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FINAL SAMPLING AND ANALYSIS PLAN (FIELD SAMPLING PLAN AND QUALITY
ASSURANCE PROJECT PLAN) CERCLA GROUNDWATER REMEDIAL INVESTIGATION
UNEXPLODED ORDNANCE 32 (UXO 32) SITE 41 SCRAP YARD NSWC INDIAN HEAD MD
06/01/2011
TETRA TECH NUS INC

SAP Worksheet #1 -- Title and Approval Page
[\(UFP-QAPP Manual Section 2.1\)](#)

Final
SAMPLING AND ANALYSIS PLAN
(FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN)
JUNE 2011

CERCLA GROUNDWATER REMEDIAL INVESTIGATION
UXO 32, Site 41 – SCRAP YARD
NAVAL SUPPORT FACILITY INDIAN HEAD
INDIAN HEAD, MARYLAND

Prepared for:
Naval Facilities Engineering Command Washington
1314 Harwood Street, S.E.
Washington Navy Yard, D.C. 20374-5018

Prepared by:
Tetra Tech NUS, Inc.
234 Mall Boulevard, Suite 260
King of Prussia, Pennsylvania 19406
610-491-9688

Prepared under:
Contract No. N62472-03-D-0057
Contract Task Order 047

Investigative Organization's Project Manager: _____
Signature/Date
Scott Nesbit, PE, Tetra Tech NUS, Inc.

Investigative Organization's Project