	1	0.31			
Silver	7440-22-4	6020A	7.1	NC	0.36	NC	NE	NE	0.18	0.5	0.1	0.0367			
Sodium	7440-23-5	6010C	NC	NC	NC	NC	9920	64500	4960	500	500	127			
Thallium	7440-28-0	6020A	0.016	2	12	0.8	NC	NC	0.008	0.2	0.1	0.0268			
Vanadium	7440-62-2	6020A	7.8	NC	20	20	26.2	26.2	3.9	1	0.2	0.0657			
Zinc	7440-66-6	6020A	470	NC	119.82	NC	4.52	4.52	2.26	10	4	1.5			

Notes:

<sup>1</sup> The PAL for each analyte is the lower of the criteria shown. Refer to Section 6.2 for a detailed discussion on PALs by matrix. Background 95 percent UTLs are shown for both aquifers at CAX, AOC 1 South is associated with the Cornwallis Cave aquifer. AOC 6 and AOC 7 are associated with the Yorktown-Eastover aquifer.

<sup>2</sup> PQL goals are equal to half of the minimum applicable PALs.

<sup>3</sup> DoD QSM v.4.1 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where statistical in-house limits are used.

NC indicates that there is no criterion for an analyte.

NE indicates that the 95 percent UTL was not evaluated for this analyte.

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

TABLE 10-3C  
 Reference Limits and Evaluation Table

Matrix: Groundwater  
 Analytical Group: Dissolved Metals

Analyte	CAS Number	Analytical Method	Adjusted Tapwater RSL <sup>1</sup> (Nov 2012) (µg/L)	MCL <sup>1</sup> (µg/L)	ESV <sup>1</sup> (µg/L)	BTAG Values <sup>1</sup> (µg/L)	Cornwallis Cave Aquifer 95% UTL background <sup>1</sup> (µg/L)	Yorktown Eastover Aquifer 95% UTL Background <sup>1</sup> (µg/L)	PQL Goal <sup>2</sup> (µg/L)	Laboratory-Specific (µg/L)			LCS, MS/MSD %R and RPD Limits <sup>3</sup>		
										LOQ	LOD	DL	LCL	UCL	%RPD
Aluminum	7429-90-5	6010C	1600	NC	87	NC	NE	NE	43.5	100	50	13.1	80	120	20
Antimony	7440-36-0	6020A	0.6	6	30	NC	NE	NE	0.3	2	0.5	0.148			
Arsenic	7440-38-2	6020A	0.045	10	150	NC	1.37	1.37	0.0225	5	0.5	0.177			
Barium	7440-39-3	6020A	290	2000	4	NC	127	127	2	2	0.5	0.136			
Beryllium	7440-41-7	6020A	1.6	4	0.66	NC	NE	NE	0.33	1	0.4	0.111			
Cadmium	7440-43-9	6020A	0.69	5	0.246	0.25	0.177	0.177	0.0885	0.2	0.1	0.0385			
Calcium	7440-70-2	6010C	NC	NC	NC	NC	148000	113000	56500	500	500	230			
Chromium	7440-47-3	6020A	0.031	100	11	11	6.04	6.04	0.0155	1	0.5	0.195			
Cobalt	7440-48-4	6020A	0.47	NC	23	NC	NE	NE	0.235	1	0.2	0.0501			
Copper	7440-50-8	6020A	62	1300	8.96	8.96	NE	NE	4.48	1	0.5	0.127			
Iron	7439-89-6	6010C	1100	NC	1000	NC	631	275	137.5	20	10	6.53			
Lead	7439-92-1	6020A	15	15	2.52	2.52	NE	NE	1.26	1	0.5	0.152			
Magnesium	7439-95-4	6010C	NC	NC	NC	NC	3880	11200	1940	500	500	143			
Manganese	7439-96-5	6020A	32	NC	120	NC	49.5	49.5	16	2	0.5	0.141			
Mercury	7439-97-6	7470A	0.43	2	0.77	NC	NE	NE	0.215	0.2	0.1	0.0551			
Nickel	7440-02-0	6020A	30	NC	52.01	52	NE	NE	15	1	0.5	0.171			
Potassium	7440-09-7	6010C	NC	NC	NC	NC	1710	12600	855	100	100	32.9			
Selenium	7782-49-2	6020A	7.8	50	4.61	NC	NE	NE	2.305	5	1	0.31			
Silver	7440-22-4	6020A	7.1	NC	0.36	3.22	NE	NE	0.18	0.5	0.1	0.0367			
Sodium	7440-23-5	6010C	NC	NC	NC	NC	10000	62800	5000	500	500	127			
Thallium	7440-28-0	6020A	0.016	2	12	NC	NC	NC	0.008	0.2	0.1	0.0268			
Vanadium	7440-62-2	6020A	7.8	NC	20	NC	NE	NE	3.9	1	0.2	0.0657			
Zinc	7440-66-6	6020A	470	NC	118.14	118	NE	NE	59	10	4	1.5			

Notes:

<sup>1</sup> The PAL for each analyte is the lower of the criteria shown. Refer to Section 6.2 for a detailed discussion on PALs by matrix. Background 95 percent UTLs are shown for both aquifers at CAX, AOC 1 South is associated with the Cornwallis Cave aquifer. AOC 6 and AOC 7 are associated with the Yorktown-Eastover aquifer.

<sup>2</sup> PQL goals are equal to half of the minimum applicable PALs.

<sup>3</sup> DoD QSM v.4.1 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where statistical in-house limits are used.

NC indicates that there is no criterion for an analyte.

NE indicates that the 95 percent UTL was not evaluated for this analyte.

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

TABLE 10-4A  
 Reference Limits and Evaluation Table

Matrix: Surface Water  
 Analytical Group: PAHs

Analyte	CAS Number	SW-846 8270C Method	Adjusted Tapwater RSL X 10 for SW <sup>1</sup> (Nov 2012) (µg/L)	ESV <sup>1</sup> (µg/L)	BTAG Values <sup>1</sup> (µg/L)	PQL Goal <sup>2</sup> (µg/L)	Laboratory-Specific (µg/L)			LCS, MS, and MSD %R Limits <sup>3</sup>		
							LOQ	LOD	DL	LCL	UCL	%RPD
2-Methylnaphthalene	91-57-6	SIM	27	330	4.7	2.35	0.05	0.05	0.0094	45	105	30
Acenaphthene	83-32-9	SIM	400	23	5.8	2.9	0.05	0.05	0.011	45	110	
Acenaphthylene	208-96-8	SIM	400	4840	NC	200	0.05	0.05	0.0072	50	105	
Anthracene	120-12-7	SIM	1300	0.73	0.012	0.006	0.05	0.05	0.0039	55	110	
Benzo(a)anthracene	56-55-3	SIM	0.29	0.027	0.018	0.009	0.05	0.05	0.0124	55	110	
Benzo(a)pyrene	50-32-8	SIM	0.029	0.014	0.015	0.007	0.05	0.05	0.008	55	110	
Benzo(b)fluoranthene	205-99-2	SIM	0.29	9.07	NC	0.145	0.05	0.05	0.0153	45	120	
Benzo(g,h,i)perylene	191-24-2	SIM	87	7.64	NC	3.82	0.05	0.05	0.0057	40	125	
Benzo(k)fluoranthene	207-08-9	SIM	2.9	9.07	NC	1.45	0.05	0.05	0.0167	45	125	
Chrysene	218-01-9	SIM	29	NC	NC	14.5	0.05	0.05	0.0103	55	110	
Dibenz(a,h)anthracene	53-70-3	SIM	0.029	NC	NC	0.0145	0.05	0.05	0.0158	40	125	
Fluoranthene	206-44-0	SIM	630	8.1	0.04	0.02	0.05	0.05	0.0108	55	115	
Fluorene	86-73-7	SIM	220	3.9	3	1.5	0.05	0.05	0.0099	50	110	
Indeno(1,2,3-cd)pyrene	193-39-5	SIM	0.29	4.31	NC	0.145	0.05	0.05	0.0147	45	125	
Naphthalene	91-20-3	SIM	1.4	12	1.1	0.55	0.05	0.05	0.0098	40	100	
Phenanthrene	85-01-8	SIM	1300	6.3	0.4	0.2	0.05	0.05	0.01	50	115	
Pyrene	129-00-0	SIM	87	0.025	0.025	0.0125	0.05	0.05	0.0036	50	130	

Notes:

<sup>1</sup> The PAL for each analyte is the lower of the criteria shown. Refer to Section 6.2 for a detailed discussion on PALs by matrix. No 95 percent UTL background values have been established for VOCs in groundwater at CAX.

<sup>2</sup> PQL goals are equal to half of the minimum applicable PALs.

<sup>3</sup> DoD QSM v.4.1 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where statistical in-house limits are used.

NC indicates that there is no criterion for an analyte.

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

TABLE 10-4B  
 Reference Limits and Evaluation Table

Matrix: Surface Water  
 Analytical Group: Total Metals

Analyte	CAS Number	Analytical Method	Adjusted Tapwater RSL <sup>1</sup> (Nov 2012) (µg/L)	ESV <sup>1</sup> (µg/L)	BTAG Values <sup>1</sup> (µg/L)	PQL Goal <sup>2</sup> (µg/L)	Laboratory-Specific (µg/L)			LCS, MS/MSD %R and RPD Limits <sup>3</sup>		
							LOQ	LOD	DL	LCL	UCL	%RPD
Aluminum	7429-90-5	6010C	1600	87	87	43.5	100	50	13.1	80	120	20
Antimony	7440-36-0	6020A	0.6	30	30	0.3	2	0.5	0.148			
Arsenic	7440-38-2	6020A	0.045	150	5	0.0225	5	0.5	0.177			
Barium	7440-39-3	6020A	290	4	4	2	2	0.5	0.136			
Beryllium	7440-41-7	6020A	1.6	0.66	0.66	0.33	1	0.4	0.111			
Cadmium	7440-43-9	6020A	0.69	0.27	NC	0.135	0.2	0.1	0.0385			
Calcium	7440-70-2	6010C	NC	NC	NC	0	500	500	230			
Chromium	7440-47-3	6020A	0.031	11.4	NC	0.0155	1	0.5	0.195			
Cobalt	7440-48-4	6020A	0.47	23	23	0.235	1	0.2	0.0501			
Copper	7440-50-8	6020A	62	9.33	NC	4.665	1	0.5	0.127			
Cyanide	57-12-5	9014	0.14	5.2	5	0.07	10	5	2.9	80	120	
Iron	7439-89-6	6010C	1100	1000	300	150	20	10	6.53	80	120	
Lead	7439-92-1	6020A	15	3.18	NC	1.59	1	0.5	0.152			
Magnesium	7439-95-4	6010C	NC	NC	NC	0	500	500	143			
Manganese	7439-96-5	6020A	32	120	120	16	2	0.5	0.141			
Mercury	7439-97-6	7470A	0.43	0.91	0.026	0.013	0.2	0.1	0.0551			
Nickel	7440-02-0	6020A	30	52.16	NC	15	1	0.5	0.171			
Potassium	7440-09-7	6010C	NC	NC	NC	0	100	100	32.9			
Selenium	7782-49-2	6020A	7.8	5	1	0.5	5	1	0.31			
Silver	7440-22-4	6020A	7.1	0.36	NC	0.18	0.5	0.1	0.0367			
Sodium	7440-23-5	6010C	NC	NC	NC	0	500	500	127			
Thallium	7440-28-0	6020A	0.016	12	0.8	0.008	0.2	0.1	0.0268			
Vanadium	7440-62-2	6020A	7.8	20	20	3.9	1	0.2	0.0657			
Zinc	7440-66-6	6020A	470	119.82	NC	59.91	10	4	1.5			

Notes:

<sup>1</sup> The PAL for each analyte is the lower of the criteria shown. Refer to Section 6.2 for a detailed discussion on PALs by matrix.

<sup>2</sup> PQL goals are equal to half of the minimum applicable PALs.

<sup>3</sup> DoD QSM v.4.1 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where statistical in-house limits are used.

NC indicates that there is no criterion for an analyte.

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

TABLE 10-4C  
 Reference Limits and Evaluation Table

Matrix: Surface Water  
 Analytical Group: Dissolved Metals

Analyte	CAS Number	Analytical Method	Adjusted Tapwater RSL <sup>1</sup> (Nov 2012) (µg/L)	ESV <sup>1</sup> (µg/L)	BTAG Values <sup>1</sup> (µg/L)	PQL Goal <sup>2</sup> (µg/L)	Laboratory-Specific (µg/L)			LCS, MS/MSD %R and RPD Limits <sup>3</sup>		
							LOQ	LOD	DL	LCL	UCL	%RPD
Aluminum	7429-90-5	6010C	1600	87	NC	43.5	100	50	13.1	80	120	20
Antimony	7440-36-0	6020A	0.6	30	NC	0.3	2	0.5	0.148			
Arsenic	7440-38-2	6020A	0.045	150	NC	0.0225	5	0.5	0.177			
Barium	7440-39-3	6020A	290	4	NC	2	2	0.5	0.136			
Beryllium	7440-41-7	6020A	1.6	0.66	NC	0.33	1	0.4	0.111			
Cadmium	7440-43-9	6020A	0.69	0.246	0.25	0.123	0.2	0.1	0.0385			
Calcium	7440-70-2	6010C	NC	NC	NC	0	500	500	230			
Chromium	7440-47-3	6020A	0.031	11	11	0.0155	1	0.5	0.195			
Cobalt	7440-48-4	6020A	0.47	23	NC	0.235	1	0.2	0.0501			
Copper	7440-50-8	6020A	62	8.96	8.96	4.48	1	0.5	0.127			
Iron	7439-89-6	6010C	1100	1000	NC	500	20	10	6.53			
Lead	7439-92-1	6020A	15	2.52	2.52	1.26	1	0.5	0.152			
Magnesium	7439-95-4	6010C	NC	NC	NC	0	500	500	143			
Manganese	7439-96-5	6020A	32	120	NC	16	2	0.5	0.141			
Mercury	7439-97-6	7470A	0.43	0.77	NC	0.215	0.2	0.1	0.0551			
Nickel	7440-02-0	6020A	30	52.01	52	15	1	0.5	0.171			
Potassium	7440-09-7	6010C	NC	NC	NC	0	100	100	32.9			
Selenium	7782-49-2	6020A	7.8	4.61	NC	2.305	5	1	0.31			
Silver	7440-22-4	6020A	7.1	0.36	3.22	0.18	0.5	0.1	0.0367			
Sodium	7440-23-5	6010C	NC	NC	NC	0	500	500	127			
Thallium	7440-28-0	6020A	0.016	12	NC	0.008	0.2	0.1	0.0268			
Vanadium	7440-62-2	6020A	7.8	20	NC	3.9	1	0.2	0.0657			
Zinc	7440-66-6	6020A	470	118.14	118	59	10	4	1.5			

Notes:

<sup>1</sup> The PAL for each analyte is the lower of the criteria shown. Refer to Section 6.2 for a detailed discussion on PALs by matrix.

<sup>2</sup> PQL goals are equal to half of the minimum applicable PALs.

<sup>3</sup> DoD QSM v.4.1 is the basis for LCS and MS/MSD limits; values are bolded to indicate instances where statistical in-house limits are used.

NC indicates that there is no criterion for an analyte.

NE indicates that the 95 percent UTL was not evaluated for this analyte.

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

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TABLE 10-4D  
 Reference Limits and Evaluation Table

Matrix: Surface Water

Analytical Group: Wet Chemistry

Analyte	CAS Number <sup>3</sup>	PIL <sup>1,2</sup> (µg/L)	Laboratory-Specific (µg/L)			LCS, MS, and MSD %R and %RPD Limits <sup>4</sup>		
			LOQ	LOD	DL	LCL	UCL	%RPD
Hardness	HARDNESS	25,000	2,000	2,000	1,020	92	110	20

Notes:

<sup>1</sup> There are no action limits for wet chemistry analytes because they are screening data. PILs are approximate threshold values for results that will help support the ERA.

<sup>2</sup> Hardness data will be used to adjust the ESVs for certain metals.

<sup>3</sup> A contractor-specific identifier is used.

<sup>4</sup> DoD QSM v.4.1 is the basis for LCS and MS/MSD limits: values are bolded to indicate instances where statistical in-house limits are used.

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# 11 Analytical SOP References Table

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

Information regarding the laboratory SOPs and to be used for the handling and analysis of samples is provided in Analytical SOP References Tables, **Tables 11-1** and **11-2**.

TABLE 11-1  
 Analytical SOP References Table  
 Laboratory Name and Address: TriMatrix Laboratories  
 5560 Corporate Exchange Ct. SE,  
 Grand Rapids, MI 49512

POC: Walt Roudebush  
 Phone Number: (616) 975-4561

Lab SOP Number	Title, Revision Date, and Number	Date reviewed if not revised	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work?
GR-01-100	Inductively Coupled Plasma (ICP) Atomic Emission Spectroscopy (AES)-Perkin Elmer OPTIMA-3300DV/5300DV; 9/20/11, rev 5.9	10/04/12	Definitive	Solid, Water/Metals	ICP/AES	None	No
GR-01-123	Mercury by semi-Automated Cold Vapor Atomic Absorption (CVAA); 9/25/11, rev 5.8	10/04/12	Definitive	Solid, Water/Metals	CVAA	None	No
GR-01-129	Inductively Coupled Plasma Mass Spectrometry (ICPMS) Perkin Elmer ELAN-6000/6100; 03/25/12; rev 4.1	In review	Definitive	Solid, Water/Metals	ICPMS	None	No
GR-01-137	Block Digestion of Solids for ICP and ICPMS, 10/31/12, rev 1.7	N/A	Definitive	Solid/Metals	N/A	None	No
GR-01-139	Preparation Procedure for Mercury in Soils, Wastes, and Oils, 01/09/12, rev 0.2	In review	Definitive	Solid/Metals	N/A	None	No
GR-01-140	Preparation Procedure for Mercury in Water, Wastewater, and Liquid Waste, 01/09/12, rev 0.4	In review	Definitive	Water/Metals	N/A	None	No
GR-01-147	Block Digestion of Total Metals in Water for ICP, 09/15/12, rev 0.5	N/A	Definitive	Water/Metals	N/A	None	No
GR-01-148	Block Digestion of Aqueous Samples and Extracts for Total/Dissolved Metals by ICPMS, 10/20/11, rev 0.4	10/04/12	Definitive	Water/Metals	N/A	None	No
GR-03-120	Organochlorine Pesticides Analysis by Gas Chromatography (GC); 9/30/11, rev 4.6	10/04/12	Definitive	Solid/Pesticides	GC/Electron capture detector (ECD)	None	No
GR-03-128	PCBs by GC, 02/28/12, rev 2.7	In review	Definitive	Solid/PCBs	GC/ECD	None	No
GR-04-103	Base/Neutral/Acid (BNA) Compounds by Gas Chromatography/Mass Spectrometry (GC/MS), 07/21/12, rev 5.8	N/A	Definitive	Solid, Water/SVOC	GC/MS	None	No
GR-04-104	VOCs by Purge and Trap Capillary Column GC/MS, 04/25/13, rev 4.8	N/A	Definitive	Water/VOC	GC/MS	None	No
GR-05-122	Total and Amenable Cyanide by Konelab Ultraviolet (UV) Spectrophotometry, 03/25/12	In review	Definitive	Solid, Water/Cyanide	Spectrophotometer	None	No
GR-05-132	Leco Carbon Analyzer (Organic Carbon), 1/20/12, rev 0.0	02/04/13	Definitive	Solid/Wet Chemistry	Carbon Analyzer	None	No
GR-06-104	Total Hardness as CaCO <sub>3</sub> , Titrimetric, EDTA, 8/10/11, rev 2.4	In review	Definitive	Water/Wet Chemistry	N/A	None	No
GR-07-100	Potentiometric pH, 1/25/12, rev 3.5	In review	Screening	Water/Wet Chemistry	pH meter	None	No
GR-07-113	pH Potentiometric Method Soils and Wastes (Non-Aqueous Liquids), 1/25/12, rev 0.3	In review	Screening	Solid/Wet Chemistry	pH meter	None	No
GR-09-101	Extraction of BNA from Water, 08/05/12, rev 3.5	N/A	Definitive	Water/SVOC	N/A	None	No
GR-09-103	Extraction of BNA Semivolatiles from Soil, Sediment, and Sludge, 01/31/13, rev 3.8	N/A	Definitive	Solid/SVOC	N/A	None	No
GR-09-108	Extraction of Organochlorine Pesticides, and PCBs from Soil, Sludge and Wipe Samples, 11/05/11, rev 2.4	N/A	Definitive	Solid/Pesticides, PCBs	N/A	None	No
GR-10-104	Internal Chain of Custody, 02/28/13, 2.4	N/A	N/A	N/A	N/A	None	No
GR-15-100	Sample Receipt and Log-In, 12/30/12, rev 3.4	N/A	N/A	N/A	N/A	None	No
GR-15-102	Laboratory Waste Disposal Guidelines, 08/15/12, rev 2.4	N/A	N/A	N/A	N/A	None	No
GR-16-119	Particle-Size Analysis of Soils, 04/15/13, rev 0.1	N/A	Definitive	Solid/Grain-size	sieves	None	No
GR-18-106	Total and Amenable Cyanide Extraction and/or Macro-Distillation, 08/15/12, rev 3.4	N/A	Definitive	Solid, Water/Cyanide	N/A	None	No
GR-19-100	AVS and Selected SEM, 02/04/13, rev 2.3	N/A	Definitive	Solid/Wet Chemistry	Spectrophotometer, ICP/AES, CVAA	None	No

Notes:

DoD Environmental Laboratory Accreditation Program (ELAP) certification is required for this work. TriMatrix meets this requirement; their DoD ELAP current certification was issued 5/30/13 and is valid nominally 2 years from that date. A copy of the current DoD ELAP letter is included in **Appendix B**.

TABLE 11-2  
 Analytical SOP References Table

Laboratory Name and Address: ALS-Rochester  
 1565 Jefferson Road  
 Building 300, Suite 360  
 Rochester, NY 14623

POC: Deb Patton

Phone Number: (585) 672-7473

Lab SOP Number	Title, Revision Date, and Number	Date reviewed if not revised	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work?
GEN-7199	Hexavalent Chromium by Ion Chromatography, rev 05, 06/07/12	N/A	Definitive	water and soil	Ion Chromatography	None	No
GEN-3060A	Alkaline Digestion for Hexavalent Chromium in Soils, rev 03, 03/01/13	N/A	Prep	soil	Prep	None	No
HPLC-8330	Nitroaromatics and Nitramines (Explosives) by High Performance Liquid Chromatography (HPLC), Revision 1, 5/27/11	In review	Definitive	water and soil	HPLC-UV	None	No

Notes:

DoD ELAP certification is required for this work. ALS-Rochester meets this requirement; their DoD ELAP current certification was issued 4/7/2012 and is valid for nominally 2 years from that date. A copy of the current DoD ELAP letter is included in Appendix B.

# 12 Laboratory QC Samples Table

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

Laboratories analyzing samples in support of this work will perform laboratory QC samples at the frequency required by the DoD QSM 4.1. Details regarding each laboratory QC sample are provided in the Laboratory QC Samples Tables, **Tables 12-1 through 12-14**.

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TABLE 12-1  
 Laboratory QC Samples Table

Matrix: Groundwater  
 Analytical Group: VOCs  
 Analytical Method/SOP Reference: SW-846 8260B/GR-04-104

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of up to 20 samples.	No analytes detected > 1/2 LOQ and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.	Correct the problem. If required, re-prepare and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/Laboratory Area Supervisor	Contamination/Bias	Same as Method/SOP QC Acceptance Limits.
LCS containing all analytes to be reported, including surrogates		QC acceptance criteria specified in DoD QSM v4.2; refer to Table A10-3A.	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.		Accuracy/Bias	
MS		Same as LCS.	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Accuracy/Bias	
MSD		Same as MS, and refer to Table A10-3a for RPD.	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Precision/Accuracy/Bias	
Internal Standards (IS) verification	Every field sample, standard, and QC sample	Retention times for IS must be ± 30 seconds from retention time of the midpoint standard in the initial calibration (ICAL) and the responses within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and/or gas chromatograph for malfunctions. Reanalysis of samples analyzed while system was malfunctioning is mandatory.		Precision/Accuracy/Bias	
Surrogate spike	All field and QC samples.	1,2-dichloroethane-d <sub>4</sub> 70-120, 4-Bromofluorobenzene 75-120, dibromofluoromethane 85-115 Toluene-d <sub>8</sub>	For QC and field samples, correct problem then re-prepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.		Accuracy/Bias	

TABLE 12-2  
 Laboratory QC Samples Table

Matrix: Soil (surface and subsurface), Sediment (surface and subsurface), Surface Water

Analytical Group: SVOCs (and/or PAHs)

Analytical Method/SOP Reference: SW-846 8270C and 8270C-SIM/GR-04-103

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of up to 20 samples.	No analytes detected > 1/2 LOQ and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.	Correct the problem. If required, re-prepare and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/Laboratory Area Supervisor	Contamination/Bias	Same as Method/SOP QC Acceptance Limits.
LCS containing all analytes to be reported, including surrogates		QC acceptance criteria specified in DoD QSM v4.2; refer to Tables 10-1A, 10-2A, 10-4A.	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.		Accuracy/Bias	
MS		Same as LCS.	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Accuracy/Bias	
MSD		Same as MS, and refer to Tables 10-1A, 10-2A, 10-4A for RPD.	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Precision/Accuracy/Bias	
IS verification	Every field sample, standard, and QC sample	Retention times for IS must be ± 30 seconds from retention time of the midpoint standard in the ICAL and the responses within -50% to +100% of ICAL midpoint standard.	Inspect mass spectrometer and/or gas chromatograph for malfunctions. Reanalysis of samples analyzed while system was malfunctioning is mandatory.		Precision/Accuracy/Bias	
Surrogate spike	All field and QC samples.	<u>Solids:</u> Nitrobenzene-d5 35-100; 2-Fluorobiphenyl 45-105; o-Terphenyl 30-125; Phenol-d6 40-100; 2-Fluorophenol 35-105; 2,4,6-Tribromophenol 35-125 <u>Waters:</u> Nitrobenzene-d5 40-110; 2-Fluorobiphenyl 50-110; o-Terphenyl 50-135; Phenol-d6 10-115; 2-Fluorophenol 20-110; 2,4,6-Tribromophenol 40-125	For QC and field samples, correct problem then re-prepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.		Accuracy/Bias	

TABLE 12-3  
 Laboratory QC Samples Table

Matrix: Soil (surface, subsurface, composite)

Analytical Group: Pesticides

Analytical Method/SOP Reference: SW-846 8081B/GR-03-120

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of up to 20 samples.	No analytes detected > 1/2 LOQ and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.	Correct the problem. If required, re-prepare and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/Laboratory Area Supervisor	Contamination/Bias	Same as Method/SOP QC Acceptance Limits.
LCS containing Aroclor-1016 and Aroclor-1260		QC acceptance criteria specified in DoD QSM v4.2; refer to Table A10-1B.	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.		Accuracy/Bias	
MS		Same as LCS.	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Accuracy/Bias	
MSD		Same as MS, and refer to Table A10-3B for RPD.	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Precision/Accuracy/Bias	
Surrogate spike	All field and QC samples.	Decachlorobiphenyl within 55-130 %R and Tetrachloro-m-xylene (TCMX) within 70-125%R.	For QC and field samples, correct problem then re-prepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.		Accuracy/Bias	

TABLE 12-4  
 Laboratory QC Samples Table

Matrix: Soil (surface, subsurface, composite)

Analytical Group: PCBs

Analytical Method/SOP Reference: SW-846 8082A/GR-03-128

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of up to 20 samples.	No analytes detected > 1/2 LOQ and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > LOQ.	Correct the problem. If required, re-prepare and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/Laboratory Area Supervisor	Contamination/Bias	Same as Method/SOP QC Acceptance Limits.
LCS containing Aroclor-1016 and Aroclor-1260		QC acceptance criteria specified in DoD QSM v4.2; refer to Table A10-1C.	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.		Accuracy/Bias	
MS		Same as LCS.	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Accuracy/Bias	
MSD		Same as MS, and refer to Table A10-1C for RPD.	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Precision/Accuracy/Bias	
Surrogate spike	All field and QC samples.	Decachlorobiphenyl within 60-125%R.	For QC and field samples, correct problem then re-prepare and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.		Accuracy/Bias	

TABLE 12-5  
 Laboratory QC Samples Table

Matrix: Soil (surface and subsurface), Sediment (surface and subsurface), Surface Water, Groundwater  
 Analytical Group: METALS (refer to Tables A1 for a specific list of analytes by this method)  
 Analytical Method/SOP Reference: SW-846 6010C/GR-01-100

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of up to 20 samples.	No analytes detected > 1/2 RL and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL.	Correct the problem. If required, re-prepare and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/Laboratory Area Supervisor	Contamination/Bias	Same as Method/SOP QC Acceptance Limits.
LCS containing all analytes to be reported		QC acceptance criteria specified in DoD QSM v4.1.; refer to Tables 10-1 through 10-4.	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.		Accuracy/Bias	
MS		Same as LCS.	Examine results of LCS. If both the LCS and MS/MSD or MS/duplicate (DUP) are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Accuracy/Bias	
MSD or Sample DUP		Same as MS and refer to Tables 10-1 through 10-4.	Examine results of LCS. If both the LCS and MS/MSD or MS/DUP are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Precision/Accuracy/Bias	
Serial Dilution (aka Dilution test)	One per preparatory batch for samples with concentration > 50 x LOQ.	Five-fold dilution must agree within ± 10% of the original measurement.	Perform post-digestion spike (PDS) addition.		Precision/Accuracy	
PDS	When serial dilution fails or analyte concentration in all samples < 50 x LOD.	Recovery within 75-125%.	Run all associated sample in the preparatory batch by method of standard additions (MSA) or qualify results.		Precision/Accuracy	
IS	N/A	IS intensity within 70-125% of intensity of the IS in the ICAL.	Reanalyze sample at five-fold dilution with addition of appropriate amounts of IS.		Accuracy/Bias	

TABLE 12-6  
 Laboratory QC Samples Table

Matrix: Soil (surface and subsurface), Sediment (surface and subsurface), Surface Water, Groundwater

Analytical Group: METALS (refer to Tables A1 for a specific list of analytes by this method)

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

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of up to 20 samples.	No analytes detected > 1/2 RL and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL.	Correct the problem. If required, re-prepare and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/Laboratory Area Supervisor	Contamination/Bias	Same as Method/SOP QC Acceptance Limits.
LCS containing all analytes to be reported		QC acceptance criteria specified in DoD QSM v4.1; refer to Tables 10-1 through 10-4.	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.		Accuracy/Bias	
MS		Same as LCS.	Examine results of LCS. If both the LCS and MS/MSD or MS/DUP are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Accuracy/Bias	
MSD or Sample DUP		Same as MS and refer to Tables 10-1 through 10-4.	Examine results of LCS. If both the LCS and MS/MSD or MS/DUP are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Precision/Accuracy/Bias	
Serial Dilution (aka Dilution test)	One per preparatory batch for samples with concentration > 50 x LOQ.	Five-fold dilution must agree within ± 10% of the original measurement.	Perform PDS addition.		Precision/Accuracy	
PDS	When serial dilution fails or analyte concentration in all samples < 50 x LOD.	Recovery within 75-125%.	Run all associated sample in the preparatory batch by MSA or qualify results.		Precision/Accuracy	
IS	N/A.	IS intensity within 30-120% of intensity of the IS in the ICAL.	Reanalyze sample at five-fold dilution with addition of appropriate amounts of IS.		Accuracy/Bias	

TABLE 12-7  
 Laboratory QC Samples Table

Matrix: Soil (surface and subsurface), Sediment (surface and subsurface), Surface Water, Groundwater

Analytical Group: METALS (Mercury)

Analytical Method/SOP Reference: SW-846 7471A and 7470A/GR-01-123

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of up to 20 samples.	No analytes detected > 1/2 RL and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected > RL.	Correct the problem. If required, re-prepare and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/Laboratory Area Supervisor	Contamination/Bias	Same as Method/SOP QC Acceptance Limits.
LCS containing analyte to be reported		QC acceptance criteria specified in DoD QSM v4.1; refer to Tables 10-1 through 10-4.	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.		Accuracy/Bias	
MS		Same as LCS.	Examine results of LCS. If both the LCS and MS/MSD or MS/DUP are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Accuracy/Bias	
MSD or Sample DUP		Same as MS and refer to Tables 10-1 through 10-4.	Examine results of LCS. If both the LCS and MS/MSD or MS/DUP are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Precision/Accuracy/Bias	

TABLE 12-8  
 Laboratory QC Samples Table

Matrix: Soil (surface and subsurface), Sediment (surface and subsurface), Surface Water, Groundwater

Analytical Group: METALS (Cyanide)

Analytical Method/SOP Reference: SW-846 9014/GR-05-122

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of up to 20 samples.	No analytes detected > 1/2 RL and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct the problem. If required, re-prepare and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/Laboratory Area Supervisor	Contamination/Bias	Same as Method/SOP QC Acceptance Limits.
LCS		QC acceptance criteria specified in DoD QSM v4.1; refer to Tables 10-1 through 10-4.	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for the failed analyte, if sufficient sample material is available.		Accuracy/Bias	
MS		Use in-house limits for LCS.	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Accuracy/Bias	
MSD or Sample DUP		Same as MS and refer to Tables 10-1 through 10-4.	Examine results of LCS. If both the LCS and MS/MSD or MS/DUP are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.		Precision/Accuracy/Bias	

TABLE 12-9  
 Laboratory QC Samples Table

Matrix: Soil (surface and subsurface)  
 Analytical Group: Hexavalent Chromium  
 Analytical Method/SOP Reference: SW-846 7199/GEN-7199

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	1 per batch of 20 or fewer samples.	No target compounds should be >1/2 LOQ.	Reclean, reanalyze and/or qualify the data.	Analyst/Supervisor	Bias/Contamination	Same as Method/SOP QC Acceptance Limits.
LCS-insoluble		Refer to Table 10-2B.	Redigest if possible. If samples are out of holding time, redigest and report both sets of data. If insufficient sample is available to redigest, flag. If the LCS recoveries are high and the sample results are <LOQ, narrate.		Accuracy/Bias	
LCS-insoluble					Accuracy/Bias	
MS-soluble		75-125% of the true value.	Redigest entire batch unless spike is diluted out (sample result > 4x spike concentration). If redigest fails, contact client about possible matrix investigations. If samples are out of holding time, redigest and report both sets of data. If insufficient sample is available to redigest, flag. Flag results associated with out of control matrix spike.		Accuracy/Bias	
MS-insoluble		If parent concentration is >4x the LOQ, RPD<20%; if the parent concentration is <4x the LOQ, duplicate is acceptable if the difference is not > +/- LOQ.	Re-prepare and reanalyze sample and duplicate unless obvious or historical interferences or lack of volume.		Precision	
DUP (or MSD)					Bias	
Post-digestion MS						

TABLE 12-10  
 Laboratory QC Samples Table

Matrix: Soil (surface and subsurface)

Analytical Group: Explosives

Analytical Method/SOP Reference: SW-846 8330A/HPLC-8330

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Surrogate	All field and QC samples - one pre sample	1,2-Dinitrobenzene 40-140% water 50-150% soil	Evaluate and reanalyze if possible. If the surrogate is outside the established limits due to well-documented matrix effects, the results must be flagged and an explanation included in the case narrative.	Analyst/Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptable Limits
Method Blank	1 per batch of 20 or fewer samples	No analytes detected > 1/2 the LOQ.	Correct problem. If required, re-prepare and reanalyze method blank and samples with hits <10x method blank contamination. If reanalysis is not possible, flag associated results.		Bias/Contamination	
LCS		QC acceptance criteria specified in DoD QSM v4.1; refer to Table A10-1E.	Evaluate, reextract and reanalyze batch if possible. If the LCS recoveries are high but the sample results <LOQ then narrate, otherwise re-prepare and reanalyze.		Accuracy/Bias	
MS		Same as LCS.	If LCS acceptable, may report with qualifier and note outliers in the case narrative		Precision/Accuracy/Bias	
MSD		Same as MS, and refer to Table A10-1e.	If LCS acceptable, may report with qualifier and note outliers in the case narrative unless RPD indicates prep/analytical difficulties.		Precision/Accuracy/Bias	
Second Column Confirmation		All positive results must be confirmed	Results between primary and second column must be RPD<40%		Apply J flag if RPD >40%. Discuss in case narrative.	

TABLE 12-11  
 Laboratory QC Samples Table

Matrix: Soil (surface and subsurface), Sediment (surface and subsurface)

Analytical Group: Wet Chemistry (TOC)

Analytical Method/SOP Reference: Lloyd Kahn/GR-05-132

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of up to 20 samples.	Analyte not detected > 1/2 RL and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Re-prepare and analyze all associated samples. Discuss with client/qualify if re-analysis not feasible.	Analyst/Laboratory Area Supervisor	Contamination/Bias	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparatory batch of up to 20 samples.	QC acceptance criteria specified in DoD QSM v4.1; refer to Tables 10-1F and 10-2C.	Re-prepare and analyze all associated samples. Discuss with client/qualify if re-analysis not feasible.	Analyst/Laboratory Area Supervisor	Accuracy/Bias	
MS	One per preparatory batch of up to 20 samples.	For matrix evaluation use QC acceptance criteria specified for LCS.	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.	Analyst/Laboratory Area Supervisor	Accuracy/Bias	
MSD	One per preparatory batch of up to 20 samples.	Same as MS, and refer to Tables 10-1F and 10-2C.	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.	Analyst/Laboratory Area Supervisor	Accuracy/Bias	

TABLE 12-12  
 Laboratory QC Samples Table

Matrix: Soil (surface and subsurface), Sediment (surface and subsurface)

Analytical Group: WCHEM (pH)

Analytical Method/SOP Reference: SW-846 9045C/GR-07-113

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Standard Reference Material	Two per preparatory batch of up to 20 samples.	$\pm 0.05$ pH units of certified value	Re-prepare and analyze all associated samples.	Analyst/Laboratory Area Supervisor	Accuracy	Same as Method/SOP QC Acceptance Limits.
Laboratory DUP	One per preparatory batch of up to 20 samples.	RPD limit for pH is 20.	Re-prepare and analyze all associated samples.	Analyst/Laboratory Area Supervisor	Bias	

TABLE 12-13  
 Laboratory QC Samples Table

Matrix: Surface Water  
 Analytical Group: Wet Chemistry (Hardness)  
 Analytical Method/SOP Reference: SM 2340 C/GR-06-104

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of up to 20 samples.	Analyte not detected > 1/2 RL and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Re-prepare and analyze all associated samples. Discuss with client/qualify if re-analysis not feasible.	Analyst/Laboratory Area Supervisor	Contamination/Bias	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparatory batch of up to 20 samples.	Refer to Table A10-4D.	Re-prepare and analyze all associated samples. Discuss with client/qualify if re-analysis not feasible.	Analyst/Laboratory Area Supervisor	Accuracy/Bias	
MS	One per preparatory batch of up to 20 samples.	Same as LCS.	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.	Analyst/Laboratory Area Supervisor	Accuracy/Bias	
MSD	One per preparatory batch of up to 20 samples.	Same as MS, and refer to Table A10-4D.	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.	Analyst/Laboratory Area Supervisor	Accuracy/Bias	

TABLE 12-14  
 Laboratory QC Samples Table

Matrix: Sediment (surface and subsurface)

Analytical Group: AVS/SEM

Analytical Method/SOP Reference: AVS/SEM; SOP GR-19-100

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	MPC
Method Blank	One per preparatory batch of up to 20 samples.	No analytes detected > 1/2 RL and greater than 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct the problem. If required, re-prepare and reanalyze the method blank and all samples processed with the contaminated blank.	Analyst/Laboratory Area Supervisor	Contamination/Bias	Same as Method/SOP QC Acceptance Limits.
LCS	One per preparatory batch of up to 20 samples.	Refer to Table 10-2D.	Correct problem, then re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for the failed analyte, if sufficient sample material is available.	Analyst/Laboratory Area Supervisor	Accuracy/Bias	
MS	One per preparatory batch of up to 20 samples.	Use in-house limits for LCS.	Examine results of LCS. If both the LCS and MS/MSD are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.	Analyst/Laboratory Area Supervisor	Accuracy/Bias	
MSD or Sample DUP	One per preparatory batch of up to 20 samples.	Same as MS, and refer to Table A10-2D.	Examine results of LCS. If both the LCS and MS/MSD or MS/DUP are unacceptable, re-prepare and analyze the associated samples and QC, otherwise report and narrate.	Analyst/Laboratory Area Supervisor	Precision/Accuracy/Bias	

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

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

Data will be collected and reviewed for quality and completeness as detailed in **Table 13-1**, the *Data Verification and Validation (Steps I and IIa/IIb) Process Table* as follows. More information about data validation and usability is provided in **Section 6.2.5**.

TABLE 13-1  
 Data Verification and Validation (Steps I and IIa/IIb)<sup>1</sup> Process Table

Data Review Input	Description	Responsible for Verification/Validation	Internal/External <sup>2</sup>
Chains 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 chains of custody retained in the site file, and the original and remaining copies taped inside the cooler for shipment. Chains of custody will also be reviewed for adherence to the SAP by the PC.	FTL/CH2M HILL PC/CH2M HILL	Internal and External
Sample Condition upon Receipt	Any discrepancies, missing, or broken containers will be communicated to the PC in the form of laboratory logins.	PC/CH2M HILL	External
Documentation of Laboratory Method Deviations	Laboratory Method Deviations will be discussed and approved by the PC. Documentation will be incorporated into the case narrative, which becomes part of the final hardcopy data package.	PC/CH2M HILL	External
Electronic Data Deliverables	Electronic Data Deliverables will be compared against hardcopy laboratory results (10 percent check).	PC/CH2M HILL	External
Case Narrative	Case narratives will be reviewed by the DV during the data validation process. This is verification that they were generated and applicable to the data packages.	DV/CH2M HILL	External
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal.	Respective Laboratory QAO	Internal
Laboratory Data	The data will be verified for completeness by the PC.	PC/CH2M HILL	External
Audit Reports	Upon report completion, a copy of all audit reports will be placed in the site file. If CAs are required, a copy of the documented CA taken will be attached to the appropriate audit report in the QA site file. Periodically, and at the completion of site work, site file audit reports and CA forms will be reviewed internally to ensure that all appropriate CAs have been taken and that CA reports are attached. If CAs have not been taken, the site manager will be notified to ensure action is taken.	PM/CH2M HILL PC/CH2M HILL	Internal
CA Reports	CA reports will be reviewed by the PC or PM and placed into the project file for archival at project closeout.	PM/CH2M HILL PC/CH2M HILL	External
Laboratory Methods	Ensure the laboratory analyzed samples using the correct methods.	PC/CH2M HILL	External

TABLE 13-1  
 Data Verification and Validation (Steps I and IIa/IIb)<sup>1</sup> Process Table

Data Review Input	Description	Responsible for Verification/Validation	Internal/External <sup>2</sup>
Target Compound List and Target Analyte List	Ensure the laboratory reported all analytes from each analysis group.	PC/CH2M HILL	External
RLs	Ensure the laboratory met the PQLs. If QLs were not met, the reason will be determined and documented.	PC/CH2M HILL	External
Field SOPs	Ensure that all field SOPs were followed.	FTL/CH2M HILL	Internal
Laboratory SOPs	Ensure that approved analytical laboratory SOPs were followed.	Respective Laboratory QAO	Internal
Raw Data	10 percent review of raw data to confirm laboratory calculations.	DV/CH2M HILL	External
Onsite Screening	All non-analytical field data will be reviewed against SAP requirements for completeness and accuracy based on the field calibration records.	FTL/CH2M HILL	Internal
Documentation of Method QC Results	Establish that all required QC samples were run.	DV/CH2M HILL	External
Documentation of Field QC Sample Results	Establish that all required QC samples were run.	PC/CH2M HILL	Internal
DoD ELAP Evaluation	Ensure that each laboratory is DoD ELAP-certified for the analyses they are to perform. Ensure evaluation timeframe does not expire.	PC/CH2M HILL	External
Analytical data for VOCs, SVOCs, PAHs, Pesticides, PCBs, Metals (total and dissolved), Mercury (total and dissolved), Cyanide, Hexavalent Chromium, and Explosives in all matrixes analyzed, such as groundwater, soil (surface, subsurface, composite), sediment (surface and subsurface), and/or surface water.	Analytical methods and laboratory SOPs as presented in this SAP will be used to evaluate compliance against QA/QC criteria. Should adherence to QA/QC criteria yield deficiencies, data may be qualified. The data qualifiers used are those presented in <i>Region 3 Modifications to the National Functional Guidelines for Organic Data Review</i> (USEPA, 1994) and in <i>Region 3 Modifications to the Laboratory Data Validation Guidelines for Inorganic Data Review</i> (USEPA, 1993). National Functional Guidelines will not be used for data validation; however, the specific qualifiers listed therein may be applied to data should non-conformances against the QA/QC criteria as presented in this SAP be identified.	DV/CH2M HILL	External
Analytical data for wet chemistry, grain size, or AVS/SEM in all matrixes analyzed, such as soil (surface and subsurface), sediment (surface and subsurface), and/or surface water.	Wet chemistry (Natural Attenuation Indication Parameters), AVS/SEM and grain-size analytical data will not undergo third-party data validation, but are subject to all other previously detailed data review.	N/A	N/A

Notes:

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

<sup>2</sup> Internal or external is in relation to the data generator.

Should CH2M HILL find discrepancies during the verification or validation procedures above, an email documenting the issue will be circulated to the internal project team, and a Corrections to File Memo will be prepared identifying the issues and the corrective action needed. This memo will be sent to the laboratory, or applicable party, and maintained in the project file.

## 14 References

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- CH2M HILL. 2011a. *Final Site Inspection Report, Site 4, Site 9, and Area of Concern 3, Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia.* December.
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- CH2M HILL. 2012. *Final Site Inspection Report, Areas of Concern 1, 2, 6, 7, and 8, Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia.* May.
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- Dames & Moore. 1986. *Confirmation Study Step 1A (Verification), Round One, Naval Supply Center, Cheatham Annex, Williamsburg, VA and Naval Supply Center, Yorktown Fuels Division, Yorktown, VA.*
- Dames & Moore. 1991. *Remedial Investigation Interim Report, Naval Supply Center (Norfolk), Cheatham Annex.*
- Roy F. Weston, Inc. (Weston). 1999. *Final Site Inspection Narrative Report, Penniman Shell Loading Plant, Williamsburg, Virginia.* August 9.
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## Figures

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**Legend**

-  Study Area Boundary
-  Cheatham Annex Boundary



Figure 1  
Base Location Map  
Expanded Site Inspection UFP-SAP  
Cheatham Annex  
Williamsburg, Virginia



- Legend**
- Outfall
  - Former Drainage Ditch
  - Elevation Contour (5 ft)
  - - - Storm Water Line
  - Groundwater Flow Path
  - ▭ Study Area Boundary
  - ▭ Water Body

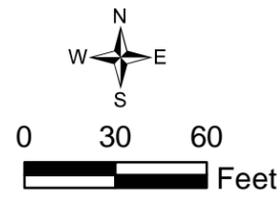


Figure 2  
Site 9 Site Map  
Expanded Site Inspection UFP-SAP  
Cheatham Annex  
Williamsburg, Virginia



**Legend**

-  Utility Poles
-  Drainage Channel (arrow represents flow direction)
-  Anticipated Surface Water Flow
-  Approximate Study Area Boundary

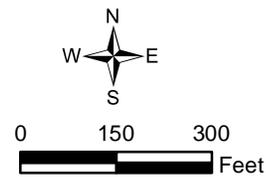


Figure 3  
AOC 1 Site Map  
Expanded Site Inspection UFP-SAP  
Cheatham Annex  
Williamsburg, Virginia



**Legend**

-  Anticipated Surface Water Flow
-  Contour Elevations (10 ft)
-  Approximate Study Area Boundary
-  CAX Boundary / Fenceline

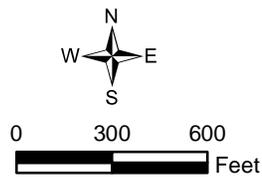


Figure 4  
AOC 6 Site Map  
Expanded Site Inspection UFP-SAP  
Cheatham Annex  
Williamsburg, Virginia



**Legend**

-  Anticipated Surface Water Flow
-  Topographic Surface Contour (feet above mean sea level)
-  Approximate AOC 7 Study Area
-  Approximate area of the Former Drum Disposal Area
-  Approximate Extent of Buried Debris within the Can Pit (4-16 feet below ground surface)

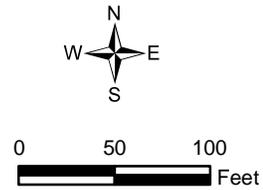
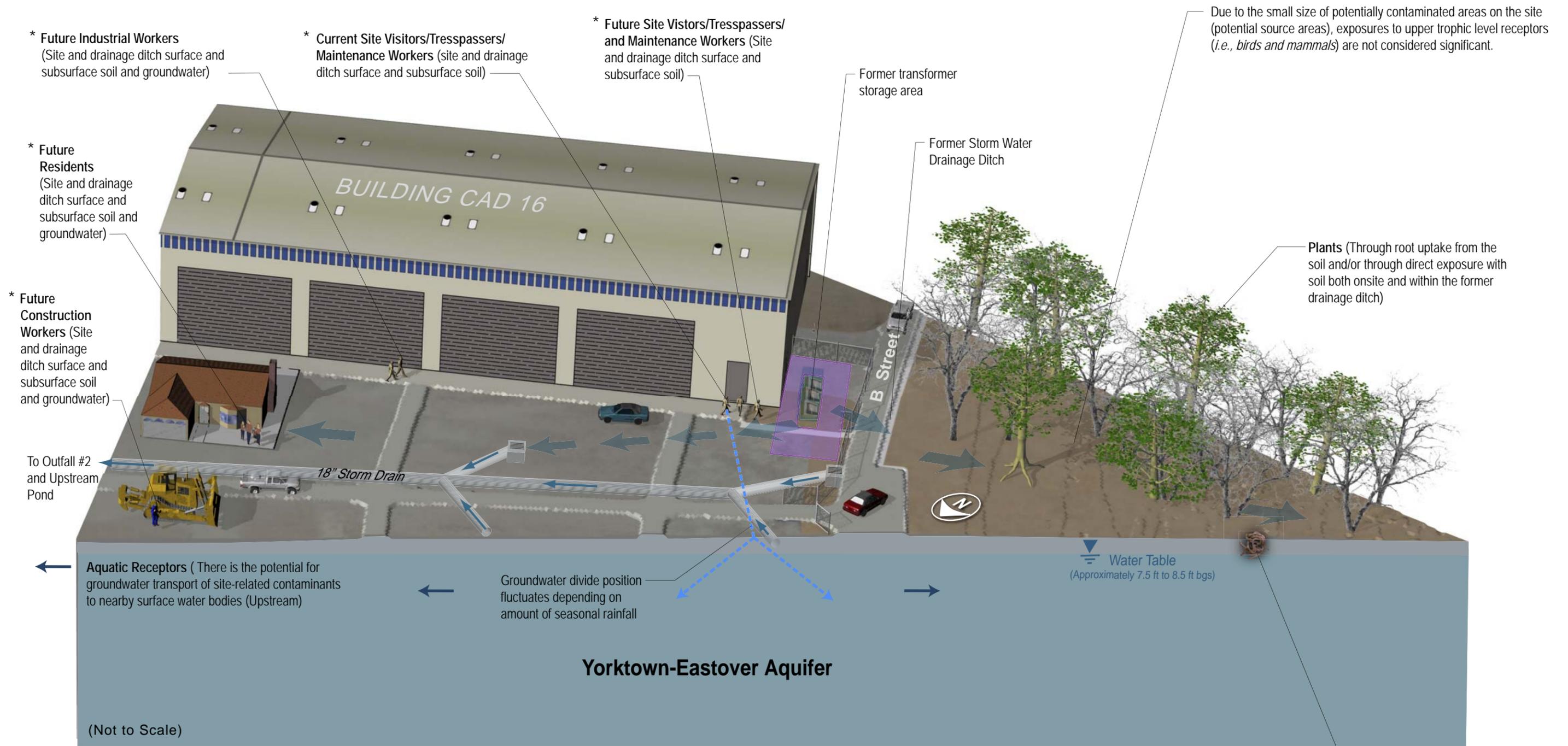


Figure 5  
AOC 7 Site Map  
Expanded Site Inspection UFP-SAP  
Cheatham Annex  
Williamsburg, Virginia



Due to the small size of potentially contaminated areas on the site (potential source areas), exposures to upper trophic level receptors (i.e., birds and mammals) are not considered significant.

**Soil Invertebrates** (Through direct contact with soil both onsite and within the former drainage ditch)

**LEGEND**

- Site Study Area
- Stormwater Flow
- Groundwater Flow Path
- Approximate Location of Groundwater Divide
- Water Table
- Overland Surface Water Flow
- Drop Inlet
- Feet Below Ground Surface

\* These potential receptors may be exposed to site-related contaminants through incidental ingestion of, inhalation of particulates from, and dermal contact with site and drainage ditch soil; and ingestion of and/or dermal contact with groundwater.

**Figure 6**  
Site 9 Conceptual Site Model  
Expanded Site Inspection UFP-SAP  
Cheatham Annex  
Williamsburg, Virginia



**Legend**

- 1986 Soil Sample Location
- Proposed Surface Soil Sample
- ▲ Proposed Co-Located Surface/Subsurface Drainage Soil Sample
- Proposed 5-Point Composite Drainage Soil Sample
- ⊕ Surface/Subsurface Drainage Soil sample for Hexavalent Chromium Analysis
- 2009 SI Sediment Sample Location
- 2009 SI Well Point Groundwater Sample Location
- ▲ 2009 SI Soil Sample Location
- ➡ Groundwater Flow Path
- - - Storm Water Line
- Former Drainage Ditch
- Elevation Contour (5 ft interval)
- ▭ Site 9 Study Area Boundary



Figure 7  
 Site 9 Proposed Sampling Locations  
 Expanded Site Inspection UFP-SAP  
 Cheatham Annex  
 Williamsburg, Virginia

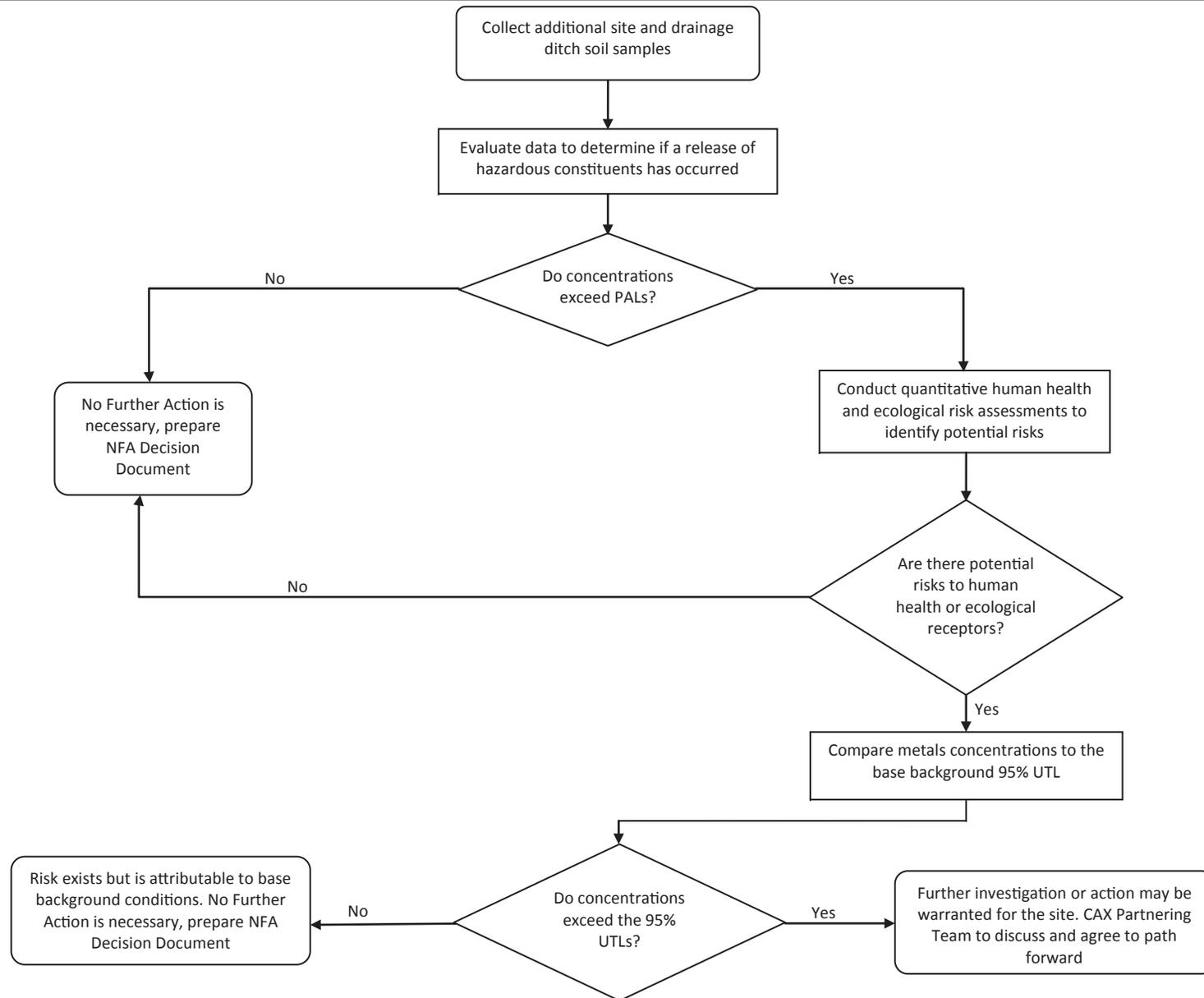


FIGURE 8  
 Site 9 - Expanded Site Inspection Decision Logic  
 Cheatham Annex  
 Williamsburg, Virginia

**Aquatic Receptors** (There is also the potential for transport of site-related constituents via surface flow and groundwater to nearby surface water bodies [Jones Pond and its tributaries], at which point there may be potential exposures [surface water and/or sediment] to lower trophic level aquatic receptors [plants, amphibians, reptiles, fish, and benthic invertebrates], as well as to upper trophic level aquatic receptors [birds and mammals].)

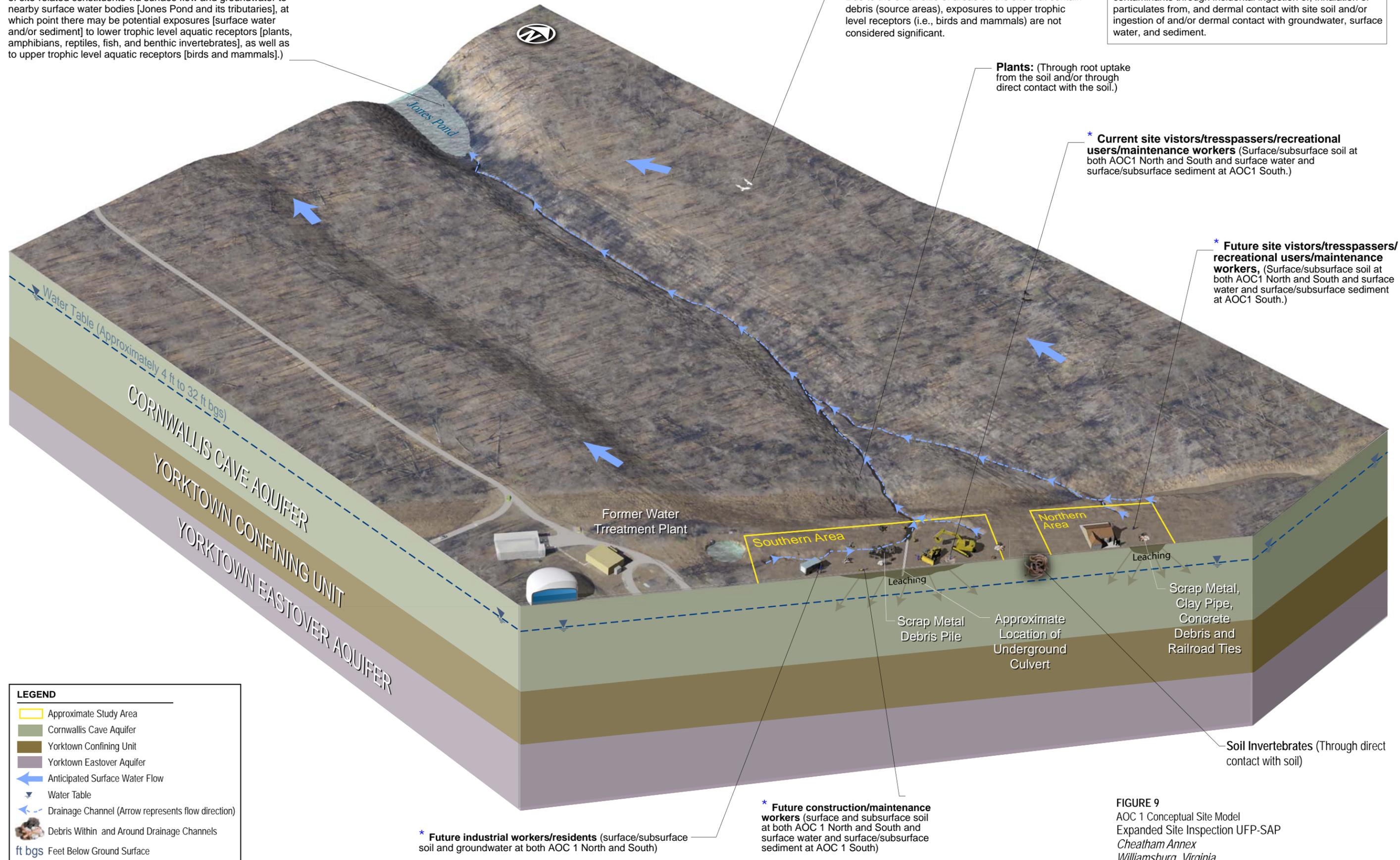
Due to the small size of areas on the site that contain debris (source areas), exposures to upper trophic level receptors (i.e., birds and mammals) are not considered significant.

\* These potential receptors may be exposed to site-related contaminants through incidental ingestion of, inhalation of particulates from, and dermal contact with site soil and/or ingestion of and/or dermal contact with groundwater, surface water, and sediment.

**Plants:** (Through root uptake from the soil and/or through direct contact with the soil.)

\* **Current site visitors/trespassers/recreational users/maintenance workers** (Surface/subsurface soil at both AOC1 North and South and surface water and surface/subsurface sediment at AOC1 South.)

\* **Future site visitors/trespassers/recreational users/maintenance workers**, (Surface/subsurface soil at both AOC1 North and South and surface water and surface/subsurface sediment at AOC1 South.)



**LEGEND**

- Approximate Study Area
- Cornwallis Cave Aquifer
- Yorktown Confining Unit
- Yorktown Eastover Aquifer
- Anticipated Surface Water Flow
- Water Table
- Drainage Channel (Arrow represents flow direction)
- Debris Within and Around Drainage Channels

ft bgs Feet Below Ground Surface

\* **Future industrial workers/residents** (surface/subsurface soil and groundwater at both AOC 1 North and South)

\* **Future construction/maintenance workers** (surface and subsurface soil at both AOC 1 North and South and surface water and surface/subsurface sediment at AOC 1 South)

**FIGURE 9**  
AOC 1 Conceptual Site Model  
Expanded Site Inspection UFP-SAP  
Cheatham Annex  
Williamsburg, Virginia



**Legend**

- SI Groundwater/Soil Sample Location
- SI Soil Sample Location
- ⊗ Proposed Groundwater Sample
- Proposed Surface Soil Sample
- 🌿 Utility Poles
- ➡ Drainage Channel
- - - Overhead Utility Lines
- ▭ Approximate Boundary of Scrap Metal Debris Pile (~20'H x ~52"W)
- ▭ Approximate Study Area Boundary



Figure 10  
 AOC 1 South Proposed Sample Locations  
 Expanded Site Inspection UFP-SAP  
 Cheatham Annex  
 Williamsburg, Virginia



**Legend**

- SI Groundwater/Soil Sample Location
- SI Soil Sample Location
- Proposed Surface/Subsurface Soil Location
- ⊗ Proposed Groundwater Sample Location
- ▼ Proposed Surface Sediment, Subsurface Sediment & Surface Water Sample Location
- ⚡ Utility Poles
- Drainage Channel
- - - Overhead Utility Lines
- Approximate Boundary of Scrap Metal Debris Pile (~20' H x ~52' W)
- Approximate Study Area Boundary

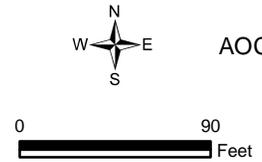


Figure 11  
 AOC 1 South Proposed Sample Locations  
 Expanded Site Inspection UFP-SAP  
 Cheatham Annex  
 Williamsburg, Virginia

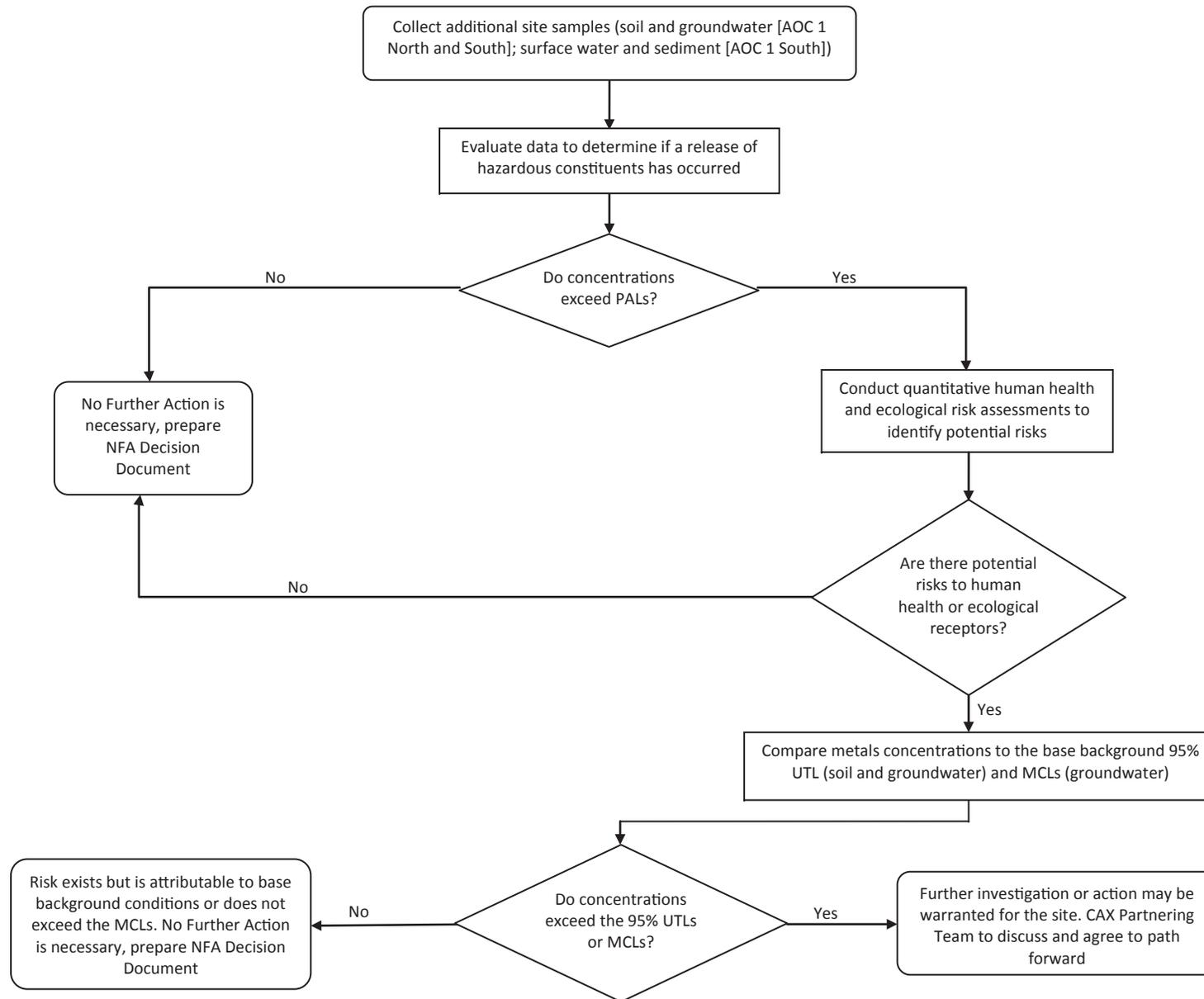
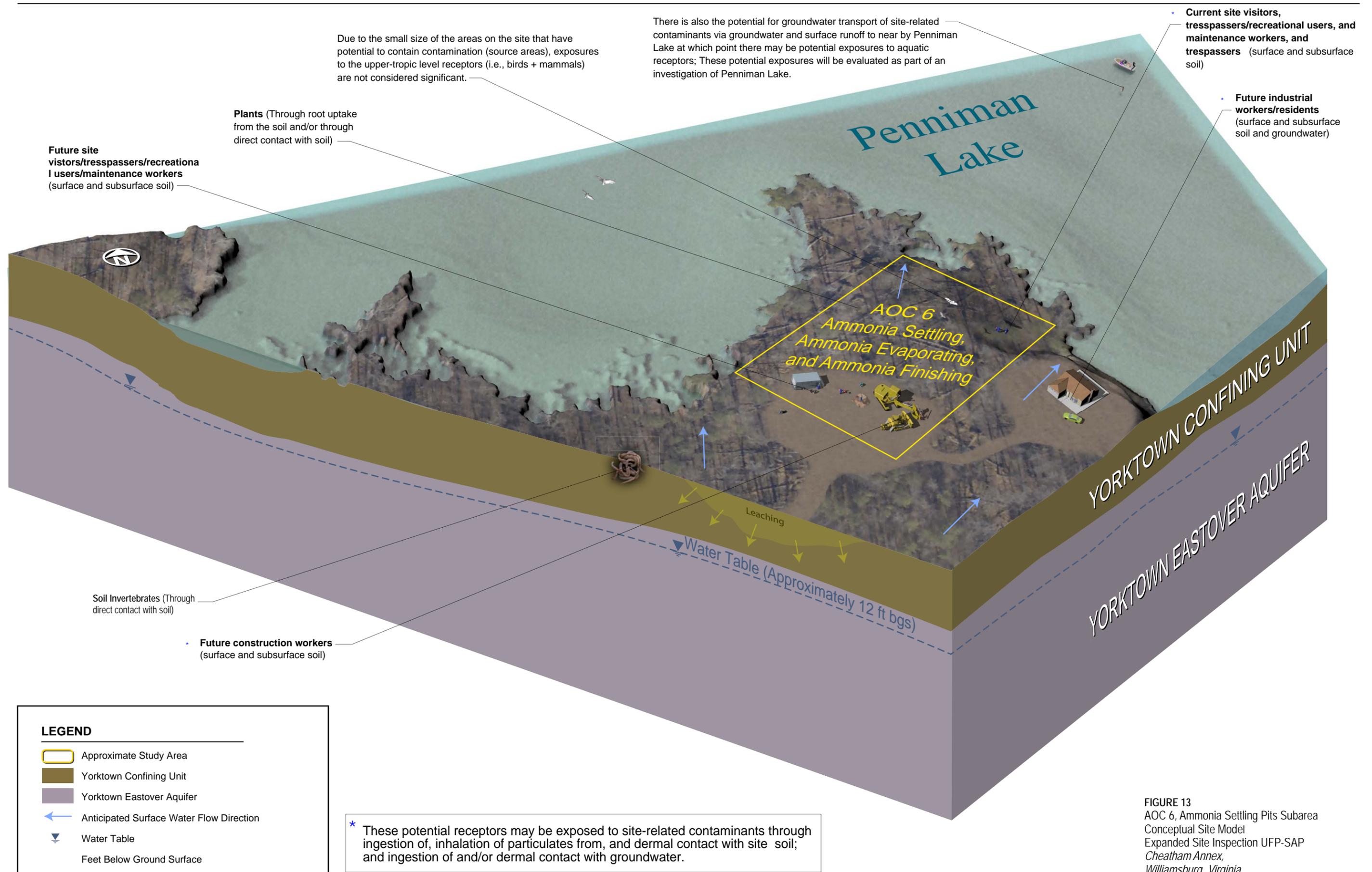


FIGURE 12  
**AOC 1 - Expanded Site Inspection Decision Logic**  
*Cheatham Annex*  
*Williamsburg, Virginia*



**FIGURE 13**  
AOC 6, Ammonia Settling Pits Subarea  
Conceptual Site Model  
Expanded Site Inspection UFP-SAP  
Cheatham Annex,  
Williamsburg, Virginia



**Legend**

- SI Groundwater/Soil Sample
- SI Soil Sample
- Proposed Surface/Subsurface Soil Sample Location
- ⊗ Proposed Groundwater Location
- Anticipated Surface Water Flow
- Former Buildings
- Approximate AOC 6 Study Area

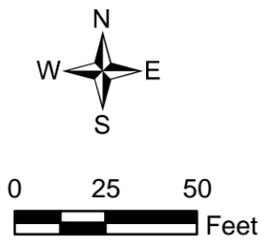


Figure 14  
Ammonia Settling Pits Subarea  
AOC 6 Proposed Sample Locations  
Expanded Site Inspection UFP-SAP  
Cheatham Annex  
Williamsburg, Virginia

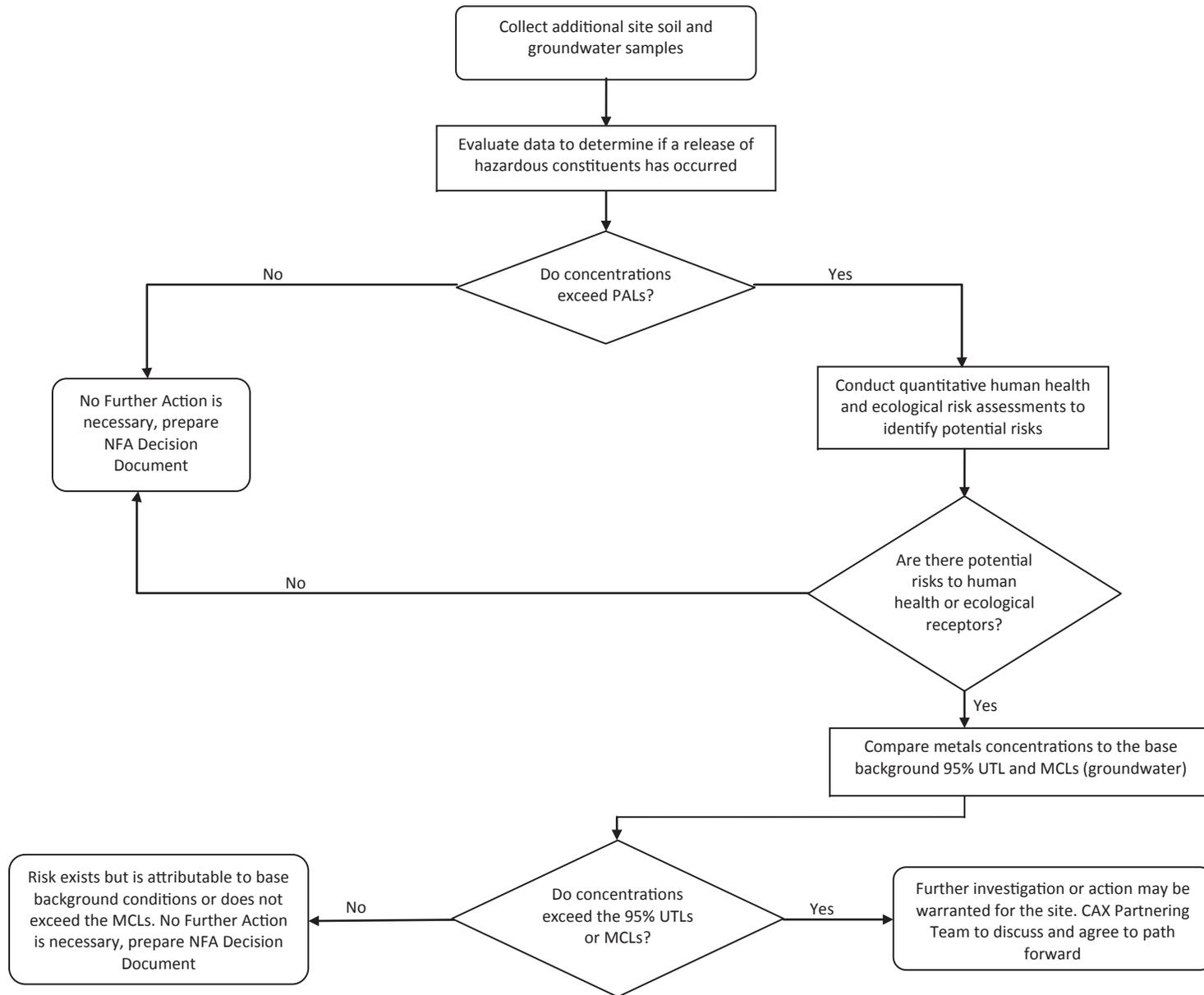
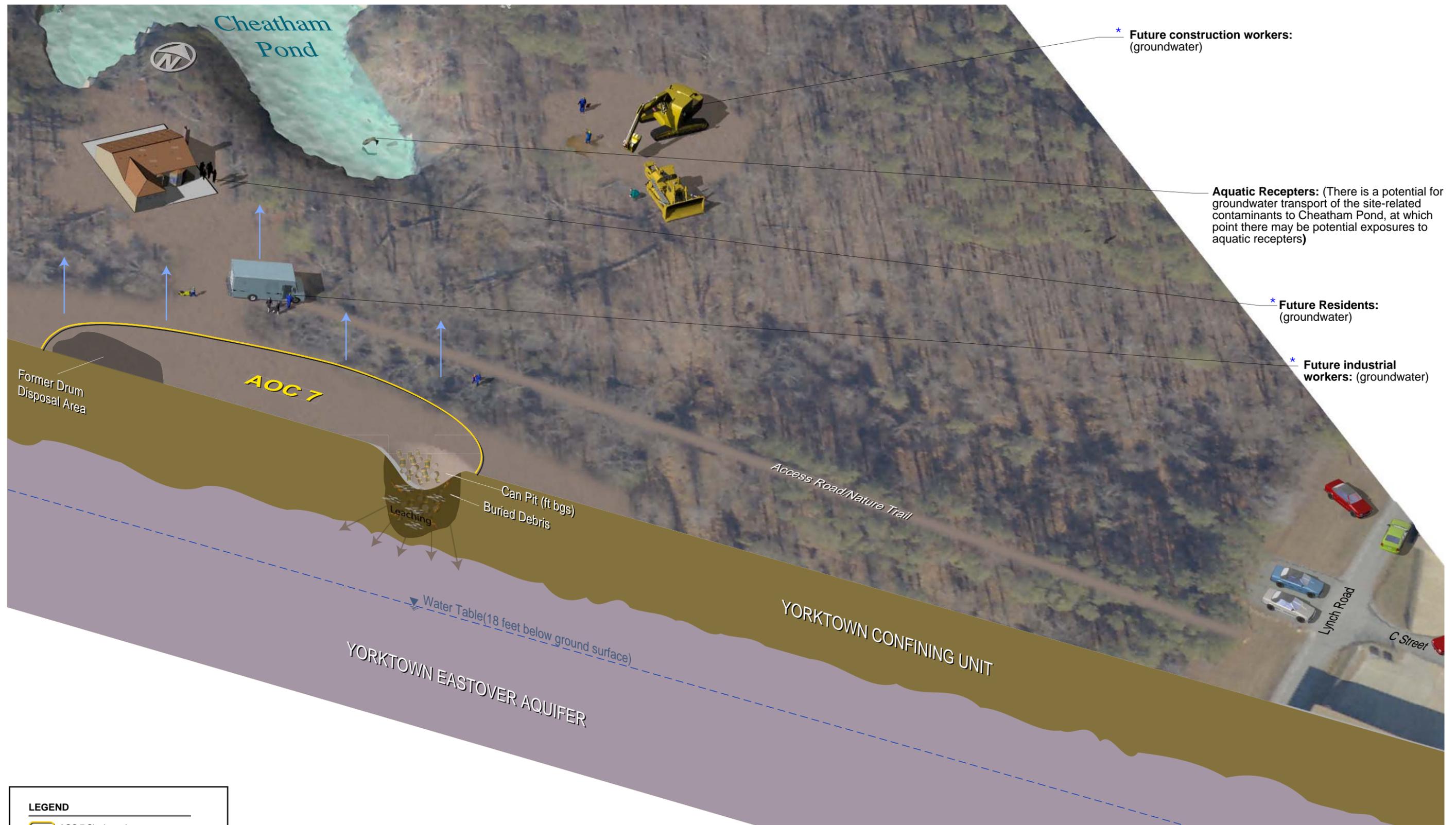


FIGURE 15  
**AOC 6 - Expanded Site Inspection Decision Logic**  
*Cheatham Annex*  
*Williamsburg, Virginia*



LEGEND	
	AOC 7 Site boundary
	Yorktown Confining Unit
	Yorktown Eastover Aquifer
	Anticipated Surface Water Flow Direction
	Water Table
ft bgs	Feet Below Ground Surface

\* These potential receptors may be exposed to site-related contaminants through ingestion of groundwater and inhalation and dermal contact with the groundwater while bathing/showering.

**FIGURE 16**  
 AOC 7 Conceptual Site Model  
 Expanded Site Inspection UFP-SAP  
 Cheatham Annex,  
 Williamsburg, Virginia



**Legend**

- SI Groundwater/Soil Sample Location
- SI Soil Sample Location
- ⊗ Proposed Groundwater Sample Location
- Topographic Surface Contour (feet above mean sea level)
- ➔ Anticipated Surface Water Flow
- Approximate area of the Former Drum Disposal Area
- Approximate Extent of Buried Debris within the Can Pit (4-16 feet below ground surface)
- Approximate AOC 7 Study Area

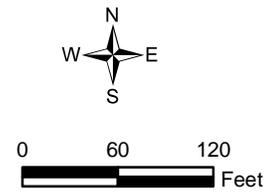


Figure 17  
 AOC 7 Proposed Sample Locations  
 Expanded Site Inspection UFP-SAP  
 Cheatham Annex  
 Williamsburg, Virginia

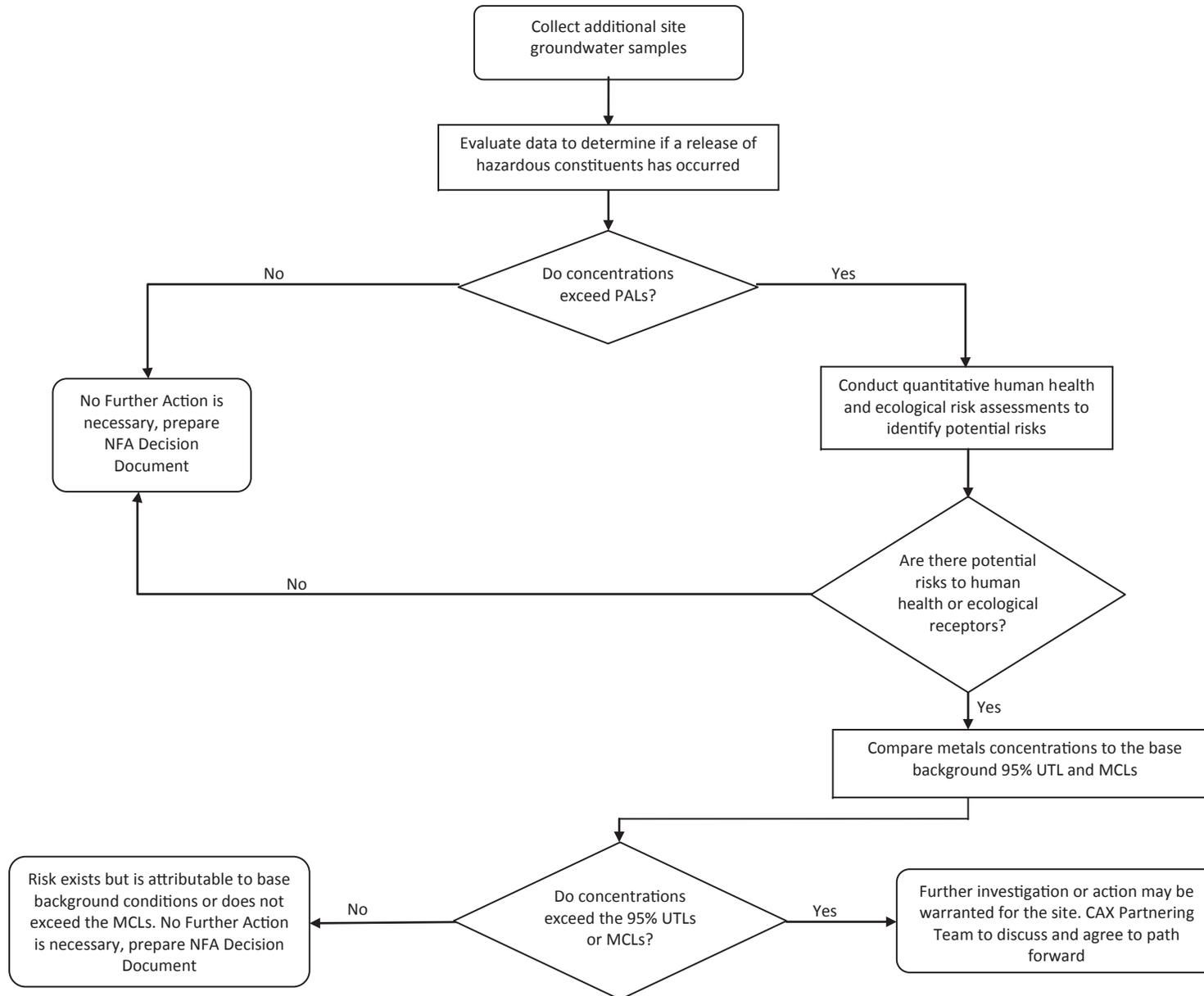


FIGURE 18  
**AOC 7 - Expanded Site Inspection Decision Logic**  
*Cheatham Annex*  
*Williamsburg, Virginia*

**Appendix A**  
**Field Standard Operating Procedures**

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# Equipment Blank and Field Blank Preparation

---

## I. Purpose

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

## II. Scope

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

## III. Equipment and Materials

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

## IV. Procedures and Guidelines

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

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

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

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

## **V. Attachments**

None.

## **VI. Key Checks and Items**

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

# Chain-of-Custody

---

## I Purpose

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

## II Scope

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

## III Definitions

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

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

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

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

## IV Responsibilities

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

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

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

## V Procedures

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

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

### V.1 Sample Identification

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

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

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

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

Measurements and observations shall be recorded using waterproof ink.

### **V.1.1 Sample Label**

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

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

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

### **V.2 Chain-of-Custody Procedures**

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

## V.2.1 Field Custody Procedures

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

## V.2.2 Transfer of Custody and Shipment

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

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

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

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

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

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

## **VI Quality Assurance Records**

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

## **VII Attachments**

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

## VIII References

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

**Attachment A**  
**Example Sample Label**



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

Client \_\_\_\_\_  
Sample No. \_\_\_\_\_  
Location \_\_\_\_\_  
Analysis \_\_\_\_\_  
Preservative **HCL** \_\_\_\_\_  
Date \_\_\_\_\_ By \_\_\_\_\_

**CEIMIC CORPORATION**

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

<b>SITE NAME</b>	<b>DATE</b>
<b>ANALYSIS</b>	<b>TIME</b>
	<b>PRESERVATIVE</b>

**SAMPLE TYPE**  
 Grab  Composite  Other \_\_\_\_\_

**COLLECTED BY:** \_\_\_\_\_

**Attachment B**  
**Example Chain-of-Custody Record**



**Attachment C**  
**Example Custody Seal**



**CUSTODY SEAL**

Date

Signature

# Decontamination of Personnel and Equipment

---

## I. Purpose

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

## II. Scope

This is a general description of decontamination procedures.

## III. Equipment and Materials

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

## IV. Procedures and Guidelines

### A. PERSONNEL DECONTAMINATION

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

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

B. SAMPLING EQUIPMENT DECONTAMINATION – GROUNDWATER SAMPLING PUMPS

Sampling pumps are decontaminated after each use as follows.

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

C. SAMPLING EQUIPMENT DECONTAMINATION – OTHER EQUIPMENT

Reusable sampling equipment is decontaminated after each use as follows.

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

D. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

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

#### E. SAMPLE CONTAINER DECONTAMINATION

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

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

#### F. HEAVY EQUIPMENT AND TOOLS

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

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

### V. Attachments

None.

### VI. Key Checks and Items

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

# Decontamination of Drilling Rigs and Equipment

---

## I. Purpose and Scope

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

## II. Equipment and Materials

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

## III. Procedures and Guidelines

### A. Drilling Rigs and Monitoring Well Materials

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

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

### B. Downhole Drilling Tools

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

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

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

### **C. Field Analytical Equipment**

#### **1. Water Level Indicators**

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

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

#### **2. Probes**

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

## **IV. Attachments**

None.

## **V. Key Checks and Preventative Maintenance**

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

# Sampling Contents of Tanks and Drums

---

## I. Scope and Application

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

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

## II. References

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

## III. Summary of Methods

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

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

## IV. Comments

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

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

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

## V. Required Equipment and Apparatus

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

## VI. Procedures

### A. Drums

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

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

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

**B. Underground Storage Tanks**

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

**C. Tank Trailers or Above-Ground Storage Tanks**

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

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

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

Drum

Glass tube	–	Procedure 1
COLIWASA	–	Procedure 2

Storage Tank and Tank Trailer

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

## VII. Contamination Control

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

## VIII. Attachments

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

## IX. Field Checklist

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

# Attachment A Collection of Liquid-Containerized Wastes Using Glass Tubes

## Discussion

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

## Uses

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

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

## Procedures for Use

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

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

Optional Method (if sample of bottom sludge is desired)

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

Note:

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

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

## Discussion

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

## Uses

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

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

## Procedures for Use

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

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

# Attachment C: Sampling Containerized Wastes using the Bacon Bomb Sampler

## Discussion

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

## Uses

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

## Procedures for Use

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

# Attachment D: Gravity Corer for Sampling Sludges in Large Containers

## Discussion

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

## Uses

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

## Procedures for Use

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

## Attachment E: Construction of a Typical COLIWASA

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

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

The sampler is assembled as follows:

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

# Attachment F: Drum Opening Techniques and Equipment <sup>1</sup>

## I. Introduction

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

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

## II. Manual Drum Opening

### A. Bung Wrench

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

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

### B. Drum Deheader

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

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

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

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

#### C. Hand Pick or Spike

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

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

### III. Remote Opening

#### A. Backhoe Spike

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

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

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

#### B. Hydraulic Devices

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

#### C. Pneumatic Devices

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

## IV. Summary

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

# Disposal of Waste Fluids and Solids

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## I. Purpose and Scope

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

## II. Equipment and Materials

### A. Fluids

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

### B. Solids

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

## III. Procedures and Guidelines

### A. Methodology

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

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

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

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

## **B. Labels**

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

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

## **C. Fluids**

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

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

#### **D. Solids**

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

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

#### **E. Storage and Disposal**

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

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

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

### **IV. Attachments**

None.

### **V. Key Checks and Preventative Maintenance**

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

# Global Positioning System

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## 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>.

# Homogenization of Soil and Sediment Samples

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## I. Purpose

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

## II. Scope

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

## III. Equipment and Materials

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

## IV. Procedures and Guidelines

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

Samples for VOCs should be taken immediately upon collection and should not be homogenized.

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

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

## **V. Attachments**

None.

## **VI. Key Checks and Items**

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

# Preparing Field Log Books

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## I. Purpose

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

## II. Scope

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

## III. Equipment and Materials

- Log book
- Indelible pen

## IV. Procedures and Guidelines

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

### A. PROCEDURES FOR COMPLETING FIELD LOG BOOKS

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

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

B. INFORMATION TO BE INCLUDED IN FIELD LOG BOOKS

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

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

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

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

C. SUGGESTED FORMAT FOR RECORDING FIELD DATA

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

## V. Attachments

Example field notes.

(47)

MAY 12, 2003

EXAMPLE

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

AT SITE 17

0725 BB ~~Calibrates~~ JS Calibrates  
 PID: 101 ppm / 100 ppm OK  
 PID Model #, SERIAL #

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

0738 SURVEY CREW ARRIVES ON SITE  
 → List NAMES

0745 BB Holds H+S TALK ON SLIPS,  
 TRIPS, FALLS, TICKETS + AIR MONITORING  
 JS + SURVEY CREW ATTEND  
 No H+S ISSUES IDENTIFIED AS  
 CONCERNS. All work is in "LEVEL D."

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

JS  
5-12-03

MAY 12, 2003

EXAMPLE (48)

SITE 14 LTM

BREATHING ZONE (BZ)

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

0815 PM (PAUL PAPER PUSHER) CALLS AND  
 INFORMS JS TO COLLECT GW SAMPLE  
 AT WELL MW-44 TODAY FOR 24 HOUR  
 TAT ANALYSIS OF VOC'S

0820 Purging MW-22  
 → RECORD WATER QUALITY DATA JS  
5-12-03

0843 Collect SAMPLE AT MW-22 FOR  
 total TAT METALS AND VOC'S. NO  
 Dissolved METALS NEEDED PER PM

0905 JS + BB Mobilize to site 17 to  
 show surveyors wells to survey.

0942 Mobilize to well MW-22 to  
 collect SAMPLE...

0950 CAN NOT ACCESS WELL MW-22  
 due to BASE OPERATIONS; CONTACT  
 PAUL PAPER PUSHER AND HE STATED  
 HE WILL CHECK ON GAINING ACCESS  
 WITH BASE CONTACT.

0955 Mobilize to well MW-19

JS  
5-12-03

# Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region I and III

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## I. Purpose and Scope

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

## II. Equipment and Materials

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

## III. Procedures and Guidelines

### A. Setup and Purging

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

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

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

## **B. Sample Collection**

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

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

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

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

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

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

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

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

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

**C. Additional remarks**

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

## IV. Attachments

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

## V. Key Checks and Preventative Maintenance

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

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

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

## **White Paper on Low-Flow Sampling**

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

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

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

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

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

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

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

# Mini RAE Photoionization Detector (PID)

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## 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

<u>Function</u>	<u>Frequency</u>
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.

# General Guidance for Monitoring Well Installation

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## I. Purpose

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

## II. Scope

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

## III. Equipment and Materials

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

## IV. Procedures and Guidelines

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

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

## Monitoring Well Installation

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

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

## Well Development

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

## V. Attachments

None.

## VI. Key Check and Items

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

# Groundwater Sampling from Monitoring Wells – EPA Region I and III

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## I. Purpose and Scope

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

## II. Equipment and Materials

- Peristaltic pump, pneumatic bladder pump, or electric submersible pump, pump shroud, tubing, support cables, air compressor, control box, and power supply
- Water quality meter, such as Horiba® U-22 or a combination of equivalent devices for monitoring 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 water quality probe
- Disposable 0.45µm filters (QED® FF8100 or equivalent), if applicable
- Bailer (Teflon or stainless steel) and nylon cord, if applicable

*Note: bailers and peristaltic pumps should only be used when site access or other limitations prevent the use of sampling pumps*

## III. Procedures and Guidelines

### A. Setup and Purging

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

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

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

where:  $\pi = 3.14$

v = volume of water in well (gallons)

r = Radius of the well (feet)

h = height of water in well (feet)

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

2-inch diameter well:

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

4-inch diameter well:

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

6-inch diameter well:

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

9. Attach tubing, support cable or rope, and air line (if applicable) to the pump. The support line should bear the weight of the pump. Set pump in the well at the desired sampling interval, typically mid-screen, and begin purging. If a bailer is being used, it is removed from its protective covering and attached to a cord compatible with constituents.
10. If a RediFlo or other similar electric submersible pump is to be used in a large diameter well (greater than 4 inches), a pump shroud should be used to direct the flow of water across the pump motor. Failure to use a shroud in this situation can lead to overheating of the motor and loss of volatiles from the pump discharge.
11. If a bailer is being used, it should be removed from its protective covering and attached to a cord compatible with the site contaminants. The bailer should be lowered into the top of the water column, allowed to fill, and removed. It is critical that bailers be slowly and gently immersed into the top of the water column, particularly during final stages of purging, to minimize turbidity and disturbance of volatile

organic constituents. The use of bailers for purging and sampling is discouraged because the correct technique is highly operator dependent and improper use may result in an unrepresentative sample.

12. Field parameters including pH, ORP, turbidity, dissolved oxygen, specific conductance, and temperature are measured and recorded in the field logbook. The water quality probes are inserted into a flow-through cell. The purged groundwater is directed through the cell by connecting the pump discharge tubing to the bottom port on the flow through cell, allowing measurements to be collected before the water contacts the atmosphere.
13. During purging, the water quality parameters are measured at least once for each well volume. A minimum of three well volumes must be purged (up to 5 well volumes may be purged if water quality parameters do not stabilize) prior to sampling. In nonproductive wells, if the well is purged dry, it is not necessary to remove a minimum of three well volumes; however, the well should be allowed to recover sufficiently to allow collection of all samples.
14. Three to five well volumes are purged (more may be purged if parameters do not stabilize). Purging is stopped when field parameters have stabilized over three consecutive well volumes. Field Water quality parameters are considered stable when pH measurements agree within 0.1 units, specific conductance measurements agree within 3 percent, ORP measurements agree within 10 mV, dissolved oxygen measurements agree within 10 percent, and turbidity measurements agree within 10 percent or are as low as practicable given sampling conditions.

## **B. Sample Collection**

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

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

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

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 disturbance. 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. If the sample tubing or bailer is dedicated, it is returned to the well and the well is capped and locked. Nondedicated equipment is cleaned and decontaminated in accordance with the *Decontamination of Personnel and Equipment SOP*.

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

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)

Additional remarks

## IV. Attachments

None.

## V. Key Checks and Preventative Maintenance

- Use of peristaltic pumps and bailers should be avoided, if possible.
- Allow the field parameters to stabilize within the specified criteria as much as possible.
- Fill bottles for VOC samples first.
- Be sure the sample identification is properly specified.

- Maintain field equipment in accordance with the manufacturer's recommendations. This may include, but is not limited to:
  - Inspect sampling pump regularly and replace as warranted
  - Bring supplies for replacing the bladder and "O" rings if using a positive-displacement bladder pump
  - Inspect tubing regularly and replace as warranted
  - Inspect air/ sample line quick-connects regularly and replace as warranted
  - Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

# Installation of Shallow Monitoring Wells

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## I. Purpose and Scope

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

## II. Equipment and Materials

### Drilling

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

### Well Riser/Screen and Associated Materials

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

### Sand

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

### **Bentonite**

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

### **Protective Casing**

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

### **Well Development**

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

## **III. Procedures and Guidelines**

### **A. Drilling Method**

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

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

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

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

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

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

## **B. Monitoring-Well Installation**

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

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

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

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

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

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

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

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

### **C. Well Completion**

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

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

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

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

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

#### **D. Well Development**

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

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

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

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

## **IV. Attachments**

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

# Logging of Soil Borings

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## I. Purpose and Scope

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

## II. Equipment and Materials

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

## III. Procedures and Guidelines

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

### A. Instructions for Completing Soil Boring Logs

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

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

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

## B. Heading Information

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

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

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

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

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

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

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

**Logger.** Enter the first and last name.

## C. Technical Data

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

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

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

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

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

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

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

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

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

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

Specific information might include the following:

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

#### **D. Field Classification of Soil**

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

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

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

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

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

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

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

#### **E. Soil Name**

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

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

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

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

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

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

#### **F. Group Symbol**

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

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

#### **G. Color**

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

#### **H. Moisture Content**

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

#### **I. Relative Density or Consistency**

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

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

#### **J. Soil Structure, Mineralogy, and Other Descriptors**

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

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

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

#### **K. Equipment and Calibration**

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

### **IV. Attachments**

Soil Boring Log (Sample Soil Boring Log.xls)

CH2M HILL Form D1586 and a completed example (Soil\_Log\_Examp.pdf)

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

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

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

### **V. Key Checks and Preventive Maintenance**

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

# Sediment Sampling

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## I. Purpose

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

## II. Scope

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

## III. Equipment and Materials

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

## IV. Procedures and Guidelines

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

3. Note in the field book any possible outside sources of contamination. For example, the outlet to a drainage culvert in the water body near your sampling location.
4. Transfer sample into appropriate sample jars with a stainless steel utensil or plastic disposable scoop. Be especially careful to avoid the loss of the very fine clay/silt particles when collecting the sample. The fine particles have a higher adsorption capacity than larger particles. Minimize the amount of water that is collected within the sample matrix. Decant the water off of the sample slowly and carefully to maximize retention of the very fine particles. The sampler's fingers should never touch the sediment since gloves may introduce organic interference into the sample. Classify the soil type of the sample using the Unified Soil Classification System, noting particularly the percentage of silt and clay.
5. Samples for volatile organics should immediately be placed in jars. Rocks and other debris should be removed before placement in jars.
6. For channel sampling, be on the alert for submerged hazards (rocks, tree roots, drop-offs, loss silt and muck) which can make wading difficult.
7. Sample sediment for TOC and pH also, to give context to organic and inorganic data during the risk assessment.
8. Follow the site safety plan designed for the specific nature of the site's sampling activities and locations.
9. Decontaminate all sampling implements and protective clothing according to prescribed procedures.

## V. Attachments

None.

## VI. Key Checks and Items

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

# Surface Water Sampling

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## I. Purpose and Scope

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

## II. Materials and Equipment

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

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

## III. Procedures and Guidelines

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

### A. Manual Sampling

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

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

A sample is taken with the following specific steps:

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

#### **IV. Attachments**

None.

#### **V. Key Checks and Items**

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

# Packaging and Shipping Procedures for Low-Concentration Samples

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## 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

# Shallow Soil Sampling

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## I. Purpose

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

## II. Scope

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

## III. Equipment and Materials

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

## IV. Procedures and Guidelines

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

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

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

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

## V. Attachments

None.

## VI. Key Checks and Items

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

# Aquifer Slug Testing

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## I. Purpose and Scope

The purpose of this procedure is to outline the equipment and methods that will be used to perform variable-head tests (“slug” tests) on piezometers and monitoring wells. The guidance covers use of both air and solid displacement methods.

## II. Equipment and Materials

- In-Situ data loggers or equivalent
- Well-testing assembly
  - packer
  - fittings for pressure transducers
  - fittings for air supply
  - release valve
- Compressed air
- Computer and associated equipment
- Solid displacement device with rope

## III. Procedures and Guidelines

The tests to be performed are rising head tests. The tests are accomplished by lowering the head of water in the well and monitoring the recovery of the water level to the static water level. The water level will be lowered by one of two methods. One method is the use of an air displacement device. Alternatively, a solid displacement device removed from the well will be used.

The air displacement apparatus consists of a packer assembly, fittings to accommodate transducers and air pressurization, and a pressure-release valve. The packer is lowered into the upper portion of the monitoring well, secured in place and inflated, providing a seal between the apparatus and the inside of the well. Two fittings are provided for pressure transducers: one transducer is fed through the inside of the device and positioned below the water surface and the other is inserted to measure the air pressure inside the assembly. A third fitting is connected to the pressurized air supply, a compressed air tank.

The datalogger will be programmed to display the air pressure in units of head, the head measured by the submerged transducer, and the difference between the two. The difference between the two pressure transducers is the height of the water column on the submerged transducer. The readings are recorded in a field notebook, and then the assembly is pressurized. The air pressure applied will be equivalent to 3 to 7 feet

of head. The pressures are allowed to stabilize. The pressure of the air should not lower the water level to below the base of the bentonite seal installed in the well.

Each test is started by releasing the air pressure inside the assembly and allowing the water level to rise to the static water level. When the datalogger perceives a change in water level in the well above a preset trigger amount, it automatically begins to record the water levels and elapsed time. Each test will be terminated when the water level has recovered to at least 90 percent of the original equilibrium level before pressurization. Note that the test method cannot be used if the well is screened across or near the water table.

An alternate method of lowering the water level is to use a solid displacement device. A single transducer will be installed in the well below the water table. A weighted solid displacement device is added to the well and the water level allowed to stabilize at the original static water level. The test is started by rapidly removing the displacement device, which causes a drop in the water level. The data logger begins recording the water level and elapsed time when the preset trigger amount is reached. Readings are taken as above, and the test stopped when the well has recovered to 90 percent of the original level.

At least two valid tests will be performed in each well. Additional tests will be required if there is some evidence that any of the tests were unacceptable.

At the end of each test, the test results will be transferred to a laptop and the data downloaded and checked for preliminary completeness.

#### **IV. Attachments**

None.

#### **V. Key Checks and Preventive Maintenance**

- Check that the packer assembly is in good condition and not leaking. Provide a repair kit including tape and clamps. Take additional packer assembly and other spare parts.
- Check the batteries for the datalogger and computer. Check that the computer disks containing the programs for the datalogger are packed.
- Check the datalogger calculation of the well hydraulic conductivity at the end of each test to determine if these are consistent with expectations.

# Soil Sampling

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## I. Purpose and Scope

The purpose of this procedure is to provide guidelines for obtaining samples of surface and subsurface soils using hand and drilling-rig mounted equipment.

## II. Equipment and Materials

- Stainless-steel trowel, shovel, scoop, coring device, hand auger, or other appropriate hand tool
- Stainless-steel, split-spoon samplers
- Thin-walled sampling tubes
- Drilling rig or soil-coring rig
- Stainless-steel pan/bowl or disposable sealable bags
- Sample bottles

## III. Procedures and Guidelines

Before sampling begins, equipment will be decontaminated using the procedures described in SOP *Decontamination of Drilling Rigs and Equipment*. The sampling point is located and recorded in the field logbook. Debris should be cleared from the sampling location.

### A. Surface and Shallow Subsurface Sampling

A shovel, post-hole digger, or other tool can be used to remove soil to a point just above the interval to be sampled. A decontaminated sampling tool will be used to collect the sample when the desired sampling depth has been reached. Soil for semivolatile organic and inorganic analyses is placed in the bowl and mixed; soil for volatile organic analysis is not mixed or composited but is placed directly into the appropriate sample bottles. A stainless-steel or dedicated wooden tongue depressor is used to transfer the sample from the bowl to the container.

The soils removed from the borehole should be visually described in the field log book, including approximated depths.

When sampling is completed, photo-ionization device (PID) readings should be taken directly above the hole, and the hole is then backfilled.

More details are provided in the SOP *Shallow Soil Sampling*.

## **B. Split-Spoon Sampling**

Using a drilling rig, a hole is advanced to the desired depth. For split-spoon sampling, the samples are then collected following the ASTM D 1586 standard (attached). The sampler is lowered into the hole and driven to a depth equal to the total length of the sampler; typically this is 24 inches. The sampler is driven in 6-inch increments using a 140-pound weight ("hammer") dropped from a height of 30 inches. The number of hammer blows for each 6-inch interval is counted and recorded. To obtain enough volume of sample for subsequent laboratory analysis, use of a 3-inch ID sampler may be required. Blow counts obtained with a 3-inch ID spoon would not conform to ASTM D 1586 and would therefore not be used for geotechnical evaluations.

Once retrieved from the hole, the sampler is carefully split open. Care should be taken not to allow material in the sampler to fall out of the open end of the sampler. To collect the sample, the surface of the sample should be removed with a clean tool and disposed of. Samples collected for volatiles analysis should be placed directly into the sample containers from the desired depth in the split spoon. Material for samples for all other parameters should be removed to a decontaminated stainless steel tray or disposable sealable bag. The sample for semivolatile organic and inorganic analyses should be homogenized in the field by breaking the sample into small pieces and removing gravel. The homogenized sample should be placed in the sample containers. If sample volume requirements are not met by a single sample collection, additional sample volume may be obtained by collecting a sample from below the sample and compositing the sample for non-volatile parameters only.

Split-spoon samples also will be collected using a tripod rig. When using a tripod rig the soil samples are collected using an assembly similar to that used by the drilling rig.

## **C. Thin-Walled Tube Sampling**

Undisturbed fine grained samples may be collected for analysis for geotechnical parameters such as vertical hydraulic conductivity. These samples will be collected using thin-walled sampling tubes (sometimes called Shelby tubes) according to ASTM D 1587 (attached). Tubes will be 24- to 36 inches long and 3- to 4-inches in diameter, depending upon the quantity of sample required. Undisturbed samples will be obtained by smoothly pressing the sampling tube through the interval to be sampled using the weight of the drilling rig. Jerking the sample should be avoided. Once the sample is brought to the surface, the ends will be sealed with bees wax and then sealed with end caps and heavy tape. The sample designation, data and time of sampling, and the up direction will be noted on the sampling tube. The tube shall be kept upright as much as possible and will be protected from freezing, which could disrupt the undisturbed nature of the sample. Samples for geochemical analysis normally are not collected from thin-walled tube samples.

## IV. Attachments

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

*ASTM D 1587 Standard Practice for Thin-Walled Tube Sampling of Soils (ASTM D1587.pdf)*

## V. Key Checks and Preventative Maintenance

- Check that decontamination of equipment is thorough.
- Check that sample collection is swift to avoid loss of volatile organics during sampling.

# Locating and Clearing Underground Utilities

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## I. Purpose

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

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

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

## II. Scope

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

### Scenario 1

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

### Scenario 2

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

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

Scenario 1 is preferred because under this scenario the Navy tends to assume the responsibility if the location is improperly cleared, a utility is struck, and property damage results. However, our experience has been that the clearance services provided by the Navy do not meet the standards that we consider to be adequate, in that they

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

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

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

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

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

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

### **III. Services and Equipment**

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

#### **Services**

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

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

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

## Equipment

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

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

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

## IV. Procedures and Guidelines

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

### Activity Notification and Dig Permit Procedures

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

Activity Specific: To be provided by Activity or Project Manager

### CH2M HILL Utility Clearance Procedures

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

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

- **Ground Penetrating Radar (GPR)**, which can detect pipes, including gas pipes, tanks, conduits, cables etc, both metallic and non-metallic at depths up to 30 feet depending on equipment. Sensitivity for both minimum object size and maximum depth detectable depends on equipment selected, soil conditions, etc.
- **Radio Frequency (RF)**, involves inducing an RF signal in the pipe or cable and using a receiver to trace it. Some electric and telephone lines emit RF naturally and can be detected without an induced signal. This method requires knowing where the conductive utility can be accessed to induce RF field if necessary.

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

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

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

sidewalks and streets. *Any particular marking requirements need to be provided in the subcontractor SOW.*

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

## **IV. Attachments**

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

# Attachment A – Example SOW for Subcontracting Underground Utilities Locating Services

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CTO-XXX

Scope of Work

Subsurface Utility Locating

Site XX

Navy Activity

City, State

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

## Proposed Scope of Work

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

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

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

Field verification will include detection using nonintrusive subsurface detection equipment (magnetometers, GPR, etc) as well as opening manhole covers to verify pipe directions. As part of the bid, the Subcontractor shall provide a list of the various

subsurface investigation tools they propose to have available and use at the site and what the limitations are of each tool.

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

## Field Marking and Documentation

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

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

## Bid Sheet/Payment Units

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

## Health and Safety Requirements

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

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

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

Subcontractor personnel showing indications of being under the influence of alcohol or illegal drugs will be sent off the job site and their employers will be notified.

Subcontractor personnel under the influence of prescription or over-the-counter

medication that may impair their ability to operate equipment will not be permitted to do so. It is expected that the subcontractor will assign them other work and provide a capable replacement (if necessary) to operate the equipment to continue work.

## **Security**

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

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

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

## **Quality Assurance**

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

## **Subcontractor Standby Time**

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

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

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

### **Down Time**

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

### **Schedule**

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

# **Attachment B - Services Available for Identifying and Marking Underground Utilities**

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

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

Each are discussed below.

## **Navy Public Works Department**

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

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

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

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

Miss Utility or "One Call" service centers are information exchange centers for excavators, contractors and property owners planning any kind of excavation or digging. The "One Call" center notifies participating public utilities of the upcoming excavation work so they can locate and mark their underground utilities in advance to prevent possible damage to underground utility lines, injury, property damage and service outages. In some instances, such with southeastern Virginia bases, the Navy has entered into agreement with Ms. Utilities and is part of the response process for Miss Utilities. Generally, a minimum of 48 hours is required for the public utility mark-outs

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

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

Name	Phone	Website	Comments
Miss Utility of DELMARVA	800-257-7777	<a href="http://www.missutility.net">www.missutility.net</a>	Public utility mark-outs in Delaware, Maryland, Washington, DC, and Northern Virginia
Miss Utility of Southern Virginia (One Call)	800-552-7001	<a href="#">not available</a>	Public utility mark-outs in Southern Virginia
Miss Utility of Virginia	800-257-7777 800-552-7007	<a href="http://www.missutilityofvirginia.com">www.missutilityofvirginia.com</a>	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	<a href="http://www.ncocc.org/ncocc/default.htm">www.ncocc.org/ncocc/default.htm</a>	Public Utility Markouts in North Carolina

## Private Subcontractors

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

The level of service required from the subcontractor will vary depending on the nature of the site. At sites where utility locations are well defined on the maps and recent construction is limited, CH2M HILL may be confident with a limited effort from a traditional utility-locating subcontractor providing a simple EM survey. At sites where utility locations are not well defined, where recent constructions may

have altered utility locations, or the nature of the site makes utility location difficult, CH2M HILL will require the services of a comprehensive geophysical surveying subcontractor, with a wide range of GPR and EM services available for use on an "as-needed" basis. Typical costs for geophysical surveying subcontractors will range from approximately \$200 per day for a simple EM effort (usually one crew member and one instrument) to approximately \$1,500 per day for a comprehensive geophysical surveying effort (usually a two-person crew and multiple instruments). Comprehensive geophysical surveying efforts may also include field data interpretation (and subsequent report preparation) and non-destructive excavation to field-verify utility depths and locations.

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

Company Name and Address	Contact Name and Phone Number	Equipment <sup>1</sup>					Other Services <sup>2</sup>		
		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.

<sup>1</sup>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

<sup>2</sup>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 C – Equipment Used for Identifying Underground Utilities

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

## CH2M HILL In-house Utility Location Experts

**Tamir Klaff/WDC**

Home Office Phone – 703-669-9611

## Electromagnetic Induction (EMI) Methods

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

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

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

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

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

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

### **Ground Penetrating Radar (GPR)**

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

### **Magnetic Field Methods**

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

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

### **Optical Methods**

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

# **Attachment D – Utility Clearance Documentation Form**

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# **Attachment E – Utility Marking Color Codes**

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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

PMS 219

PMS 1795\*

PMS 118

PMS 144\*

13.5" oars process  
2.5" parts reflex

PMS 253

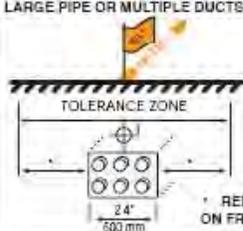
PMS 3415

**ADWA** **UNIFORM COLOR CODE**

	WHITE - Proposed Excavation
	PINK - Temporary Survey Markings
	<b>RED</b> - Electric Power Lines, Cables, Conduit and Lighting Cables
	<b>YELLOW</b> - Gas, Oil, Steam, Petroleum or Gaseous Materials
	<b>ORANGE</b> - Communication, Alarm or Signal Lines, Cables or Conduit
	<b>BLUE</b> - Potable Water
	<b>PURPLE</b> - Reclaimed Water, Irrigation and Slurry Lines
	<b>GREEN</b> - Sewers and Drain Lines

**TYPICAL MARKING**

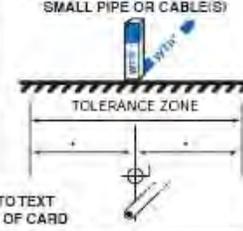
LARGE PIPE OR MULTIPLE DUCTS



TOLERANCE ZONE

24"  
500 mm

SMALL PIPE OR CABLE(S)



TOLERANCE ZONE

\* REFER TO TEXT ON FRONT OF CARD

Customize with your center's phone and address information

## **GUIDELINES FOR UNIFORM TEMPORARY MARKING OF UNDERGROUND FACILITIES**

This marking guide provides for universal use and understanding of the temporary marking of subsurface facilities to prevent accidents and damage or service interruption by contractors, excavators, utility companies, municipalities or any others working on or near underground facilities.

### **ONE-CALL SYSTEMS**

The One-Call damage prevention system shall be contacted prior to excavation.

### **PROPOSED EXCAVATION**

Use white marks to show the location, route or boundary of proposed excavation. Surface marks on roadways do not exceed 1.5" by 18" (40 mm by 450 mm). The facility color and facility owner identity may be added to white flags or stakes.

### **USE OF TEMPORARY MARKING**

Use color-coded surface marks (i.e., paint or chalk) to indicate the location or route of active and out-of-service buried lines. To increase visibility, color-coded vertical markers (i.e., stakes or flags) should supplement surface marks. Marks and markers indicate the name, initials or logo of the company that owns or operates the line, and width of the facility if it is greater than 2" (50 mm). Marks placed by other than line owner/operator or its agent indicate the identity of the designating firm. Multiple lines in joint trench are marked in tandem. If the surface over the buried line is to be removed, supplementary offset markings are used. Offset markings are on a uniform alignment and clearly indicate the actual facility is a specific distance away.

### **TOLERANCE ZONE**

Any excavation within the tolerance zone is performed with non-powered hand tools or non-invasive method until the marked facility is exposed. The width of the tolerance zone may be specified in law or code. If not, a tolerance zone including the width of the facility plus 18" (450 mm) measured horizontally from each side of the facility is recommended.

### **ADOPT UNIFORM COLOR CODE**

The American Public Works Association encourages public agencies, utilities, contractors, other associations, manufacturers and all others involved in excavation to adopt the APWA Uniform Color Code, using ANSI standard Z535.1 Safety Colors for temporary marking and facility identification.

Rev. 4/99

## 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.

# Water-Level Measurements

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## 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.

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

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## I. Purpose and Scope

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

## II. Equipment and Materials

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

## III. Procedures and Guidelines

### A. Parameters and Specifications:

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

### B. Calibration:

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

### Horiba Calibration procedure:

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

### YSI Calibration procedure:

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

#### **A. Conductivity Calibration:**

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

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

**NOTE:** The sensor must be completely immersed past its vent hole. Using the recommended volumes from the Instrument Manual Calibration Volumes should ensure that the vent hole is covered.

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

**B. Dissolved Oxygen Calibration:**

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

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

**C. pH Calibration:**

- 1) Go to the calibrate screen.
- 2) Use the arrow keys to highlight the **pH** selection.
- 3) Press **Enter**. The pH calibration screen is displayed.

- Select the **1-point** option only if you are adjusting a previous calibration. If a 2-point or 3-point calibration has been performed previously, you can adjust the calibration by carrying out a one point calibration. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select only one pH buffer.
  - Select the **2-point** option to calibrate the pH sensor using only two calibration standards. Use this option if the media being monitored is known to be either basic or acidic. For example, if the pH of a pond is known to vary between 5.5 and 7, a two-point calibration with pH 7 and pH 4 buffers is sufficient. A three point calibration with an additional pH 10 buffer will not increase the accuracy of this measurement since the pH is not within this higher range.
  - Select the **3-point** option to calibrate the pH sensor using three calibration solutions. In this procedure, the pH sensor is calibrated with a pH 7 buffer and two additional buffers. The 3-point calibration method assures maximum accuracy when the pH of the media to be monitored cannot be anticipated. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select a third pH buffer.
- 4) Use the arrow keys to highlight the **2-point** selection.
  - 5) Press **Enter**. The pH Entry Screen is displayed.
  - 6) Place the correct amount of pH buffer into a clean, dry or pre-rinsed transport/calibration cup.
    - NOTE:** For maximum accuracy, the pH buffers you choose should be within the same pH range as the water you are preparing to sample.
    - NOTE:** Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the pH sensor with a small amount of buffer that can be discarded. Be certain that you avoid cross-contamination of buffers with other solutions.
  - 7) Carefully immerse the sensor end of the probe module into the solution.
  - 8) Gently rotate and/or move the probe module up and down to remove any bubbles from the pH sensor.
    - NOTE:** The sensor must be completely immersed. Using the recommended volumes from Table 6.1 Calibration Volumes, should ensure that the sensor is covered.
  - 9) Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.
    - NOTE:** Do not over tighten as this could cause damage to the threaded portions.
  - 10) Use the keypad to enter the calibration value of the buffer you are using **at the current temperature**.
    - NOTE:** pH vs. temperature values are printed on the labels of all YSI pH buffers.
  - 11) Press **Enter**. The pH calibration screen is displayed.
  - 12) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
  - 13) Observe the reading under pH, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
  - 14) Press **Enter**. This returns you to the Specified pH Calibration Screen.

- 15) Rinse the probe module, transport/calibration cup and sensors in tap or purified water and dry.
- 16) Repeat steps 6 through 13 above using a second pH buffer.
- 17) Press **Enter**. This returns you to the pH Calibration Screen.
- 18) Press **Escape** to return to the calibrate menu.
- 19) Rinse the probe module and sensors in tap or purified water and dry.

#### **D. ORP Calibration:**

- 1) Go to the calibrate screen.
- 2) Use the arrow keys to highlight the **ORP** selection.
- 3) Press **Enter**. The ORP calibration screen is displayed.
- 4) Place the correct amount of a known ORP solution into a clean, dry or pre-rinsed transport/calibration cup.  
**NOTE:** Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the ORP sensor with a small amount of solution that can be discarded. Be certain that you avoid cross-contamination with other solutions.
- 5) Carefully immerse the sensor end of the probe module into the solution.
- 6) Gently rotate and/or move the probe module up and down to remove any bubbles from the ORP sensor.  
**NOTE:** The sensor must be completely immersed.
- 7) Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.
- 8) Use the keypad to enter the correct value of the calibration solution you are using at the current temperature.
- 9) Press **Enter**. The ORP calibration screen is displayed.
- 10) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
- 11) Observe the reading under ORP, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
- 12) Press **Enter**. This returns you to the Calibrate Screen.
- 13) Rinse the probe module and sensors in tap or purified water and dry.  
Record the calibration data (e.g. time, instrument ID, solution lot number and expiration date, final calibrated readings, and solution temperature in the field logbook.

#### **C. Sample Measurement:**

##### **Horiba measurement procedure:**

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

##### **YSI measurement procedure:**

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

## **IV. Key Checks and Preventive Maintenance**

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

## **V. References**

YSI 556 Multi Probe System Operator Manual

**Appendix B**  
**Laboratory DoD ELAP Certifications**

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# PERRY JOHNSON LABORATORY ACCREDITATION, INC.

## Certificate of Accreditation

*Perry Johnson Laboratory Accreditation, Inc. has assessed the Laboratory of:*

***Columbia Analytical Services***  
***1565 Jefferson Road, Building 300, Suite 360, Rochester, NY 14623***

*(Hereinafter called the Organization) and hereby declares that Organization has met the requirements of ISO/IEC 17025:2005 “General Requirements for the competence of Testing and Calibration Laboratories” and the DoD Quality Systems Manual for Environmental Laboratories Version 4.1 4/22/2009 and is accredited in accordance with the:*

**United States Department of Defense  
Environmental Laboratory Accreditation Program  
(DoD-ELAP)**

***This accreditation demonstrates technical competence for the defined scope:  
Environmental Testing  
(As detailed in the supplement)***

Accreditation claims for such testing and/or calibration services shall only be made from addresses referenced within this certificate. This Accreditation is granted subject to the system rules governing the Accreditation referred to above, and the Organization hereby covenants with the Accreditation body’s duty to observe and comply with the said rules.

For PJLA:

Tracy Szerszen  
President/Operations Manager

Perry Johnson Laboratory  
Accreditation, Inc. (PJLA)  
755 W. Big Beaver, Suite 1325  
Troy, Michigan 48084

<i>Initial Accreditation Date:</i>	<i>Issue Date:</i>	<i>Accreditation No.:</i>	<i>Certificate No.:</i>
January 22, 2010	April 7, 2012	65817	L12-48

*The validity of this certificate is maintained through ongoing assessments based on a continuous accreditation cycle. The validity of this certificate should be confirmed through the PJLA website: [www.pjlabs.com](http://www.pjlabs.com)*



*Certificate of Accreditation: Supplement*  
ISO/IEC 17025:2005 and DoD-ELAP

**Columbia Analytical Services**

1565 Jefferson Road, Building 300, Suite 360, Rochester, NY 14609  
Lisa Reyes Phone: 585-288-5380

*Accreditation is granted to the facility to perform the following testing:*

<b>Matrix</b>	<b>Standard/Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous	(CAS SOP) GEN-TICW	UV-VIS	Total inorganic carbon
Aqueous	EPA 1631	CVAFS	Mercury
Aqueous	EPA 1664A	Gravimetric	Oil and grease
Aqueous	EPA 1664A	Gravimetric	Total petroleum hydrocarbons
Aqueous	EPA 218.6	IC-UV	Chromium, Hexavalent
Aqueous	EPA 245.1	CVAA	Mercury
Aqueous	EPA 300.0	IC	Chloride
Aqueous	EPA 300.0	IC	Fluoride
Aqueous	EPA 300.0	IC	Nitrate
Aqueous	EPA 300.0	IC	Sulfate
Aqueous	EPA 351.2	UV-VIS	Nitrogen, total Kjeldahl
Aqueous	EPA 353.2	UV-VIS	Nitrite as N
Aqueous	EPA 410.4	UV-VIS	Chemical oxygen demand
Aqueous	EPA 7470A	CVAA	Mercury
Aqueous	EPA 8151A	GC-ECD	Dinoseb
Aqueous	EPA 8260C	GC-MS-SIM	1,1-Dichloroethene
Aqueous	EPA 8260C	GC-MS-SIM	1,2-Dichlorobenzene
Aqueous	EPA 8260C	GC-MS-SIM	1,2-Dichloroethane
Aqueous	EPA 8260C	GC-MS-SIM	1,4-Dioxane
Aqueous	EPA 8260C	GC-MS-SIM	Carbon tetrachloride
Aqueous	EPA 8260C	GC-MS-SIM	Dichloromethane
Aqueous	EPA 8260C	GC-MS-SIM	Ethylbenzene
Aqueous	EPA 8260C	GC-MS-SIM	m- + p-Xylene
Aqueous	EPA 8260C	GC-MS-SIM	o-Xylene
Aqueous	EPA 8260C	GC-MS-SIM	Tetrachloroethene
Aqueous	EPA 8260C	GC-MS-SIM	Trichloroethene
Aqueous	EPA 8260C	GC-MS-SIM	Vinyl chloride
Aqueous	EPA 8260C	GC-MS-SIM	Xylenes, total
Aqueous	EPA 8310	HPLC-UV/FLUOR	Acenaphthene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Acenaphthylene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Anthracene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Benzo(a)anthracene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Benzo(a)pyrene



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<b>Matrix</b>	<b>Standard/Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous	EPA 8310	HPLC-UV/FLUOR	Benzo(b)fluoranthene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Benzo(g,h,i)perylene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Benzo(k)fluoranthene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Chrysene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Dibenzo(a,h)anthracene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Fluoranthene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Fluorene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Indeno(1,2,3-cd)pyrene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Naphthalene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Phenanthrene
Aqueous	EPA 8310	HPLC-UV/FLUOR	Pyrene
Aqueous	EPA 9040B, C	POT	pH
Aqueous	EPA 9060, A	UV-VIS	Total organic carbon
Aqueous	EPA 9066	UV-VIS	Phenolics, total
Aqueous	RSK-175	GC-FID	Ethane
Aqueous	RSK-175	GC-FID	Ethylene
Aqueous	RSK-175	GC-FID	Methane
Aqueous	RSK-175	GC-FID	Propane
Aqueous	RSK-175	GC-FID	Acetylene
Aqueous	SM 2320B	Titration	Alkalinity, total, carbonate, and bicarbonate
Aqueous	SM 2340C	Titration	Hardness, total
Solids	(CAS SOP) GEN-351.2	UV-VIS	Nitrogen, total Kjeldahl
Solids	(CAS SOP) GEN-420.4/9066	UV-VIS	Phenolics, total
Solids	EPA Lloyd Kahn	UV-VIS	Total organic carbon
Solids	EPA 300.0	IC	Chloride
Solids	EPA 300.0	IC	Fluoride
Solids	EPA 300.0	IC	Nitrate
Solids	EPA 300.0	IC	Sulfate
Solids	EPA 7471B	CVAA	Mercury
Solids	EPA 8330A	HPLC-UV	1,3,5-Trinitrobenzene
Solids	EPA 8330A	HPLC-UV	1,3-Dinitrobenzene
Solids	EPA 8330A	HPLC-UV	2,4,6-Trinitrotoluene
Solids	EPA 8330A	HPLC-UV	2,4-Dinitrotoluene



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<b>Matrix</b>	<b>Standard/Method</b>	<b>Technology</b>	<b>Analyte</b>
Solids	EPA 8330A	HPLC-UV	2,6-Dinitrotoluene
Solids	EPA 8330A	HPLC-UV	2-Amino-4,6-dinitrotoluene
Solids	EPA 8330A	HPLC-UV	2-Nitrotoluene
Solids	EPA 8330A	HPLC-UV	3-Nitrotoluene
Solids	EPA 8330A	HPLC-UV	4-Amino-2,6-dinitrotoluene
Solids	EPA 8330A	HPLC-UV	4-Nitrotoluene
Solids	EPA 8330A	HPLC-UV	HMX
Solids	EPA 8330A	HPLC-UV	Nitrobenzene
Solids	EPA 8330A	HPLC-UV	RDX
Solids	EPA 8330A	HPLC-UV	Tetryl
Solids	EPA 9045C, D	POT	pH
Solids	SM 5220B	Titration	Chemical oxygen demand
Aqueous/Solids	EPA 1010A	Pensky Martin	Ignitability
Aqueous/Solids	EPA 353.2	UV-VIS	Nitrate/nitrite as N
Aqueous/Solids	EPA 6010C	ICP-AES	Aluminum
Aqueous/Solids	EPA 6010C	ICP-AES	Antimony
Aqueous/Solids	EPA 6010C	ICP-AES	Arsenic
Aqueous/Solids	EPA 6010C	ICP-AES	Barium
Aqueous/Solids	EPA 6010C	ICP-AES	Beryllium
Aqueous/Solids	EPA 6010C	ICP-AES	Boron
Aqueous/Solids	EPA 6010C	ICP-AES	Cadmium
Aqueous/Solids	EPA 6010C	ICP-AES	Calcium
Aqueous/Solids	EPA 6010C	ICP-AES	Chromium
Aqueous/Solids	EPA 6010C	ICP-AES	Cobalt
Aqueous/Solids	EPA 6010C	ICP-AES	Copper
Aqueous/Solids	EPA 6010C	ICP-AES	Iron
Aqueous/Solids	EPA 6010C	ICP-AES	Lead
Aqueous/Solids	EPA 6010C	ICP-AES	Magnesium
Aqueous/Solids	EPA 6010C	ICP-AES	Manganese
Aqueous/Solids	EPA 6010C	ICP-AES	Nickel
Aqueous/Solids	EPA 6010C	ICP-AES	Potassium
Aqueous/Solids	EPA 6010C	ICP-AES	Selenium
Aqueous/Solids	EPA 6010C	ICP-AES	Silver



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ISO/IEC 17025:2005 and DoD-ELAP

**Columbia Analytical Services**

1565 Jefferson Road, Building 300, Suite 360, Rochester, NY 14609  
Lisa Reyes Phone: 585-288-5380

*Accreditation is granted to the facility to perform the following testing:*

<b>Matrix</b>	<b>Standard/Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous/Solids	EPA 6010C	ICP-AES	Sodium
Aqueous/Solids	EPA 6010C	ICP-AES	Thallium
Aqueous/Solids	EPA 6010C	ICP-AES	Tin
Aqueous/Solids	EPA 6010C	ICP-AES	Vanadium
Aqueous/Solids	EPA 6010C	ICP-AES	Zinc
Aqueous/Solids	EPA 6020A	ICP-MS	Arsenic
Aqueous/Solids	EPA 6020A	ICP-MS	Antimony
Aqueous/Solids	EPA 6020A	ICP-MS	Barium
Aqueous/Solids	EPA 6020A	ICP-MS	Beryllium
Aqueous/Solids	EPA 6020A	ICP-MS	Cadmium
Aqueous/Solids	EPA 6020A	ICP-MS	Chromium
Aqueous/Solids	EPA 6020A	ICP-MS	Cobalt
Aqueous/Solids	EPA 6020A	ICP-MS	Copper
Aqueous/Solids	EPA 6020A	ICP-MS	Lead
Aqueous/Solids	EPA 6020A	ICP-MS	Manganese
Aqueous/Solids	EPA 6020A	ICP-MS	Nickel
Aqueous/Solids	EPA 6020A	ICP-MS	Selenium
Aqueous/Solids	EPA 6020A	ICP-MS	Silver
Aqueous/Solids	EPA 6020A	ICP-MS	Thallium
Aqueous/Solids	EPA 6020A	ICP-MS	Vanadium
Aqueous/Solids	EPA 6020A	ICP-MS	Zinc
Aqueous/Solids	EPA 680	GC-MS	Monochlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Dichlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Trichlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Tetrachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Pentachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Hexachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Heptachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Octachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Nonachlorobiphenyls, Total
Aqueous/Solids	EPA 680	GC-MS	Decachlorobiphenyls, Total
Aqueous/Solids	EPA 6850	HPLC-MS	Perchlorate



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Aqueous/Solids	EPA 7196A	UV-VIS	Chromium, hexavalent
Aqueous/Solids	EPA 7199	IC-UV	Chromium, hexavalent
Aqueous/Solids	EPA 8015C	GC-FID	Gasoline range organics
Aqueous/Solids	EPA 8015C	GC-FID	Diesel range organics
Aqueous/Solids	EPA 8081B	GC-ECD	4,4'-DDD
Aqueous/Solids	EPA 8081B	GC-ECD	4,4'-DDE
Aqueous/Solids	EPA 8081B	GC-ECD	4,4'-DDT
Aqueous/Solids	EPA 8081B	GC-ECD	Aldrin
Aqueous/Solids	EPA 8081B	GC-ECD	$\alpha$ -BHC
Aqueous/Solids	EPA 8081B	GC-ECD	Alpha-chlordane
Aqueous/Solids	EPA 8081B	GC-ECD	$\beta$ -BHC
Aqueous/Solids	EPA 8081B	GC-ECD	Chlordane, technical
Aqueous/Solids	EPA 8081B	GC-ECD	$\delta$ -BHC
Aqueous/Solids	EPA 8081B	GC-ECD	Dieldrin
Aqueous/Solids	EPA 8081B	GC-ECD	Endosulfan I
Aqueous/Solids	EPA 8081B	GC-ECD	Endosulfan II
Aqueous/Solids	EPA 8081B	GC-ECD	Endosulfan sulfate
Aqueous/Solids	EPA 8081B	GC-ECD	Endrin
Aqueous/Solids	EPA 8081B	GC-ECD	Endrin aldehyde
Aqueous/Solids	EPA 8081B	GC-ECD	Endrin ketone
Aqueous/Solids	EPA 8081B	GC-ECD	$\gamma$ -BHC (Lindane)
Aqueous/Solids	EPA 8081B	GC-ECD	$\gamma$ -Chlordane
Aqueous/Solids	EPA 8081B	GC-ECD	Heptachlor
Aqueous/Solids	EPA 8081B	GC-ECD	Heptachlor epoxide
Aqueous/Solids	EPA 8081B	GC-ECD	Hexachlorobenzene
Aqueous/Solids	EPA 8081B	GC-ECD	Methoxychlor
Aqueous/Solids	EPA 8081B	GC-ECD	Toxaphene
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1016
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1221
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1232
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1242
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1248
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1254



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<b>Matrix</b>	<b>Standard/Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1260
Aqueous/Solids	EPA 8082A	GC-ECD	PCB 1268
Aqueous/Solids	EPA 8151A	GC-ECD	2,4-D
Aqueous/Solids	EPA 8151A	GC-ECD	Dicamba
Aqueous/Solids	EPA 8151A	GC-ECD	2,4,5-T
Aqueous/Solids	EPA 8151A	GC-ECD	2,4,5-TP
Aqueous/Solids	EPA 8151A	GC-ECD	Pentachlorophenol (PCP)
Aqueous/Solids	EPA 8260C	GC-MS	1,1,1,2-Tetrachloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,1,1-Trichloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,1,2,2-Tetrachloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)
Aqueous/Solids	EPA 8260C	GC-MS	1,1,2-Trichloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,1-Dichloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,1-Dichloroethene
Aqueous/Solids	EPA 8260C	GC-MS	1,1-Dichloropropene
Aqueous/Solids	EPA 8260C	GC-MS	1,2,3-Trichlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,2,3-Trichloropropane
Aqueous/Solids	EPA 8260C	GC-MS	1,2,4-Trichlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,2,4-Trimethylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dibromo-3-chloropropane
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dibromoethane
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon-114)
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichloro-1,1,2-trifluoroethane (Freon 123a)
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichloroethane
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichloroethene, total
Aqueous/Solids	EPA 8260C	GC-MS	1,2-Dichloropropane
Aqueous/Solids	EPA 8260C	GC-MS	1,3,5-Trimethylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,3-Dichlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,3-Dichloropropane
Aqueous/Solids	EPA 8260C	GC-MS	1,4-Dichlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	1,4-Dioxane



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Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids	EPA 8260C	GC-MS	2,2-Dichloro-1,1,1-trifluoroethane (Freon 123)
Aqueous/Solids	EPA 8260C	GC-MS	2,2-Dichloropropane
Aqueous/Solids	EPA 8260C	GC-MS	2-Butanone (MEK)
Aqueous/Solids	EPA 8260C	GC-MS	2-Chloro-1,3-butadiene
Aqueous/Solids	EPA 8260C	GC-MS	2-Chloroethylvinyl ether
Aqueous/Solids	EPA 8260C	GC-MS	2-Chlorotoluene
Aqueous/Solids	EPA 8260C	GC-MS	2-Hexanone
Aqueous/Solids	EPA 8260C	GC-MS	2-Methyl-1-propanol (Isobutyl alcohol)
Aqueous/Solids	EPA 8260C	GC-MS	2-Methyl-2-propanol (Tertbutyl alcohol)
Aqueous/Solids	EPA 8260C	GC-MS	2-Nitropropane
Aqueous/Solids	EPA 8260C	GC-MS	2-Propanol
Aqueous/Solids	EPA 8260C	GC-MS	3-Chloro-1-propene (Allyl chloride)
Aqueous/Solids	EPA 8260C	GC-MS	4-Chlorotoluene
Aqueous/Solids	EPA 8260C	GC-MS	4-Ethyltoluene
Aqueous/Solids	EPA 8260C	GC-MS	4-Isopropyltoluene
Aqueous/Solids	EPA 8260C	GC-MS	4-Methyl-2-pentanone (MIBK)
Aqueous/Solids	EPA 8260C	GC-MS	Acetone
Aqueous/Solids	EPA 8260C	GC-MS	Acetonitrile
Aqueous/Solids	EPA 8260C	GC-MS	Acrolein
Aqueous/Solids	EPA 8260C	GC-MS	Acrylonitrile
Aqueous/Solids	EPA 8260C	GC-MS	Benzene
Aqueous/Solids	EPA 8260C	GC-MS	Benzyl chloride
Aqueous/Solids	EPA 8260C	GC-MS	Bromobenzene
Aqueous/Solids	EPA 8260C	GC-MS	Bromochloromethane
Aqueous/Solids	EPA 8260C	GC-MS	Bromodichloromethane
Aqueous/Solids	EPA 8260C	GC-MS	Bromoform
Aqueous/Solids	EPA 8260C	GC-MS	Bromomethane
Aqueous/Solids	EPA 8260C	GC-MS	Carbon disulfide
Aqueous/Solids	EPA 8260C	GC-MS	Carbon tetrachloride
Aqueous/Solids	EPA 8260C	GC-MS	Chlorobenzene
Aqueous/Solids	EPA 8260C	GC-MS	Chloroethane
Aqueous/Solids	EPA 8260C	GC-MS	Chloroform
Aqueous/Solids	EPA 8260C	GC-MS	Chloromethane



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<b>Matrix</b>	<b>Standard/Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous/Solids	EPA 8260C	GC-MS	cis-1,2-Dichloroethene
Aqueous/Solids	EPA 8260C	GC-MS	cis-1,3-Dichloropropene
Aqueous/Solids	EPA 8260C	GC-MS	Cyclohexane
Aqueous/Solids	EPA 8260C	GC-MS	Cyclohexanone
Aqueous/Solids	EPA 8260C	GC-MS	Dibromochloromethane
Aqueous/Solids	EPA 8260C	GC-MS	Dibromomethane
Aqueous/Solids	EPA 8260C	GC-MS	Dichlorodifluoromethane (Freon 12)
Aqueous/Solids	EPA 8260C	GC-MS	Dichlorofluoromethane (Freon 21)
Aqueous/Solids	EPA 8260C	GC-MS	Dichloromethane
Aqueous/Solids	EPA 8260C	GC-MS	Diethyl ether
Aqueous/Solids	EPA 8260C	GC-MS	Diisopropyl ether
Aqueous/Solids	EPA 8260C	GC-MS	Ethyl methacrylate
Aqueous/Solids	EPA 8260C	GC-MS	Ethyl tert-butyl ether
Aqueous/Solids	EPA 8260C	GC-MS	Ethylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	Hexachlorobutadiene
Aqueous/Solids	EPA 8260C	GC-MS	Iodomethane
Aqueous/Solids	EPA 8260C	GC-MS	Isopropylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	m- + p-Xylene
Aqueous/Solids	EPA 8260C	GC-MS	Methacrylonitrile
Aqueous/Solids	EPA 8260C	GC-MS	Methyl acetate
Aqueous/Solids	EPA 8260C	GC-MS	Methyl methacrylate
Aqueous/Solids	EPA 8260C	GC-MS	Methylcyclohexane
Aqueous/Solids	EPA 8260C	GC-MS	Methyl-tert-butyl ether (MTBE)
Aqueous/Solids	EPA 8260C	GC-MS	Napthalene
Aqueous/Solids	EPA 8260C	GC-MS	N-butylacetate
Aqueous/Solids	EPA 8260C	GC-MS	N-butylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	N-heptane
Aqueous/Solids	EPA 8260C	GC-MS	N-propylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	o-Xylene
Aqueous/Solids	EPA 8260C	GC-MS	Propionitrile
Aqueous/Solids	EPA 8260C	GC-MS	sec-butylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	Styrene
Aqueous/Solids	EPA 8260C	GC-MS	tert-amyl methyl ether



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Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids	EPA 8260C	GC-MS	tert-butylbenzene
Aqueous/Solids	EPA 8260C	GC-MS	Tetra hydrofuran
Aqueous/Solids	EPA 8260C	GC-MS	Tetrachloroethene
Aqueous/Solids	EPA 8260C	GC-MS	Toluene
Aqueous/Solids	EPA 8260C	GC-MS	trans-1,2-Dichloroethene
Aqueous/Solids	EPA 8260C	GC-MS	trans-1,3-Dichloropropene
Aqueous/Solids	EPA 8260C	GC-MS	trans-1,4-Dichloro-2-butene
Aqueous/Solids	EPA 8260C	GC-MS	Trichloroethene
Aqueous/Solids	EPA 8260C	GC-MS	Trichlorofluoromethane (Freon 11)
Aqueous/Solids	EPA 8260C	GC-MS	Vinyl acetate
Aqueous/Solids	EPA 8260C	GC-MS	Vinyl chloride
Aqueous/Solids	EPA 8260C	GC-MS	Xylenes, total
Aqueous/Solids	EPA 8270D	GC-MS	1,2,4,5-Tetrachlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,2,4-Trichlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,2-Dichlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,2-Diphenylhydrazine
Aqueous/Solids	EPA 8270D	GC-MS	1,3,5-Trinitrobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,3-Dichlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,3-Dinitrobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,4-Dichlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	1,4-Dioxane
Aqueous/Solids	EPA 8270D	GC-MS	1,4-Naphthoquinone
Aqueous/Solids	EPA 8270D	GC-MS	1-Methyl-2-pyrrolidinone
Aqueous/Solids	EPA 8270D	GC-MS	1-Methylnaphthalene
Aqueous/Solids	EPA 8270D	GC-MS	1-Naphthylamine
Aqueous/Solids	EPA 8270D	GC-MS	2,3,4,6-Tetrachlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4,5-Trichlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4,6-Trichlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4-Dichlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4-Dimethylphenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4-Dinitrophenol
Aqueous/Solids	EPA 8270D	GC-MS	2,4-Dinitrotoluene
Aqueous/Solids	EPA 8270D	GC-MS	2,6-Dichlorophenol



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Aqueous/Solids	EPA 8270D	GC-MS	2,6-Dinitrotoluene
Aqueous/Solids	EPA 8270D	GC-MS	2-Acetylaminofluorene
Aqueous/Solids	EPA 8270D	GC-MS	2-Chloronaphthalene
Aqueous/Solids	EPA 8270D	GC-MS	2-Chlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	2-Methyl-5-nitroaniline (5-Nitro-o-toluidine)
Aqueous/Solids	EPA 8270D	GC-MS	2-Methylnaphthalene
Aqueous/Solids	EPA 8270D	GC-MS	2-Methylphenol
Aqueous/Solids	EPA 8270D	GC-MS	2-Naphthylamine
Aqueous/Solids	EPA 8270D	GC-MS	2-Nitroaniline
Aqueous/Solids	EPA 8270D	GC-MS	2-Nitrophenol
Aqueous/Solids	EPA 8270D	GC-MS	2-Picoline
Aqueous/Solids	EPA 8270D	GC-MS	3,3'-Dichlorobenzidine
Aqueous/Solids	EPA 8270D	GC-MS	3,3'-Dimethylbenzidine
Aqueous/Solids	EPA 8270D	GC-MS	3+4-Methylphenol
Aqueous/Solids	EPA 8270D	GC-MS	3-Methylcholanthrene
Aqueous/Solids	EPA 8270D	GC-MS	3-Nitroaniline
Aqueous/Solids	EPA 8270D	GC-MS	4,6-Dinitro-2-methylphenol
Aqueous/Solids	EPA 8270D	GC-MS	4-Aminobiphenyl
Aqueous/Solids	EPA 8270D	GC-MS	4-Bromophenyl-phenylether
Aqueous/Solids	EPA 8270D	GC-MS	4-Chloro-3-methylphenol
Aqueous/Solids	EPA 8270D	GC-MS	4-Chloroaniline
Aqueous/Solids	EPA 8270D	GC-MS	4-Chlorophenyl-phenylether
Aqueous/Solids	EPA 8270D	GC-MS	4-Nitroaniline
Aqueous/Solids	EPA 8270D	GC-MS	4-Nitrophenol
Aqueous/Solids	EPA 8270D	GC-MS	4-Nitroquinoline-1-oxide
Aqueous/Solids	EPA 8270D	GC-MS	7,12-Dimethylbenz(a)anthracene
Aqueous/Solids	EPA 8270D	GC-MS	$\alpha,\alpha$ -Dimethylphenethylamine
Aqueous/Solids	EPA 8270D	GC-MS	Acenaphthene
Aqueous/Solids	EPA 8270D	GC-MS	Acenaphthylene
Aqueous/Solids	EPA 8270D	GC-MS	Acetophenone
Aqueous/Solids	EPA 8270D	GC-MS	Aniline
Aqueous/Solids	EPA 8270D	GC-MS	Anthracene
Aqueous/Solids	EPA 8270D	GC-MS	Aramite



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Aqueous/Solids	EPA 8270D	GC-MS	Atrazine
Aqueous/Solids	EPA 8270D	GC-MS	Benzaldehyde
Aqueous/Solids	EPA 8270D	GC-MS	Benzidine
Aqueous/Solids	EPA 8270D	GC-MS	Benzo(a)anthracene
Aqueous/Solids	EPA 8270D	GC-MS	Benzo(a)pyrene
Aqueous/Solids	EPA 8270D	GC-MS	Benzo(b)fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS	Benzo(g,h,i)perylene
Aqueous/Solids	EPA 8270D	GC-MS	Benzo(k)fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS	Benzoic acid
Aqueous/Solids	EPA 8270D	GC-MS	Benzyl alcohol
Aqueous/Solids	EPA 8270D	GC-MS	Biphenyl
Aqueous/Solids	EPA 8270D	GC-MS	Bis(1-chloroisopropyl)ether
Aqueous/Solids	EPA 8270D	GC-MS	Bis(-2-chloroethoxy)methane
Aqueous/Solids	EPA 8270D	GC-MS	Bis(2-chloroethyl)ether
Aqueous/Solids	EPA 8270D	GC-MS	Bis(2-ethylhexyl)phthalate
Aqueous/Solids	EPA 8270D	GC-MS	Butyl benzyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS	Caprolactam
Aqueous/Solids	EPA 8270D	GC-MS	Carbazole
Aqueous/Solids	EPA 8270D	GC-MS	Chlorobenzilate
Aqueous/Solids	EPA 8270D	GC-MS	Chrysene
Aqueous/Solids	EPA 8270D	GC-MS	Cyclohexane, isothiocyanato-
Aqueous/Solids	EPA 8270D	GC-MS	Diallate
Aqueous/Solids	EPA 8270D	GC-MS	Dibenzo(a,h)anthracene
Aqueous/Solids	EPA 8270D	GC-MS	Dibenzofuran
Aqueous/Solids	EPA 8270D	GC-MS	Diethylphthalate
Aqueous/Solids	EPA 8270D	GC-MS	Dimethoate
Aqueous/Solids	EPA 8270D	GC-MS	Dimethyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS	Di-n-butylphthalate
Aqueous/Solids	EPA 8270D	GC-MS	Di-n-octyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS	Dinoseb
Aqueous/Solids	EPA 8270D	GC-MS	Diphenylamine
Aqueous/Solids	EPA 8270D	GC-MS	Disulfoton
Aqueous/Solids	EPA 8270D	GC-MS	Ethyl methanesulfonate



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Aqueous/Solids	EPA 8270D	GC-MS	Fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS	Fluorene
Aqueous/Solids	EPA 8270D	GC-MS	Hexachlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	Hexachlorobutadiene
Aqueous/Solids	EPA 8270D	GC-MS	Hexachlorocyclopentadiene
Aqueous/Solids	EPA 8270D	GC-MS	Hexachloroethane
Aqueous/Solids	EPA 8270D	GC-MS	Hexachlorophene
Aqueous/Solids	EPA 8270D	GC-MS	Hexachloropropene
Aqueous/Solids	EPA 8270D	GC-MS	Indeno(1,2,3-cd)pyrene
Aqueous/Solids	EPA 8270D	GC-MS	Isodrin
Aqueous/Solids	EPA 8270D	GC-MS	Isophorone
Aqueous/Solids	EPA 8270D	GC-MS	Isosafrole
Aqueous/Solids	EPA 8270D	GC-MS	Methapyrilene
Aqueous/Solids	EPA 8270D	GC-MS	Methyl methanesulfonate
Aqueous/Solids	EPA 8270D	GC-MS	Methyl parathion
Aqueous/Solids	EPA 8270D	GC-MS	Naphthalene
Aqueous/Solids	EPA 8270D	GC-MS	Nitrobenzene
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosodiethylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosodimethylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosodi-n-butylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitroso-di-n-propylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosodiphenylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosomethylethylamine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosomorpholine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosopiperidine
Aqueous/Solids	EPA 8270D	GC-MS	N-nitrosopyrrolidine
Aqueous/Solids	EPA 8270D	GC-MS	Octachlorostyrene
Aqueous/Solids	EPA 8270D	GC-MS	o,o,o-triethyl phosphorothioate
Aqueous/Solids	EPA 8270D	GC-MS	o-toluidine
Aqueous/Solids	EPA 8270D	GC-MS	Parathion (ethyl)
Aqueous/Solids	EPA 8270D	GC-MS	p-dimethylaminoazobenzene
Aqueous/Solids	EPA 8270D	GC-MS	Pentachlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS	Pentachloroethane



**Certificate of Accreditation: Supplement**  
ISO/IEC 17025:2005 and DoD-ELAP

**Columbia Analytical Services**

1565 Jefferson Road, Building 300, Suite 360, Rochester, NY 14609  
Lisa Reyes Phone: 585-288-5380

*Accreditation is granted to the facility to perform the following testing:*

<b>Matrix</b>	<b>Standard/Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous/Solids	EPA 8270D	GC-MS	Pentachloronitrobenzene
Aqueous/Solids	EPA 8270D	GC-MS	Pentachlorophenol
Aqueous/Solids	EPA 8270D	GC-MS	Phenacetin
Aqueous/Solids	EPA 8270D	GC-MS	Phenanthrene
Aqueous/Solids	EPA 8270D	GC-MS	Phenol
Aqueous/Solids	EPA 8270D	GC-MS	Phorate
Aqueous/Solids	EPA 8270D	GC-MS	Phthalimide
Aqueous/Solids	EPA 8270D	GC-MS	Pyrene
Aqueous/Solids	EPA 8270D	GC-MS	Pyridine
Aqueous/Solids	EPA 8270D	GC-MS	Safrole
Aqueous/Solids	EPA 8270D	GC-MS	Sulfotepp
Aqueous/Solids	EPA 8270D	GC-MS	Thionazin
Aqueous/Solids	EPA 8270D	GC-MS-LL	1,4-Dioxane
Aqueous/Solids	EPA 8270D	GC-MS-LL	1-Methylnaphthalene
Aqueous/Solids	EPA 8270D	GC-MS-LL	2-Methylnaphthalene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Acenaphthene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Acenaphthylene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Anthracene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Benzo(a)anthracene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Benzo(a)pyrene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Benzo(b)fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Benzo(g,h,i)perylene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Benzo(k)fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Bis(2-ethylhexyl)phthalate
Aqueous/Solids	EPA 8270D	GC-MS-LL	Butyl benzyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS-LL	Carbazole
Aqueous/Solids	EPA 8270D	GC-MS-LL	Chrysene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Dibenzo(a,h)anthracene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Dibenzofuran
Aqueous/Solids	EPA 8270D	GC-MS-LL	Diethyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS-LL	Dimethyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS-LL	Di-n-butyl phthalate
Aqueous/Solids	EPA 8270D	GC-MS-LL	Di-n-octyl phthalate



# Certificate of Accreditation: Supplement

ISO/IEC 17025:2005 and DoD-ELAP

## Columbia Analytical Services

1565 Jefferson Road, Building 300, Suite 360, Rochester, NY 14609  
Lisa Reyes Phone: 585-288-5380

*Accreditation is granted to the facility to perform the following testing:*

Matrix	Standard/Method	Technology	Analyte
Aqueous/Solids	EPA 8270D	GC-MS-LL	Fluoranthene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Fluorene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Hexachlorobenzene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Indeno(1,2,3-cd)pyrene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Naphthalene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Nitrobenzene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Octachlorostyrene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Phenanthrene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Pyrene
Aqueous/Solids	EPA 8270D	GC-MS-LL	Pyridine
Aqueous/Solids	EPA 9012A, B	UV-VIS	Cyanide, total
Aqueous/Solids	EPA 9034	Titration	Sulfide, acid soluble
Aqueous/Solids	EPA 9056A	IC	Bromide
Aqueous/Solids	EPA 9056A	IC	Chloride
Aqueous/Solids	EPA 9056A	IC	Fluoride
Aqueous/Solids	EPA 9056A	IC	Nitrate as Nitrogen
Aqueous/Solids	EPA 9056A	IC	Nitrite as Nitrogen
Aqueous/Solids	EPA 9056A	IC	Sulfate
Aqueous/Solids	GEN-AVS	Titrimetric	Acid Volatile Sulfide
Aqueous/Solids	EPA 8330B	HPLC	1,3,5-Trinitrobenzene
Aqueous/Solids	EPA 8330B	HPLC	1,3-Dinitrobenzene
Aqueous/Solids	EPA 8330B	HPLC	2,4,6-Trinitrotoluene (TNT)
Aqueous/Solids	EPA 8330B	HPLC	2,4-Dinitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	2,6-Dinitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	2-Amino 4,6-Dinitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	2-Nitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	3,5-Dinitroaniline
Aqueous/Solids	EPA 8330B	HPLC	3-Nitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	4-Amino 2,6-Dinitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	4-Nitrotoluene
Aqueous/Solids	EPA 8330B	HPLC	Hexahydro 1,3,5-Trinitro 1,3,5-Triazine
Aqueous/Solids	EPA 8330B	HPLC	Methyl 2,4,6 Trinitrophenylnitramine
Aqueous/Solids	EPA 8330B	HPLC	Nitrobenzene
Aqueous/Solids	EPA 8330B	HPLC	Nitroglycerin



**Certificate of Accreditation: Supplement**  
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**Columbia Analytical Services**

1565 Jefferson Road, Building 300, Suite 360, Rochester, NY 14609  
Lisa Reyes Phone: 585-288-5380

*Accreditation is granted to the facility to perform the following testing:*

<b>Matrix</b>	<b>Standard/Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous/Solids	EPA 8330B	HPLC	Octahydro 1.3.5.7 Tetranitro 1,3,5,7 Tetraz
Aqueous/Solids	EPA 8330B	HPLC	Pentaerythritol Tetranitrate (PETN)
Aqueous/Solids	HPLC-METACID	HPLC	Acetic Acid
Aqueous/Solids	HPLC-METACID	HPLC	Butanoic Acid (Butyric Acid)
Aqueous/Solids	HPLC-METACID	HPLC	Lactic Acid
Aqueous/Solids	HPLC-METACID	HPLC	Propionic Acid
Aqueous/Solids	HPLC-METACID	HPLC	Pyruvic Acid

<b>Matrix</b>	<b>Standard/Method</b>	<b>Technology</b>	<b>Analyte</b>
Aqueous	EPA 3010A	Acid Digestion	Metals prep
Aqueous	EPA 3510C	SF Extraction	Semivolatiles, pesticides, PCBs, DRO
Aqueous	EPA 5030B	P&T	Volatiles
Solids	EPA 3050B	Acid Digestion	Metals prep
Solids	EPA 3060A	Digestion	Hexavalent chromium digestion
Solids	EPA 3541	SOX Extraction	Semivolatiles, pesticides, PCBs, DRO
Solids	EPA 5035	P&T closed	Volatiles
Aqueous/Solids	EPA 1311	TCLP	Physical Extraction
Aqueous/Solids	EPA 1312	SPLP	Physical Extraction
Aqueous/Solids	EPA 3620B	Florisil Cleanup	Semivolatiles, pesticides, PCBs
Aqueous/Solids	EPA 3660B	Sulfur Cleanup	Semivolatiles, pesticides, PCBs
Aqueous/Solids	EPA 3665A	Sulfuric Acid Cleanup	PCBs
Aqueous/Solids	EPA 9012A, B	Distillation	Cyanide
Aqueous/Solids	EPA 9030B	Distillation	Sulfide, acid soluble



# CERTIFICATE OF ACCREDITATION

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

This is to certify that

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

has been assessed by AClass  
and meets the requirements of

**ISO/IEC 17025:2005 and DoD-ELAP**

while demonstrating technical competence in the field(s) of

**TESTING**

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

ADE-1542

Certificate Number

AClass Approval



Certificate Valid: 4/30/2013-04/30/2015  
Version No. 003 Issued: 05/30/2013



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



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

**TriMatrix Laboratories, Inc**

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

Rick Wilburn Phone: 616-975-4500

**TESTING**

Valid to: April 30, 2015

Certificate Number: ADE - 1542

**I. Environmental**

MATRIX	SPECIFIC TEST or ANALYTE GROUP**	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY
Water	Metals Digestion	200.2	Block Digestion
Water	Metals Digestion	3010A	Block Digestion
Water	Metals Digestion	3020A	Block Digestion
Solid	Metals Digestion	3050B	Block Digestion
Water	Metals	200.7 / 6010C	ICP
Water	Calcium Hardness (as CaCO <sub>3</sub> )	SM 2340B	ICP
Solid	Metals	6010C	ICP
Water	Total Hardness (as CaCO <sub>3</sub> )	SM 2340B	ICP
Water	Metals	200.8 / 6020A	ICP MS
Solid	Metals	6020A	ICP MS
Water	Mercury	245.1 / 7470A	CVAA
Solid	Mercury	7471B	CVAA



<b>MATRIX</b>	<b>SPECIFIC TEST or ANALYTE GROUP**</b>	<b>SPECIFICATION OR STANDARD METHOD (all EPA unless specified)</b>	<b>* KEY EQUIPMENT OR TECHNOLOGY</b>
Water	Mercury, Low-Level	1631E	CVAF
Water	1,2-Dibromo-3- Chloropropane & 1,2-Dibromoethane	8011	GC-ECD
Water / Solid	Carbonyl Compounds	8315A	HPLC-UV
Water / Solid	Nitroaromatics and Nitramines	8330A	HPLC-UV
Water / Solid	Nitroglycerine and PETN	8332	HPLC-UV
Water / Solid	Chlorinated Herbicides	8151A	GC-ECD
Water	Methoxychlor	608.2	GC-ECD
Water	Organochlorine Pesticides	608 / 8081B	GC-ECD
Solid	Organochlorine Pesticides	8081B	GC-ECD
Water	PCBs	608 / 8082A	GC-ECD
Solid	PCBs	8082A	GC-ECD
Water / Solid	Diesel Range Organics (DRO)	Wisconsin DRO / 8015C	GC-FID
Water / Solid	Oil Range Organics	8015C	GC-FID
Water	Dissolved Gas Analysis	RSK-175	GC-FID
Water / Solid	Nonhalogenated Organics	8015C	GC-FID
Water	Semivolatile Organic Compounds	625 / 8270C	GCMS
Solid	Semivolatile Organic Compounds	8270C	GCMS
Water / Solid	Semivolatile Organic Compounds	8270C SIM	GCMS



<b>MATRIX</b>	<b>SPECIFIC TEST or ANALYTE GROUP**</b>	<b>SPECIFICATION OR STANDARD METHOD (all EPA unless specified)</b>	<b>* KEY EQUIPMENT OR TECHNOLOGY</b>
Solid	Semivolatile Extraction	3545A	Pressurized Fluid Ext
Water	Semivolatile Extraction	3510C	Separatory Funnel Ext
Solid	Semivolatile Extraction	3550C	Ultrasonic Extraction
Water / Solid	Chlorinated Hydrocarbons	8121 / 612	GC-ECD
Water / Solid	Gasoline Range Organics (GRO)	Wisconsin GRO / 8015C	GC-FID
Solid	Volatile Organics	8021B	GC-PID; HECD
Water	Volatiles Organics	601 / 602 / 8021B	GC-PID; HECD
Water	Volatile Organics	524.2 / 624 / 8260B	GCMS
Solid	Volatile Organics	8260B	GCMS
Solid	Volatiles Extraction	5035A	Purge & Trap
Water	Volatiles Extraction	5030B	Purge & Trap/Water
Water / Solid	SPLP	1312	Acetic Acid Leaching
Water / Solid	TCLP	1311	Acetic Acid Leaching
Solid	Ignitability	1020A	Closed-Cup
Solid	Acid Volatile Sulfide and Selected Simultaneously Extractable Metals	821-R-91-100	Distillation/ Spectrophotometric
Solid	Paint Filter Test	9095B	Filtration
Water	HEM Oil and Grease / SGT-HEM Non-Polar Material	1664A / 9070A	Gravimetric



<b>MATRIX</b>	<b>SPECIFIC TEST or ANALYTE GROUP**</b>	<b>SPECIFICATION OR STANDARD METHOD (all EPA unless specified)</b>	<b>* KEY EQUIPMENT OR TECHNOLOGY</b>
Solid	HEM Oil and Grease / SGT-HEM Non-Polar Material	9071B	Gravimetric
Water	Filterable Residue (TDS)	SM 2540C	Gravimetric
Water	Non-Filterable Residue (TSS)	SM 2540D	Gravimetric
Water	Total Residue / Solids (TS)	SM 2540B	Gravimetric
Solid	Total Residue / Solids (TS)	SM 3550C	Gravimetric
Water	Volatile Residue (VS)	SM 2540E	Gravimetric
Solid	Volatile Residue (VS)	SM 2540G	Gravimetric
Water	Settleable Residue / Solids	SM 2540 F	Imhoff cone
Water	Anions	300.0/9056A	Ion Chromatographic
Solid	Anions	9056A	Ion Chromatographic
Water	Bromide	ASTM D1246	ISE
Water / Solid	Fluoride	SM 4500-F C	ISE
Water	BOD and CBOD	SM 5210B	Luminescence
Water	Turbidity	SM 2130B	Nephelometric
Water	Color	SM 2120B	Platinum-Cobalt Color
Water	pH and Corrosivity	SM 4500-H <sup>+</sup> B / 9040C	Potentiometric
Solid	pH and Corrosivity	9045D	Potentiometric
Water	Conductivity	SM 2510B / 9050A	Specific Conductance

<b>MATRIX</b>	<b>SPECIFIC TEST or ANALYTE GROUP**</b>	<b>SPECIFICATION OR STANDARD METHOD (all EPA unless specified)</b>	<b>* KEY EQUIPMENT OR TECHNOLOGY</b>
Water / Solid	Ammonia-N	SM 4500-NH <sub>3</sub> B	Distillation
Water / Solid	Ammonia-N	SM 4500-NH <sub>3</sub> G	Spectrophotometric
Water	Chloride	SM 4500-Cl E / 9251	Spectrophotometric
Solid	Chromium (VI) Cr <sup>+6</sup>	3060A	Digestion
Water	Chromium (VI) Cr <sup>+6</sup>	SM 3500-Cr B / 7196A	Spectrophotometric
Solid	Chromium (VI) Cr <sup>+6</sup>	7196A	Spectrophotometric
Water	COD	SM 5220D	Spectrophotometric
Water / Solid	Cyanide Available	OIA-1677	Amperometry
Solid	Cyanide	9010C	Distillation
Water	Cyanide	SM 4500-CN C / 9010C	Distillation
Solid	Cyanide Extraction	9013A	Extraction
Solid	Cyanide Amenable	9014	Spectrophotometric
Water	Cyanide Amenable	SM 4500-CN G / 9014	Spectrophotometric
Solid	Cyanide, Total	9014	Spectrophotometric
Water	Cyanide, Total	SM 4500-CN E / 9014	Spectrophotometric
Water	Ferrous Iron	SM 3500-Fe B	Spectrophotometric
Water / Solid	Nitrate-N	SM 4500-NO <sub>3</sub> F	Spectrophotometric
Water	Nitrate+Nitrite-N	SM 4500-NO <sub>3</sub> F	Spectrophotometric

<b>MATRIX</b>	<b>SPECIFIC TEST or ANALYTE GROUP**</b>	<b>SPECIFICATION OR STANDARD METHOD (all EPA unless specified)</b>	<b>* KEY EQUIPMENT OR TECHNOLOGY</b>
Water	Nitrite-N	SM 4500-NO <sub>2</sub> B / NO <sub>3</sub> F	Spectrophotometric
Water	o-Phosphate	SM 4500-P E	Spectrophotometric
Water / Solid	Phosphorus Total	SM 4500-P E	Spectrophotometric
Water	Silica as SiO <sub>2</sub>	SM 4500-SiO <sub>2</sub> D	Spectrophotometric
Water	Surfactants (MBAS)	SM 5540C	Spectrophotometric
Water / Solid	TKN	SM 4500-N <sub>org</sub> D	Spectrophotometric
Solid	Total Phenolics	9065	Spectrophotometric
Water	Total Phenolics	420.4 / 9065	Spectrophotometric
Water	Acidity	SM 2310B	Titrimetric
Water	Calcium Hardness (as CaCO <sub>3</sub> )	SM 2340 C	Titrimetric
Water / Solid	Sulfide	9030B	Distillation
Water	Sulfide	SM 4500-S <sub>2</sub> D	Spectrophotometric
Water	Sulfide	SM 4500-S <sub>2</sub> F	Titrimetric
Water / Solid	Sulfide	9034	Titrimetric
Water / Solid	Reactive Sulfide	7.3.4.2	Titrimetric
Water	Sulfite	SM 4500-SO <sub>3</sub> <sup>2-</sup> B	Titrimetric
Water	Total Alkalinity (as CaCO <sub>3</sub> )	SM 2320B	Titrimetric
Water	Total Hardness (as CaCO <sub>3</sub> )	SM 2340C	Titrimetric

<b>MATRIX</b>	<b>SPECIFIC TEST or ANALYTE GROUP**</b>	<b>SPECIFICATION OR STANDARD METHOD (all EPA unless specified)</b>	<b>* KEY EQUIPMENT OR TECHNOLOGY</b>
Water	Sulfate	ASTM D516 / 9038	Turbidimetric
Solid	Total Organic Carbon (TOC)	Lloyd Kahn	Infrared
Water	Total Organic Carbon (TOC)	SM 5310C / 9060A	Oxidation/CO <sub>2</sub> Det
Solid	Total Organic Carbon (TOC)	WALKLEY BLACK	Titrimetric
Solid	Extractable Organic Halides	9023	Coulometric Titration
Water	Dissolved Organic Carbon	SM 5310C	Titrimetric
Solid	Fractional Organic Carbon	ASTM D2974	Gravimetric
Solid	Grain Size	ASTM D422	Size Exclusion
Water	Total Organic Halides (TOX)	9020B	Coulometric Titration
Solid	% Moisture in Soil and Rock	ASTM D2216	Gravimetric
Solid	Shake Extraction	ASTM D3987	Water Leaching

## II. Microbiological

<b>MATRIX</b>	<b>SPECIFIC TEST or ANALYTE GROUP**</b>	<b>SPECIFICATION OR STANDARD METHOD (all EPA unless specified)</b>	<b>* KEY EQUIPMENT OR TECHNOLOGY</b>
Water	Fecal Coliform	SM 9222D	Microbiological
Water	Heterotrophic Bacteria (Std Plate)	SM 9215B	Microbiological
Water	Total Coliform / <i>E. coli</i>	SM 9223B	Microbiological

**Notes:**

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



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Vice President



**Accredited Analytes/Methods (by matrix)**

**TriMatrix Laboratoires, Inc.**

**Grand Rapids, MI**

Analyte	Matrix							
	Aqueous					Solid		
<b>Trace Metals</b>								
Aluminum	200.7	200.8	6010C	6020A			6010C	
Antimony	200.7	200.8	6010C	6020A			6010C	6020A
Arsenic	200.7	200.8	6010C	6020A			6010C	6020A
Barium	200.7	200.8	6010C	6020A			6010C	6020A
Beryllium	200.7	200.8	6010C	6020A			6010C	6020A
Boron	200.7	200.8	6010C	6020A			6010C	6020A
Cadmium	200.7	200.8	6010C	6020A			6010C	6020A
Calcium	200.7		6010C				6010C	
Chromium, total	200.7	200.8	6010C	6020A			6010C	6020A
Chromium VI	SM3500Cr B				7196A			7196A
Cobalt	200.7	200.8	6010C	6020A			6010C	6020A
Copper	200.7	200.8	6010C	6020A			6010C	6020A
Iron	200.7		6010C				6010C	
Lead	200.7	200.8	6010C	6020A			6010C	6020A
Lithium	200.7		6010C				6010C	
Magnesium	200.7		6010C				6010C	
Manganese	200.7	200.8	6010C	6020A			6010C	6020A
Mercury	245.1				7470A			7471B
Mercury (Low Level)					1631E			
Molybdenum	200.7	200.8	6010C	6020A			6010C	6020A
Nickel	200.7	200.8	6010C	6020A			6010C	6020A
Potassium	200.7		6010C				6010C	
Selenium	200.7	200.8	6010C	6020A			6010C	6020A
Silver	200.7	200.8	6010C	6020A			6010C	6020A
Sodium	200.7		6010C				6010C	
Strontium	200.7	200.8	6010C	6020A			6010C	
Thallium	200.7	200.8	6010C	6020A			6010C	6020A
Tin	200.7	200.8	6010C	6020A			6010C	6020A
Titanium	200.7		6010C				6010C	
Vanadium	200.7	200.8	6010C	6020A			6010C	6020A
Zinc	200.7	200.8	6010C	6020A			6010C	6020A
<b>Demands</b>								
TOC	SM5310C	9060A					Walkley Black	Lloyd Kahn
COD			SM5220D					
DOC-Dissolved Organic Carbon							SM5310C	

**Accredited Analytes/Methods (by matrix)**

**TriMatrix Laboratoires, Inc.**

**Grand Rapids, MI**

Analyte	Matrix							
	Aqueous					Solid		
BOD and CBOD	SM5210B							
<b>Misc Analytes</b>								
Total Alkalinity (as CaCO <sub>3</sub> )	SM2320B							
Calcium Hardness as CaCO <sub>3</sub>	SM2340B							
Total Hardness as CaCO <sub>3</sub>	SM2340B	SM2340C						
% Moisture in Soil and Rock						ASTM D2216		
Total Residue/Solids (TS)	SM2540B					3550C		
Filterable Residue (TDS)		SM2540C						
Ignitability						1020A		
Non-Filterable Residue (TSS)	SM2540D							
Volatile Residue (VS)		SM2540E				SM2540G		
Settleable Residue	SM2540F							
pH			9040C	SM4500H <sup>+</sup> B		9045D		
Sulfide	SM4500S <sup>2-</sup> D	SM4500S <sup>2-</sup> F	9034			9034		
Total Cyanide	SM4500CN E	9014				9014		
Cyanide, Amenable	SM4500CN G	9014				9014		
Ammonia	SM4500NH <sub>3</sub> G					SM4500NH <sub>3</sub> G		
Conductivity	SM2510B	9050A						
Nitrogen, Total Kjeldahl (TKN)	SM4500N <sub>org</sub> D					SM4500N <sub>org</sub> D		
Total Phenolics	420.4	9065				9065		
Total Organic Halides (TOX)	9020B							
Bromide	ASTM D1246		300.0	9056A				
Chloride	SM4500Cl E	9251	300.0	9056A		9056A		
Fluoride	SM4500F C		300.0	9056A		9056A		
Nitrate as N	SM4500NO <sub>3</sub> F		300.0	9056A		9056A	SM4500NO <sub>3</sub> F	
Nitrite as N	SM4500NO <sub>2</sub> B	SM4500NO <sub>3</sub> F	300.0	9056A		9056A		
Nitrate + Nitrite as N	SM4500NO <sub>3</sub> F		300.0	9056A		9056A		
ortho-phosphate	SM4500P E							
Total Phosphorus	SM4500P E					SM4500P E		
Silica as SiO <sub>2</sub>	SM4500SiO <sub>2</sub> D							
Sulfate	ASTM D516	9038	300.0	9056A		9056A		
Surfactants - MBAS	SM5540C							
Fecal Coliform	SM9222D							
Heterotrophic Bacteria (Std Plate)	SM9215B							
Total Coliform, E. Coli	SM9223B							

**Accredited Analytes/Methods (by matrix)**

**TriMatrix Laboratoires, Inc.**

**Grand Rapids, MI**

Analyte	Matrix							
	Aqueous					Solid		
Turbidity		SM2130B						
EOX-Extractable Organic Halides						9023		
FOC-Fractional Organic Carbon						ASTM D2974		
<b>Petroleum Hydrocarbons</b>								
SGT-HEM; Non-Polar Material	1664A	9070A				9071B		
HEM; Oil and Grease	1664A	9070A				9071B		
Gasoline Range Organics (GRO)	8015C	Wisconsin GRO				8015C	Wisconsin GRO	
Diesel Range Organics (DRO)	8015C	Wisconsin DRO				8015C	Wisconsin DRO	
Oil Range Organics (ORO)	8015C					8015C		
<b>VOCs</b>								
Acetone		624	8260B				8260B	
Acetonitrile		624	8260B				8260B	
Acrolein		624	8260B				8260B	
Acrylonitrile		624	8260B				8260B	
Benzene	524.2	624	8260B		602	8021B	8021B	8260B
Bromobenzene	524.2		8260B				8260B	
Bromochloromethane	524.2		8260B				8260B	
Bromodichloromethane	524.2	624	8260B	601		8021B	8021B	8260B
Bromoform	524.2	624	8260B	601		8021B	8021B	8260B
Bromomethane	524.2	624	8260B	601		8021B	8021B	8260B
2-Butanone (MEK)		624	8260B				8260B	
n-Butylbenzene	524.2		8260B				8260B	
sec-Butylbenzene	524.2		8260B				8260B	
tert-Butylbenzene	524.2		8260B				8260B	
Carbon disulfide		624	8260B				8260B	
Carbon Tetrachloride	524.2	624	8260B	601		8021B	8021B	8260B
Chlorobenzene	524.2	624	8260B	601	602	8021B	8021B	8260B
Chlorodibromomethane	524.2	624	8260B	601		8021B	8021B	8260B
Chloroethane	524.2	624	8260B	601		8021B	8021B	8260B
2-Chloroethylvinylether		624	8260B	601		8021B	8021B	8260B
Chloroform	524.2	624	8260B	601		8021B	8021B	8260B
Chloromethane	524.2	624	8260B	601		8021B	8021B	8260B
2-Chlorotoluene	524.2		8260B				8260B	
4-Chlorotoluene	524.2		8260B				8260B	
1,2-Dibromo-3-chloropropane (DBCP)		624	8260B				8260B	

**Accredited Analytes/Methods (by matrix)**

**TriMatrix Laboratoires, Inc.**

**Grand Rapids, MI**

Analyte	Matrix							
	Aqueous				Solid			
1,2-Dibromoethane (EDB)		624	8260B					8260B
Dibromomethane	524.2	624	8260B					8260B
1,2-Dichlorobenzene	524.2	624	8260B	601	602	8021B	8021B	8260B
1,3-Dichlorobenzene	524.2	624	8260B	601	602	8021B	8021B	8260B
1,4-Dichlorobenzene	524.2	624	8260B	601	602	8021B	8021B	8260B
Dichlorodifluoromethane	524.2	624	8260B	601		8021B	8021B	8260B
1,1-Dichloroethane	524.2	624	8260B	601		8021B	8021B	8260B
1,2-Dichloroethane	524.2	624	8260B	601		8021B	8021B	8260B
1,1-Dichloroethene	524.2	624	8260B	601		8021B	8021B	8260B
<i>cis</i> -1,2-Dichloroethene	524.2	624	8260B	601		8021B	8021B	8260B
<i>trans</i> -1,2-Dichloroethene	524.2	624	8260B	601		8021B	8021B	8260B
Dichloromethane (Methylene Chloride)	524.2	624	8260B	601		8021B	8021B	8260B
1,2-Dichloropropane	524.2	624	8260B	601		8021B	8021B	8260B
1,3-Dichloropropane	524.2		8260B					8260B
2,2-Dichloropropane	524.2		8260B					8260B
1,1-Dichloropropene	524.2		8260B					8260B
<i>cis</i> -1,3-Dichloropropene	524.2	624	8260B	601		8021B	8021B	8260B
<i>trans</i> -1,3-Dichloropropene	524.2	624	8260B	601		8021B	8021B	8260B
Di-isopropylether (DIPE)			8260B					8260B
Ethylbenzene	524.2	624	8260B		602	8021B	8021B	8260B
Ethanol			8260B			8015C	8015C	8260B
1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113)			8260B					8260B
Hexachlorobutadiene	524.2	624	8260B					8260B
2-Hexanone		624	8260B					8260B
Isopropylbenzene	524.2	624	8260B					8260B
4-Isopropyltoluene	524.2		8260B					8260B
4-Methyl-2-pentanone (MIBK)		624	8260B					8260B
Methyl-tert-butylether (MTBE)	524.2	624	8260B					8260B
Naphthalene	524.2	624	8260B					8260B
n-Propylbenzene	524.2		8260B					8260B
Styrene	524.2	624	8260B					8260B
tert-amylmethylether (TAME)			8260B					8260B
1,1,1,2-Tetrachloroethane	524.2	624	8260B					8260B
1,1,2,2-Tetrachloroethane	524.2	624	8260B	601		8021B	8021B	8260B
Tetrachloroethene	524.2	624	8260B	601		8021B	8021B	8260B
Toluene	524.2	624	8260B		602	8021B	8021B	8260B
1,2,3-Trichlorobenzene	524.2		8260B					8260B

**Accredited Analytes/Methods (by matrix)**

**TriMatrix Laboratoires, Inc.**

**Grand Rapids, MI**

Analyte	Matrix								
	Aqueous					Solid			
1,2,4-Trichlorobenzene	524.2	624	8260B					8260B	
1,1,1-Trichloroethane	524.2	624	8260B	601		8021B	8021B	8260B	
1,1,2-Trichloroethane	524.2	624	8260B	601		8021B	8021B	8260B	
Trichloroethene	524.2	624	8260B	601		8021B	8021B	8260B	
Trichlorofluoromethane (Freon 11)	524.2	624	8260B	601		8021B	8021B	8260B	
1,2,3-Trichloropropane	524.2	624	8260B					8260B	
1,2,4-Trimethylbenzene	524.2		8260B					8260B	
1,3,5-Trimethylbenzene	524.2		8260B					8260B	
Vinyl acetate		624	8260B					8260B	
Vinyl chloride	524.2	624	8260B	601		8021B	8021B	8260B	
o-Xylene		624	8260B		602			8260B	
m+p-Xylene		624	8260B		602			8260B	
Xylenes, total	524.2	624	8260B		602	8021B	8021B	8260B	
<b>SVOCs - Base/Neutrals/Acids</b>									
Acenaphthene	8270C SIM	625	8270C				8270C	8270C SIM	
Acenaphthylene	8270C SIM	625	8270C				8270C	8270C SIM	
Aniline		625	8270C				8270C		
Anthracene	8270C SIM	625	8270C				8270C	8270C SIM	
Benzo(a)anthracene	8270C SIM	625	8270C				8270C	8270C SIM	
Benzo(b)fluoranthene	8270C SIM	625	8270C				8270C	8270C SIM	
Benzo(k)fluoranthene	8270C SIM	625	8270C				8270C	8270C SIM	
Benzo(g,h,i)perylene	8270C SIM	625	8270C				8270C	8270C SIM	
Benzo(a)pyrene	8270C SIM	625	8270C				8270C	8270C SIM	
Benzidine		625	8270C				8270C		
Benzoic acid		625	8270C				8270C		
Benzyl alcohol		625	8270C				8270C		
4-Bromophenyl-phenylether		625	8270C				8270C		
Butyl benzyl phthalate		625	8270C				8270C		
Carbazole			8270C				8270C		
4-Chloroaniline		625	8270C				8270C		
bis(2-Chloroethoxy)methane		625	8270C				8270C		
bis(2-Chloroethyl)ether		625	8270C				8270C		
bis(2-Chloroisopropyl) ether		625	8270C				8270C		
4-Chloro-3-methylphenol		625	8270C				8270C		
2-Chloronaphthalene		625	8270C	612		8121	8270C	8121	
4-Chlorophenyl-phenylether		625	8270C				8270C		

**Accredited Analytes/Methods (by matrix)**

**TriMatrix Laboratoires, Inc.**

**Grand Rapids, MI**

Analyte	Matrix							
	Aqueous				Solid			
2-Chlorophenol		625	8270C				8270C	
Chrysene	8270C SIM	625	8270C				8270C	8270C SIM
Dibenzo(a,h)anthracene	8270C SIM	625	8270C				8270C	8270C SIM
Dibenzofuran		625	8270C				8270C	
Di-n-butylphthalate		625	8270C				8270C	
1,2-Dichlorobenzene		625	8270C	612		8121	8270C	8121
1,3-Dichlorobenzene		625	8270C	612		8121	8270C	8121
1,4-Dichlorobenzene		625	8270C	612		8121	8270C	8121
3,3'-Dichlorobenzidine		625	8270C				8270C	
2,4-Dichlorophenol		625	8270C				8270C	
2,6-Dichlorophenol		625	8270C				8270C	
Diethyl phthalate		625	8270C				8270C	
2,4-Dimethylphenol		625	8270C				8270C	
Dimethylphthalate		625	8270C				8270C	
Diphenylamine			8270C				8270C	
2,4-Dinitrophenol		625	8270C				8270C	
2,4-Dinitrotoluene		625	8270C				8270C	
2,6-Dinitrotoluene		625	8270C				8270C	
Di-n-octylphthalate		625	8270C				8270C	
Dinoseb			8270C				8270C	
1,4-Dioxane			8270C					
bis(2-ethylhexyl) phthalate		625	8270C				8270C	
Fluoranthene	8270C SIM	625	8270C				8270C	8270C SIM
Fluorene	8270C SIM	625	8270C				8270C	8270C SIM
Hexachlorobenzene		625	8270C	612		8121	8270C	8121
Hexachlorobutadiene		625	8270C	612		8121	8270C	8121
Hexachlorocyclopentadiene		625	8270C	612		8121	8270C	8121
Hexachloroethane		625	8270C	612		8121	8270C	8121
Indeno(1,2,3, cd)pyrene	8270C SIM	625	8270C				8270C	8270C SIM
Isophorone		625	8270C				8270C	
2-Methyl-4,6-Dinitrophenol		625	8270C				8270C	
2-Methylphenol		625	8270C				8270C	
4-Methylphenol (and/or 3-Methylphenol)		625	8270C				8270C	
2-Methylnaphthalene	8270C SIM	625	8270C				8270C	8270C SIM
Naphthalene	8270C SIM	625	8270C				8270C	8270C SIM
2-Nitroaniline		625	8270C				8270C	
3-Nitroaniline		625	8270C				8270C	

**Accredited Analytes/Methods (by matrix)**

**TriMatrix Laboratoires, Inc.**

**Grand Rapids, MI**

Analyte	Matrix							
	Aqueous				Solid			
4-Nitroaniline		625	8270C				8270C	
Nitrobenzene		625	8270C				8270C	
2-Nitrophenol		625	8270C				8270C	
4-Nitrophenol		625	8270C				8270C	
4-nitroquinoline-1-oxide			8270C				8270C	
N-Nitrosodiethylamine		625	8270C				8270C	
N-Nitrosodimethylamine		625	8270C				8270C	
N-Nitrosodiphenylamine		625	8270C				8270C	
N-Nitroso-di-n-propylamine		625	8270C				8270C	
Pentachlorobenzene		625	8270C				8270C	
Pentachlorophenol		625	8270C				8270C	
Phenanthrene	8270C SIM	625	8270C				8270C	8270C SIM
Phenol		625	8270C				8270C	
Pyrene	8270C SIM	625	8270C				8270C	8270C SIM
Pyridine		625	8270C				8270C	
1,2,4,5-Tetrachlorobenzene		625	8270C				8270C	
2,3,4,6-Tetrachlorophenol		625	8270C				8270C	
o-Toluidine		625	8270C				8270C	
1,2,4-Trichlorobenzene		625	8270C	612		8121	8270C	8121
2,4,5-Trichlorophenol		625	8270C				8270C	
2,4,6-Trichlorophenol		625	8270C				8270C	
<b>Nitroaromatic and Nitramines</b>								
4-Amino-2,6-dinitrotoluene	8330A						8330A	
2-Amino-4,6-dinitrotoluene	8330A						8330A	
1,3-Dinitrobenzene	8330A						8330A	
2,4-Dinitrotoluene	8330A						8330A	
2,6-Dinitrotoluene	8330A						8330A	
HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)	8330A						8330A	
Nitrobenzene	8330A						8330A	
Nitroglycerin	8330A	8332					8330A	8332
2-Nitrotoluene	8330A						8330A	
3-Nitrotoluene	8330A						8330A	
4-Nitrotoluene	8330A						8330A	
Pentaerythritol tetranitrate	8330A	8332					8330A	8332
RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)	8330A						8330A	
Tetryl (methyl-2,4,6-trinitrophenylnitramine)	8330A						8330A	

**Accredited Analytes/Methods (by matrix)**

**TriMatrix Laboratoires, Inc.**

**Grand Rapids, MI**

Analyte	Matrix							
	Aqueous					Solid		
1,3,5-Trinitrobenzene	8330A						8330A	
2,4,6-Trinitrotoluene	8330A						8330A	
<b>Pesticides</b>								
Aldrin	608	8081B					8081B	
alpha-BHC	608	8081B					8081B	
beta-BHC	608	8081B					8081B	
delta-BHC	608	8081B					8081B	
gamma-BHC (Lindane)	608	8081B					8081B	
alpha-Chlordane	608	8081B					8081B	
gamma-Chlordane	608	8081B					8081B	
Chlordane (technical)	608	8081B					8081B	
DDD (4,4)	608	8081B					8081B	
DDE (4,4)	608	8081B					8081B	
DDT (4,4)	608	8081B					8081B	
Dieldrin	608	8081B					8081B	
Endosulfan I	608	8081B					8081B	
Endosulfan II	608	8081B					8081B	
Endosulfan sulfate	608	8081B					8081B	
Endrin	608	8081B					8081B	
Endrin aldehyde	608	8081B					8081B	
Endrin ketone	608	8081B					8081B	
Heptachlor	608	8081B					8081B	
Heptachlor Epoxide (beta)	608	8081B					8081B	
Methoxychlor	608.2	8081B					8081B	
Toxaphene (total)	608	8081B					8081B	
<b>Organophosphorus Pesticides</b>								
Dimethoate		8270C					8270C	
Dichlorvos		8270C					8270C	
Disulfoton		8270C					8270C	
Parathion, ethyl		8270C					8270C	
Parathion, methyl		8270C					8270C	
Phorate		8270C					8270C	
Sulfotepp		8270C					8270C	
<b>Herbicides</b>								

**Accredited Analytes/Methods (by matrix)**

**TriMatrix Laboratoires, Inc.**

**Grand Rapids, MI**

Analyte	Matrix							
	Aqueous					Solid		
2,4,5-T	8151A						8151A	
2,4,5-TP (Silvex)	8151A						8151A	
2,4-D	8151A						8151A	
2,4-DB	8151A						8151A	
Dalapon	8151A						8151A	
Dicamba	8151A						8151A	
Dichloroprop	8151A						8151A	
Dinoseb	8151A						8151A	
MCPA	8151A						8151A	
MCPP	8151A						8151A	
Pentachlorophenol	8151A						8151A	
Picloram	8151A						8151A	
<b>PCBs</b>								
Aroclor 1016	608	8082A					8082A	
Aroclor 1221	608	8082A					8082A	
Aroclor 1232	608	8082A					8082A	
Aroclor 1242	608	8082A					8082A	
Aroclor 1248	608	8082A					8082A	
Aroclor 1254	608	8082A					8082A	
Aroclor 1260	608	8082A					8082A	
<b>Misc. Analytes -Additional</b>								
Iron, Ferrous	SM 3500Fe B							
Cyanide, Available	OIA-1677						OIA-1677	
Acidity	SM 2310 B							
Sulfite	SM 4500SO <sub>3</sub> <sup>2-</sup> B							
Paint Filter Liquids Test							9095B	
Color	SM 2120 B							
Acid Volatile Sulfides (AVS/SEM)							EPA-821-R-91-100	
Grain Size							ASTM D422-63	
Reactive Sulfide	7.3.4.2						7.4.3.2	
<b>PCBs - Additional Aroclors</b>								
Aroclor 1262	608	8082A					8082A	
Aroclor 1268	608	8082A					8082A	

Accredited Analytes/Methods (by matrix)

TriMatrix Laboratoires, Inc.

Grand Rapids, MI

Analyte	Matrix							
	Aqueous				Solid			
<b>Misc. Organics</b>								
Ethane	RSK-175							
Ethylene	RSK-175							
Methane	RSK-175							
<b>Additional Compounds</b>								
<b>Volatiles</b>								
1,2-dibromo-3-chloropropane	8011							
1,2-dibromoethane	8011							
1,2,3-Trimethylbenzene			8260B				8260B	
1,4-dioxane			8260B				8260B	
1-chlorohexane			8260B				8260B	
sec-butanol		8015C	8260B			8015C	8260B	
2-chloro-1,3-butadiene (Chloroprene)			8260B				8260B	
2-methylnaphthalene			8260B				8260B	
2-nitropropane			8260B				8260B	
allyl chloride			8260B				8260B	
cyclohexane			8260B				8260B	
ETBE			8260B				8260B	
ethanol		8015C				8015C		
ethyl acetate			8260B				8260B	
ethyl ether			8260B				8260B	
ethyl methacrylate			8260B				8260B	
hexachloroethane			8260B				8260B	
hexane			8260B				8260B	
iodomethane			8260B				8260B	
isobutanol		8015C	8260B			8015C	8260B	
isopropanol		8015C	8260B			8015C	8260B	
methacrylonitrile			8260B				8260B	
methanol		8015C				8015C		
methyl acetate			8260B				8260B	
methyl methacrylate			8260B				8260B	
methylcyclohexane			8260B				8260B	
n-butanol		8015C	8260B			8015C	8260B	
n-butyl acetate			8260B				8260B	
n-propanol		8015C	8260B			8015C	8260B	

Accredited Analytes/Methods (by matrix)

TriMatrix Laboratoires, Inc.

Grand Rapids, MI

Analyte	Matrix							
	Aqueous				Solid			
propionitrile			8260B				8260B	
t-butanol		8015C	8260B			8015C	8260B	
tetrahydrofuran			8260B				8260B	
trans -1,4,dichloro-2-butene			8260B				8260B	
trichlorotrifluoromethane			8260B				8260B	
<b>SVOCs - Base/Neutrals/Acids</b>								
1,1'-Biphenyl			8270C			8270C		
1,2-Bis(2-chloroethoxy)ethane			8270C			8270C		
1,2-Diphenylhydrazine			8270C			8270C		
1,3 Dinitrobenzene			8270C			8270C		
1,4-Naphthoquinone			8270C			8270C		
1,4-Phenylenediamine			8270C			8270C		
1-Methylnaphthalene			8270C			8270C		
1-Naphthylamine			8270C			8270C		
1-Nitrosopyrrolidine			8270C			8270C		
2-Acetylaminofluorene			8270C			8270C		
2-Chloroaniline			8270C			8270C		
2-Naphthylamine			8270C			8270C		
2-Picoline			8270C			8270C		
3,3'-Dimethylbenzidine			8270C			8270C		
3-Methylchloanthrene			8270C			8270C		
4-Aminobiphenyl			8270C			8270C		
5-Nitro-o-toluidine			8270C			8270C		
7,12-Dimethylbenz(a)anthracene			8270C			8270C		
a,a-Dimethylphenethylamine			8270C			8270C		
Acetophenone			8270C			8270C		
Aramite			8270C			8270C		
Atrazine			8270C			8270C		
Benzaldehyde			8270C			8270C		
Bis(2-ethylhexyl) adipate			8270C			8270C		
Caprolactam			8270C			8270C		
Chlorobenzilate			8270C			8270C		
Diallate			8270C			8270C		
Dicyclohexyl Phthalate			8270C			8270C		
Ethyl Methacrylate			8270C			8270C		
Ethyl Methansulfonate			8270C			8270C		

**Accredited Analytes/Methods (by matrix)**

**TriMatrix Laboratoires, Inc.**

**Grand Rapids, MI**

Analyte	Matrix							
	Aqueous				Solid			
Famphur			8270C				8270C	
Hexachlorophene			8270C				8270C	
Hexachloropropene			8270C				8270C	
Isodrin			8270C				8270C	
Isosafrole			8270C				8270C	
Kepone			8270C				8270C	
Methapyrilene			8270C				8270C	
Methyl Methacrylate			8270C				8270C	
Methyl Methanesulfonate			8270C				8270C	
N-Nitroso-di-n-butylamine			8270C				8270C	
N-Nitrosomethylethylamine			8270C				8270C	
N-Nitrosomorpholine			8270C				8270C	
N-Nitrosopiperidine			8270C				8270C	
o,o,o-Triethylphosphorothioate			8270C				8270C	
p-Dimethylaminoazobenzene			8270C				8270C	
Phenacetin			8270C				8270C	
Pentachloroethane			8270C				8270C	
Pentachloronitrobenzene			8270C				8270C	
Pronamide			8270C				8270C	
Safrole			8270C				8270C	
Thionazin			8270C				8270C	
1,3,5-Trinitrobenzene			8270C				8270C	
<b>Carbonyls</b>								
Formaldehyde	8315A						8315A	
Acetaldehyde	8315A						8315A	
Propanal	8315A						8315A	
Crotonaldehyde	8315A						8315A	
Butanal	8315A						8315A	
Pentanal	8315A						8315A	
Cyclohexanone	8315A						8315A	
m-Tolualdehyde	8315A						8315A	
Hexanal	8315A						8315A	
Heptanal	8315A						8315A	
Octanal	8315A						8315A	
Nonanal	8315A						8315A	
Decanal	8315A						8315A	



## ANSI-ASQ National Accreditation Board

April 30, 2013

**VIA EMAIL**

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

**Re: Extension for ISO/IEC 17025:2005 & DoD ELAP accreditation**

Dear Rick Wilburn:

This letter is to inform you that your accreditation for ISO/IEC 17025:2005 & DoD ELAP will expire on April 30, 2013. We have granted you an extension of 30 days from the expiration date on your certificate and scope of accreditation. If you have any questions or concerns regarding this matter, please feel free to give me a call at 703-836-0025 x-203.

Regards,

Keith Greenaway  
Vice President



# CERTIFICATE OF ACCREDITATION

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

This is to certify that

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

has been assessed by AClass  
and meets the requirements of

**ISO/IEC 17025:2005 and DoD-ELAP**

while demonstrating technical competence in the field(s) of

**TESTING**

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

ADE-1542

Certificate Number

AClass Approval



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



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



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

**TriMatrix Laboratories, Inc**

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

Rick Wilburn Phone: 616-975-4500

**TESTING**

Valid to: April 30, 2013

Certificate Number: ADE - 1542

**I. Environmental**

MATRIX	SPECIFIC TEST or ANALYTE GROUP**	SPECIFICATION OR STANDARD METHOD (all EPA unless specified)	* KEY EQUIPMENT OR TECHNOLOGY
Water/Solid	TKN	351.2	Spectrophotometric
Water/Solid	Nitroaromatics and Nitramines	8330A	HPLC-UV
Solid	Ignitability	1020A	Closed-Cup
Water	HEM Oil and Grease/SGT-HEM Non-Polar Material	1664A/9070A	Gravimetric
Solid	HEM Oil and Grease/SGT-HEM Non-Polar Material	9071B	Gravimetric
Water	Metals	200.7/6010C	ICP
Solid	Metals	6010C	ICP
Water	Metals	200.8/6020A	ICP MS
Solid	Metals	6020A	ICP MS
Water	Calcium Hardness As CaCO <sub>3</sub>	SM2340B	ICP
Water	Total Hardness As CaCO <sub>3</sub>	SM2340B	ICP
Water	Mercury	245.1/7470A	CVAA



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

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

<b>MATRIX</b>	<b>SPECIFIC TEST or ANALYTE GROUP**</b>	<b>SPECIFICATION OR STANDARD METHOD (all EPA unless specified)</b>	<b>* KEY EQUIPMENT OR TECHNOLOGY</b>
Water	Sulfide	SM 4500-S <sub>2</sub> D	Spectrophotometric
Water	Sulfide	SM 4500-S <sub>2</sub> F	Titrimetric
Water/Solid	Sulfide	9034	Titrimetric
Water	Sulfite	SM 4500-SO <sub>3</sub> <sup>2-</sup> B	Titrimetric
Water	o-Phosphate	SM 4500-P E	Spectrophotometric
Water/Solid	Phosphorus Total	SM 4500-P E	Spectrophotometric
Water	Silica as SiO <sub>2</sub>	SM 4500-SiO <sub>2</sub> D	Spectrophotometric
Water	COD	SM 5220 D	Spectrophotometric
Water	Total Organic Carbon (TOC)	SM 5310 C/9060A	Oxidation/CO <sub>2</sub> Det
Water	Surfactants (MBAS)	SM 5540 C	Spectrophotometric
Water	Heterotrophic Bacteria (Std Plate)	SM 9215 B	Microbiological
Water	Fecal Coliform	SM 9222 D	Microbiological
Water	Total Coliform, E. Coli	SM 9223 B	Microbiological
Solid	Total Residue/Solids (TS)	SM 3550C	Gravimetric
Water/Solid	Diesel Range Organics (DRO)	Wisconsin DRO/8015C	GC-FID
Water/Solid	Gasoline Range Organics (GRO)	Wisconsin GRO/8015C	GC-FID
Water/Solid	Oil Range Organics	8015C	GC-FID
Water/Solid	TCLP	1311	Acetic Acid Leaching

<b>MATRIX</b>	<b>SPECIFIC TEST or ANALYTE GROUP**</b>	<b>SPECIFICATION OR STANDARD METHOD (all EPA unless specified)</b>	<b>* KEY EQUIPMENT OR TECHNOLOGY</b>
Water/Solid	SPLP	1312	Acetic Acid Leaching
Solid	Semivolatiles Extraction	3550C	Ultrasonic Extraction
Water	Metals Digestion	200.2	Block Digestion
Solid	Semivolatiles Extraction	3545A	Pressurized Fluid Ext
Solid	Volatiles Extraction	5035A	Purge & Trap
Solid	Cyanide Extraction	9013A	Extraction
Water	Metals Digestion	3010A	Block Digestion
Water	Metals Digestion	3020A	Block Digestion
Solid	Metals Digestion	3050B	Block Digestion
Water	Semivolatiles Extraction	3510C	Separatory Funnel Ext
Water	Volatiles Extraction	5030B	Purge & Trap/Water
Water	Volatile Residue (VS)	160.4	Gravimetric
Water	Methoxychlor	608.2	GC-ECD
Water	1,2-Dibromo-3- Chloropropane & 1,2- Dibromoethane	8011	GC-ECD
Water/Solid	Nitroglycerine and PETN	8332	HPLC-UV
Water	Mercury, Low-Level	1631E	CVAF
Water	Anions	300.0/9056A	Ion Chromatographic
Solid	Anions	9056A	Ion Chromatographic



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



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

**Notes:**

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




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Vice President



**Accredited Analytes/Methods (by matrix)**

**TriMatrix Laboratoires, Inc.**

**Grand Rapids, MI**

NELAC Code	Analyte	Matrix							
		Aqueous				Solid			
<b>Trace Metals</b>									
1000	Aluminum	200.7	200.8	6010C	6020A			6010C	
1005	Antimony		200.8		6020A				6020A
1010	Arsenic	200.7	200.8	6010C	6020A			6010C	6020A
1015	Barium	200.7	200.8	6010C	6020A			6010C	6020A
1020	Beryllium	200.7	200.8	6010C	6020A			6010C	6020A
1025	Boron	200.7	200.8	6010C	6020A			6010C	6020A
1030	Cadmium	200.7	200.8	6010C	6020A			6010C	6020A
1035	Calcium	200.7		6010C				6010C	
1040	Chromium, total	200.7	200.8	6010C	6020A			6010C	6020A
1045	Chromium VI	SM3500C/B				7196A			7196A
1050	Cobalt	200.7	200.8	6010C	6020A			6010C	6020A
1055	Copper	200.7	200.8	6010C	6020A			6010C	6020A
1070	Iron	200.7		6010C				6010C	
1075	Lead	200.7	200.8	6010C	6020A			6010C	6020A
1085	Magnesium	200.7		6010C				6010C	
1090	Manganese	200.7	200.8	6010C	6020A			6010C	6020A
1095	Mercury	245.1				7470A			7471A
1095	Mercury (Low Level)					1631E			
1100	Molybdenum	200.7	200.8	6010C	6020A			6010C	6020A
1105	Nickel	200.7	200.8	6010C	6020A			6010C	6020A
1125	Potassium	200.7		6010C				6010C	
1140	Selenium	200.7	200.8	6010C	6020A			6010C	6020A
1150	Silver	200.7	200.8	6010C	6020A			6010C	6020A
1155	Sodium	200.7		6010C				6010C	
1160	Strontium	200.7	200.8	6010C	6020A			6010C	
1165	Thallium	200.7	200.8	6010C	6020A			6010C	6020A
1175	Tin	200.7	200.8	6010C	6020A			6010C	6020A
1180	Titanium	200.7		6010C				6010C	
1185	Vanadium	200.7	200.8	6010C	6020A			6010C	6020A
1190	Zinc	200.7	200.8	6010C	6020A			6010C	6020A
<b>Demands</b>									
2040	TOC	SM5310C	9060A					Walkley Black	Lloyd Kahn
1565	COD			SM5220D					
	DOC-Dissolved Organic Carbon	SM5310C						SM5310C	
	BOD and CBOD	SM5210B							
<b>Misc Analytes</b>									
1505	Total Alkalinity (as CaCO <sub>3</sub> )	SM2320B							
	Calcium Hardness as CaCO <sub>3</sub>	SM2340B							
1550	Total Hardness as CaCO <sub>3</sub>	SM2340B	SM2340C						
1960	Total Residue/Solids (TS)	SM2540B						3550C	
1705	Filterable Residue (TDS)		SM2540C						
1780	Ignitability							1020A	
1955	Non-Filterable Residue (TSS)	SM2540D							
	Volatile Residue (VS)		SM2540E						
	pH			9040C	SM4500H <sup>+</sup> B				9045D
2005	Sulfide	SM4500S <sup>+</sup> D	SM4500S <sup>+</sup> F	9034					9034
1645	Total Cyanide	SM4500CN E	9014						9014
1510	Cyanide, Amenable	SM4500CN G	9014						9014
1515	Ammonia	SM4500NH <sub>3</sub> G							SM4500NH <sub>3</sub> G
1610	Conductivity	SM2510B	9050A						
1795	Nitrogen, Total Kjeldahl (TKN)	SM4500N <sub>tot</sub> D							SM4500N <sub>tot</sub> D
1905	Total Phenolics	420.4	9065						9065
2045	Total Organic Halides (TOX)	9020B							
1540	Bromide	ASTM D1246-88			9056A				
1575	Chloride	SM4500Cl E	9251	300.0	9056A				9056A
1730	Fluoride	SM4500F C		300.0	9056A				9056A
1810	Nitrate as N	SM4500NO <sub>3</sub> F		300.0	9056A				SM4500NO <sub>3</sub> F
1840	Nitrite as N	SM4500NO <sub>2</sub> B	SM4500NO <sub>2</sub> F	300.0	9056A				9056A
1820	Nitrate + Nitrite as N	SM4500NO <sub>3</sub> F		300.0	9056A				9056A
1870	ortho-phosphate	SM4500P E							
1910	Total Phosphorus	SM4500P E							SM4500P E
1990	Silica as SiO <sub>2</sub>	SM4500SiO <sub>2</sub> D							
2000	Sulfate	ASTM D516-02	9038	300.0	9056A				9056A
2025	Surfactants - MBAS	SM5540C							
	Fecal Coliform	SM9222D							
	Heterotrophic Bacteria (Std Plate)	SM9215B							
	Total Coliform, E. Coli	SM9223B							
2055	Turbidity		SM2130B						
	EOX-Extractable Organic Halides	9023							9023
	FOC-Fractional Organic Carbon	ASTM D2974-87							ASTM D2974-87
<b>Petroleum Hydrocarbons</b>									
1935	SGT-HEM; Non-Polar Material	1664A	9070A						9071B
1860	HEM; Oil and Grease	1664A	9070A						9071B
9408	Gasoline Range Organics (GRO)	8015C	Wisconsin GRO						8015C Wisconsin GRO
9369	Diesel Range Organics (DRO)	8015C	Wisconsin DRO						8015C Wisconsin DRO
	Oil Range Organics (ORO)	8015C							8015C
<b>VOCs</b>									
4315	Acetone		624	8260B					8260B
4320	Acetonitrile		624	8260B					8260B
4325	Acrolein		624	8260B					8260B
4340	Acrylonitrile		624	8260B					8260B
4375	Benzene	524.2	624	8260B		602	8021B	8021B	8260B
4385	Bromobenzene	524.2		8260B					8260B
4390	Bromochloromethane	524.2		8260B					8260B
4395	Bromodichloromethane	524.2	624	8260B	601		8021B	8021B	8260B
4400	Bromoform	524.2	624	8260B	601		8021B	8021B	8260B
4950	Bromomethane	524.2	624	8260B	601		8021B	8021B	8260B
4410	2-Butanone (MEK)		624	8260B					8260B
4435	n-Butylbenzene	524.2		8260B					8260B

**Accredited Analytes/Methods (by matrix)**

**TriMatrix Laboratoires, Inc.**

**Grand Rapids, MI**

NELAC Code	Analyte	Matrix							
		Aqueous				Solid			
4440	sec-Butylbenzene	524.2			8260B				8260B
4445	tert-Butylbenzene	524.2			8260B				8260B
4450	Carbon disulfide		624		8260B				8260B
4455	Carbon Tetrachloride	524.2	624		8260B	601		8021B	8260B
4475	Chlorobenzene	524.2	624		8260B	601	602	8021B	8260B
4575	Chlorodibromomethane	524.2	624		8260B	601		8021B	8260B
4485	Chloroethane	524.2	624		8260B	601		8021B	8260B
4500	2-Chloroethylvinylether		624		8260B	601		8021B	8260B
4505	Chloroform	524.2	624		8260B	601		8021B	8260B
4960	Chloromethane	524.2	624		8260B	601		8021B	8260B
4535	2-Chlorotoluene	524.2			8260B				8260B
4540	4-Chlorotoluene	524.2			8260B				8260B
4570	1,2-Dibromo-3-chloropropane (DBCP)		624		8260B				8260B
4585	1,2-Dibromoethane (EDB)		624		8260B				8260B
4595	Dibromomethane	524.2	624		8260B				8260B
4610	1,2-Dichlorobenzene	524.2	624		8260B	601	602	8021B	8260B
4615	1,3-Dichlorobenzene	524.2	624		8260B	601	602	8021B	8260B
4620	1,4-Dichlorobenzene	524.2	624		8260B	601	602	8021B	8260B
4625	Dichlorodifluoromethane	524.2	624		8260B	601		8021B	8260B
4630	1,1-Dichloroethane	524.2	624		8260B	601		8021B	8260B
4635	1,2-Dichloroethane	524.2	624		8260B	601		8021B	8260B
4640	1,1-Dichloroethene	524.2	624		8260B	601		8021B	8260B
4645	cis-1,2-Dichloroethene	524.2	624		8260B	601		8021B	8260B
4700	trans-1,2-Dichloroethene	524.2	624		8260B	601		8021B	8260B
4975	Dichloromethane (Methylene Chloride)	524.2	624		8260B	601		8021B	8260B
4655	1,2-Dichloropropane	524.2	624		8260B	601		8021B	8260B
4660	1,3-Dichloropropane	524.2			8260B				8260B
4665	2,2-Dichloropropane	524.2			8260B				8260B
4670	1,1-Dichloropropene	524.2			8260B				8260B
4680	cis-1,3-Dichloropropene	524.2	624		8260B	601		8021B	8260B
4685	trans-1,3-Dichloropropene	524.2	624		8260B	601		8021B	8260B
9375	Di-isopropylether (DIPE)				8260B				8260B
4765	Ethylbenzene	524.2	624		8260B		602	8021B	8260B
	Ethanol				8260				8260
3815	1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113)				8260B				8260B
4835	Hexachlorobutadiene	524.2	624		8260B				8260B
4860	2-Hexanone		624		8260B				8260B
4900	Isopropylbenzene	524.2	624		8260B				8260B
4910	4-Isopropyltoluene	524.2			8260B				8260B
4995	4-Methyl-2-pentanone (MIBK)		624		8260B				8260B
5000	Methyl-tert-butylether (MTBE)	524.2	624		8260B				8260B
5005	Naphthalene	524.2	624		8260B				8260B
5090	n-Propylbenzene	524.2			8260B				8260B
5100	Styrene	524.2	624		8260B				8260B
4370	tert-amylmethylether (TAME)				8260B				8260B
5105	1,1,1,2-Tetrachloroethane	524.2	624		8260B				8260B
5110	1,1,2,2-Tetrachloroethane	524.2	624		8260B	601		8021B	8260B
5115	Tetrachloroethene	524.2	624		8260B	601		8021B	8260B
5140	Toluene	524.2	624		8260B		602	8021B	8260B
5150	1,2,3-Trichlorobenzene	524.2			8260B				8260B
5155	1,2,4-Trichlorobenzene	524.2	624		8260B				8260B
5160	1,1,1-Trichloroethane	524.2	624		8260B	601		8021B	8260B
5165	1,1,2-Trichloroethane	524.2	624		8260B	601		8021B	8260B
5170	Trichloroethene	524.2	624		8260B	601		8021B	8260B
5175	Trichlorofluoromethane (Freon 11)	524.2	624		8260B	601		8021B	8260B
5180	1,2,3-Trichloropropane	524.2	624		8260B				8260B
5210	1,2,4-Trimethylbenzene	524.2			8260B				8260B
5215	1,3,5-Trimethylbenzene	524.2			8260B				8260B
5225	Vinyl acetate		624		8260B				8260B
5235	Vinyl chloride	524.2	624		8260B	601		8021B	8260B
5250	o-Xylene		624		8260B		602		8260B
5240	m-p-Xylene		624		8260B		602		8260B
5260	Xylenes, total	524.2	624		8260B		602	8021B	8260B
	<b>SVOCs - Base/Neutrals/Acids</b>								
5500	Acenaphthene	8270C SIM	625		8270C			8270C	8270C SIM
5505	Acenaphthylene	8270C SIM	625		8270C			8270C	8270C SIM
5545	Aniline		625		8270C				8270C
5555	Anthracene	8270C SIM	625		8270C			8270C	8270C SIM
5575	Benzo(a)anthracene	8270C SIM	625		8270C			8270C	8270C SIM
5585	Benzo(b)fluoranthene	8270C SIM	625		8270C			8270C	8270C SIM
5600	Benzo(k)fluoranthene	8270C SIM	625		8270C			8270C	8270C SIM
5590	Benzo(g,h,i)perylene	8270C SIM	625		8270C			8270C	8270C SIM
5580	Benzo(a)pyrene	8270C SIM	625		8270C			8270C	8270C SIM
5595	Ben-zidine		625		8270C				8270C
5610	Benzoic acid		625		8270C				8270C
5630	Benzyl alcohol		625		8270C				8270C
5660	4-Bromophenyl-phenylether		625		8270C				8270C
5670	Butyl benzyl phthalate		625		8270C				8270C
5680	Carbazole								8270C
5745	4-Chloroaniline		625		8270C				8270C
5760	bis(2-Chloroethoxy)methane		625		8270C				8270C
5765	bis(2-Chloroethyl)ether		625		8270C				8270C
5780	bis(2-Chloroisopropyl) ether		625		8270C				8270C
5700	4-Chloro-3-methylphenol		625		8270C				8270C
5795	2-Chloronaphthalene		625		8270C				8270C
5825	4-Chlorophenyl-phenylether		625		8270C				8270C
5800	2-Chlorophenol		625		8270C				8270C
5855	Chrysene	8270C SIM	625		8270C			8270C	8270C SIM
5895	Dibenz(a,h)anthracene	8270C SIM	625		8270C			8270C	8270C SIM
5905	Dibenzofuran		625		8270C				8270C
5925	Di-n-butylphthalate		625		8270C				8270C
4610	1,2-Dichlorobenzene		625		8270C				8270C
4615	1,3-Dichlorobenzene		625		8270C				8270C
4620	1,4-Dichlorobenzene		625		8270C				8270C

**Accredited Analytes/Methods (by matrix)**

**TriMatrix Laboratoires, Inc.**

**Grand Rapids, MI**

NELAC Code	Analyte	Matrix							
		Aqueous				Solid			
5945	3,3'-Dichlorobenzidine		625	8270C				8270C	
6000	2,4-Dichlorophenol		625	8270C				8270C	
6005	2,6-Dichlorophenol		625	8270C				8270C	
6070	Diethyl phthalate		625	8270C				8270C	
6130	2,4-Dimethylphenol		625	8270C				8270C	
6135	Dimethylphthalate		625	8270C				8270C	
	Diphenylamine			8270C				8270C	
6175	2,4-Dinitrophenol		625	8270C				8270C	
6185	2,4-Dinitrotoluene		625	8270C				8270C	
6190	2,6-Dinitrotoluene		625	8270C				8270C	
6200	Di-n-octylphthalate		625	8270C				8270C	
	Dinoseb			8270C				8270C	
4740	p-Dioxane			8270C				8270C	
6065	bis(2-ethylhexyl) phthalate		625	8270C				8270C	
6265	Fluoranthene	8270C SIM	625	8270C				8270C	8270C SIM
6270	Fluorene	8270C SIM	625	8270C				8270C	8270C SIM
6275	Hexachlorobenzene		625	8270C				8270C	
4835	Hexachlorobutadiene		625	8270C				8270C	
6285	Hexachlorocyclopentadiene		625	8270C				8270C	
4840	Hexachloroethane		625	8270C				8270C	
6315	Indeno[1,2,3, cd]pyrene	8270C SIM	625	8270C				8270C	8270C SIM
6320	Isophorone		625	8270C				8270C	
6360	2-Methyl-4,6-Dinitrophenol		625	8270C				8270C	
6400	2-Methylphenol		625	8270C				8270C	
6410	4-Methylphenol (and/or 3-Methylphenol)		625	8270C				8270C	
6385	2-Methylnaphthalene	8270C SIM	625	8270C				8270C	8270C SIM
5005	Naphthalene	8270C SIM		8270C				8270C	8270C SIM
6460	2-Nitroaniline		625	8270C				8270C	
6465	3-Nitroaniline		625	8270C				8270C	
6470	4-Nitroaniline		625	8270C				8270C	
5015	Nitrobenzene		625	8270C				8270C	
6490	2-Nitrophenol		625	8270C				8270C	
6500	4-Nitrophenol		625	8270C				8270C	
	4-nitroquinoline-1-oxide			8270C				8270C	
6525	N-Nitrosodiethylamine		625	8270C				8270C	
6530	N-Nitrosodimethylamine		625	8270C				8270C	
6535	N-Nitrosodiphenylamine		625	8270C				8270C	
6545	N-Nitroso-di-n-propylamine		625	8270C				8270C	
6590	Pentachlorobenzene		625	8270C				8270C	
6605	Pentachlorophenol		625	8270C				8270C	
6615	Phenanthrene	8270C SIM	625	8270C				8270C	8270C SIM
6625	Phenol		625	8270C				8270C	
6665	Pyrene	8270C SIM	625	8270C				8270C	8270C SIM
5095	Pyridine		625	8270C				8270C	
6715	1,2,4,5-Tetrachlorobenzene		625	8270C				8270C	
6735	2,3,4,6-Tetrachlorophenol		625	8270C				8270C	
5145	o-Toluidine		625	8270C				8270C	
5155	1,2,4-Trichlorobenzene		625	8270C				8270C	
6835	2,4,5-Trichlorophenol		625	8270C				8270C	
6840	2,4,6-Trichlorophenol		625	8270C				8270C	
	<b>Nitroaromatic and Nitramines</b>								
9306	4-Amino-2,6-dinitrotoluene	8330A						8330A	
9303	2-Amino-4,6-dinitrotoluene	8330A						8330A	
6160	1,3-Dinitrobenzene	8330A						8330A	
6185	2,4-Dinitrotoluene	8330A						8330A	
6190	2,6-Dinitrotoluene	8330A						8330A	
9522	HMX (Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine)	8330A						8330A	
5015	Nitrobenzene	8330A						8330A	
6485	Nitroglycerin	8332						8332	
9507	2-Nitrotoluene	8330A						8330A	
9510	3-Nitrotoluene	8330A						8330A	
9513	4-Nitrotoluene	8330A						8330A	
9558	Pentaerythritoltetranitrate	8332						8332	
9432	RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)	8330A						8330A	
6415	Tetryl (methyl-2,4,6-trinitrophenylnitramine)	8330A						8330A	
6885	1,3,5-Trinitrobenzene	8330A						8330A	
9651	2,4,6-Trinitrotoluene	8330A						8330A	
	<b>Pesticides</b>								
7025	Aldrin	608	8081B					8081B	
7110	alpha-BHC	608	8081B					8081B	
7115	beta-BHC	608	8081B					8081B	
7105	delta-BHC	608	8081B					8081B	
7120	gamma-BHC (Lindane)	608	8081B					8081B	
7240	alpha-Chlordane	608	8081B					8081B	
7245	gamma-Chlordane	608	8081B					8081B	
7250	Chlordane (technical)	608	8081B					8081B	
7355	DDD (4,4)	608	8081B					8081B	
7360	DDE (4,4)	608	8081B					8081B	
7365	DDT (4,4)	608	8081B					8081B	
7470	Dieldrin	608	8081B					8081B	
7510	Endosulfan I	608	8081B					8081B	
7515	Endosulfan II	608	8081B					8081B	
7520	Endosulfan sulfate	608	8081B					8081B	
7540	Endrin	608	8081B					8081B	
7530	Endrin aldehyde	608	8081B					8081B	
7535	Endrin ketone	608	8081B					8081B	
7685	Heptachlor	608	8081B					8081B	
7690	Heptachlor Epoxide (beta)	608	8081B					8081B	
7810	Methoxychlor	608.2	8081B					8081B	
8250	Toxaphene (total)	608	8081B					8081B	
	<b>Organophosphorus Pesticides</b>								
7475	Dimethoate		8270C					8270C	

**Accredited Analytes/Methods (by matrix)**

**TriMatrix Laboratoires, Inc.**

**Grand Rapids, MI**

NELAC Code	Analyte	Matrix							
		Aqueous				Solid			
8610	Dichlorvos			8270C					8270C
8625	Disulfoton			8270C					8270C
7955	Parathion, ethyl			8270C					8270C
7825	Parathion, methyl			8270C					8270C
7985	Phorate			8270C					8270C
8155	Sulfotepp			8270C					8270C
	<b>Herbicides</b>								
8655	2,4,5-T	8151A							8151A
8650	2,4,5-TP (Silvex)	8151A							8151A
8545	2,4-D	8151A							8151A
8560	2,4-DB	8151A							8151A
8555	Dalapon	8151A							8151A
8595	Dicamba	8151A							8151A
8605	Dichloroprop	8151A							8151A
8620	Dinoseb	8151A							8151A
7775	MCPA	8151A							8151A
7780	MCPP	8151A							8151A
6605	Pentachlorophenol	8151A							8151A
8645	Picloram	8151A							8151A
	<b>PCBs</b>								
8880	Aroclor 1016	608	8082A						8082A
8885	Aroclor 1221	608	8082A						8082A
8890	Aroclor 1232	608	8082A						8082A
8895	Aroclor 1242	608	8082A						8082A
8900	Aroclor 1248	608	8082A						8082A
8905	Aroclor 1254	608	8082A						8082A
8910	Aroclor 1260	608	8082A						8082A
	<b>Misc. Analytes -Additional</b>								
	Iron, Ferrous	SM 3500Fe B							
	Cyanide, Available	OIA-1677							OIA-1677
	Acidity	SM 2310 B							
	Sulfite	SM 4500SO <sub>3</sub> <sup>2-</sup> B							
	Paint Filter Liquids Test								9095B
	Color	SM 2120 B							
	Acid Volatile Sulfides (AVS/SEM)								EPA-821-R-91-100
	Grain Size	ASTM D422-63(07)							ASTM D422-63(07)
	<b>PCBs - Additional Aroclors</b>								
	Aroclor 1262	608	8082A						8082A
	Aroclor 1268	608	8082A						8082A
	<b>Misc. Organics</b>								
	Ethane	RSK-175							
	Ethylene	RSK-175							
	Methane	RSK-175							
	<b>Additional Compounds</b>								
	<b>Volatiles</b>								
	1,2-dibromo-3-chloropropane	8011							
	1,2-dibromoethane	8011							
	1,2,3-Trimethylbenzene		8260B						8260B
	1,2,3-trichlorobenzene		8260B						8260B
	1,2,3-trichloropropane		8260B						8260B
	1,4-dichlorobenzene		8260B						8260B
	1,4-dioxane		8260B						8260B
	1-chlorohexane		8260B						8260B
	sec-butanol	8015C	8260B						8015C
	2-chloro-1,3-butadiene		8260B						8260B
	2-methylnaphthalene		8260B						8260B
	2-nitropropane		8260B						8260B
	allyl chloride		8260B						8260B
	cyclohexane		8260B						8260B
	ETBE		8260B						8260B
	ethyl acetate		8260B						8260B
	ethyl ether		8260B						8260B
	ethyl methacrylate		8260B						8260B
	hexachloroethane		8260B						8260B
	hexane		8260B						8260B
	iodomethane		8260B						8260B
	isobutanol	8015C	8260B						8015C
	isopropanol	8015C	8260B						8015C
	methacrylonitrile		8260B						8260B
	methyl acetate		8260B						8260B
	methyl methacrylate		8260B						8260B
	methylcyclohexane		8260B						8260B
	n-butanol	8015C	8260B						8015C
	n-butyl acetate		8260B						8260B
	n-propanol	8015C	8260B						8015C
	propionitrile		8260B						8260B
	t-butanol	8015C	8260B						8015C
	tetrahydrofuran		8260B						8260B
	trans-1,4-dichloro-2-butene		8260B						8260B
	trichlorotrifluoromethane		8260B						8260B
	<b>SVOCs - Base/Neutrals/Acids</b>								
	1,1'-Biphenyl		8270C						8270C
	1,2-Bis(2-chloroethoxy)ethane		8270C						8270C
	1,2-Diphenylhydrazine		8270C						8270C
	1,3 Dinitrobenzene		8270C						8270C
	1,4-Naphthoquinone		8270C						8270C
	1,4-Phenylenediamine		8270C						8270C

**Accredited Analytes/Methods (by matrix)**

**TriMatrix Laboratoires, Inc.**

**Grand Rapids, MI**

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

**Attachment 1**  
**Tier II UFP-SAP Format Approval**

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## Sawyer, Stephanie/VBO

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**From:** Dodson, Anita/VBO  
**Sent:** Monday, January 30, 2012 8:25 AM  
**To:** Sawyer, Stephanie/VBO  
**Subject:** FW: Request for Tier II SAP format for Expanded SI at CAX for Multiple AOC

Hi Stephanie,

We have approval for Tier II SAP for the Expanded SI at CAX for the Multiple AOC investigation.

Thanks,  
Anita

-----Original Message-----

From: Nielsen, Janice L CIV NAVFAC LANT, EV [<mailto:janice.nielsen@navy.mil>]  
Sent: Monday, January 30, 2012 8:11 AM  
To: Dodson, Anita/VBO  
Subject: RE: Request for Tier II SAP format for Expanded SI at CAX for Multiple AOC

Anita: This looks like a good candidate for a Tier II SAP. Jan

Jan Nielsen  
Technical Support  
NAVFAC LANT  
757.322.8339

-----Original Message-----

From: [Anita.Dodson@CH2M.com](mailto:Anita.Dodson@CH2M.com) [<mailto:Anita.Dodson@CH2M.com>]  
Sent: Friday, January 27, 2012 8:54  
To: Nielsen, Janice L CIV NAVFAC LANT, EV  
Subject: Request for Tier II SAP format for Expanded SI at CAX for Multiple AOC

Hi Jan,

We are seeking approval to perform a Tier II SAP format for upcoming work at CAX for an Expanded SI. Please see the attached questionnaire, and let me know if you have any questions.

Thanks,

Anita Dodson  
Chemist

CH2M HILL  
5700 Cleveland Street, Suite 101  
Virginia Beach, VA, 23462  
Direct:: 757-671-6218  
Fax: 757-497-6885  
[www.ch2m.com](http://www.ch2m.com)

## Solutions without Boundaries

**Regulatory Acceptance**

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION III  
1650 Arch Street  
Philadelphia, Pennsylvania 19103-2029

October 25, 2013

Mr. Scott Park  
NAVFAC MIDLANT, Building N-26, Room 3208  
Attention: Code OPHE3, Mr. Scott Park  
9742 Maryland Avenue  
Norfolk, VA 23511-3095

Subject: Draft Sampling and Analysis Plan, Expanded Site Inspection – Site 9, AOC 1, Ammonia Settling Pits Subarea of AOC 6, and AOC 7, Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia, July 2013

Mr. Park:

Thank you for the opportunity to review the subject document. Attached are comments and observations on the document for your information. Since these comments don't impact the scope of the sampling plan, no response to comments is necessary. Please submit a final copy of the subject document for our records. If you have any questions, please contact me at 215-814-2077.

Sincerely,

A handwritten signature in blue ink that reads "Gerald F. Hoover".

Gerald F. Hoover, RPM  
NPL/BRAC Federal Facilities Branch

cc: Wade Smith, VDEQ

Re: Draft Sampling and Analysis Plan, Expanded Site Inspection – Site 9, AOC 1, Ammonia Settling Pits Subarea of AOC 6, and AOC 7, Naval Weapons Station Yorktown Cheatham Annex, Williamsburg, Virginia, July 2013

### **GENERAL COMMENT**

In the fifth bullet on page 44 of the report, the second sentence should be clarified as follows: “The 95<sup>th</sup> percent UCL of the mean gw concentration from the wells located within the most contaminated portion of the gw plume (if a plume is identified) will be used as the exposure point concentration for the risk calculations.”

### **SITE 9**

According to page 30 of the report, the SI performed at this site revealed contamination in subsurface soil. However, throughout the report (pages 5, 20, and 43), only surface soil collection is proposed for the ESI. Did the SI for this site provide enough info about subsurface conditions that additional sampling is unnecessary? If so, justification should be presented in this report.

The answer to the first question appearing in Section 5.1.7 (page 31) discusses surface soil contamination and associated screening criteria exceedances observed during the SI. Page 30 of the report indicates that exceedances were also present in subsurface soil. This should be mentioned in Section 5.1.7.

### **AOC 1 – NORTH**

In the discussion of contaminant distribution at AOC 1 – North (page 33), surface soil contamination is discussed. What were the findings for subsurface soil during the SI? (This comment also applies to the first paragraph of Section 5.2.7.). If contaminants were present in subsurface soil in excess of screening criteria, then either additional sample collection should be considered for the ESI or justification should be provided for not doing so.

### **AOC 1 – SOUTH**

According to page 34, additional surface soil samples are recommended for the ESI to further define the extent of contamination. However, the Executive Summary and Section 4.2 of the report state that subsurface soil samples will also be collected. Please revise the text to accurately reflect proposed sample collection for the ESI.

### **AMMONIA SETTLING PITS (AOC 6)**

Section 5.3.3 (page 38) discusses surface soil contamination and associated screening criteria exceedances observed during the SI. Page 39 of the report indicates that exceedances were also present in subsurface soil. This should be mentioned in Section 5.3.3.

### **AOC 7**

In the discussion of AOC 7 on page 6 of the report (Executive Summary), the pending Removal Action to excavate soil should be mentioned.

Section 4.3 of the report should provide additional info on the pending Removal Action for soil, such as the anticipated date of this activity.

## Sawyer, Stephanie/VBO

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**From:** Smith, Wade (DEQ) [Wade.Smith@deq.virginia.gov]  
**Sent:** Thursday, August 22, 2013 11:08 AM  
**To:** scott.park@navy.mil  
**Cc:** Ivester, Marlene/VBO; Sawyer, Stephanie/VBO; Hoover.Gerald@epa.gov  
**Subject:** CAX: Site 9, AOC 1, AOC 6, & AOC 7 SAP - DEQ Comments

Thank you for giving the DEQ the opportunity to comment on the July 2013 Draft SAP for Site 9, AOC 1, AOC 6, and AOC 7 at CAX.

The Draft SAP was received by the DEQ on July 31, 2013.

Based on the scoping sessions associated with this Draft SAP, the DEQ concurs with the Sampling Design and Rationale and recommends submittal of the Final SAP.

Please let me know if you have any questions.

Sincerely,

Wade M. Smith  
Remediation Project Manager  
Virginia Department of Environmental Quality  
Office of Remediation Programs  
Phone: (804) 698-4125  
[wade.smith@deq.virginia.gov](mailto:wade.smith@deq.virginia.gov)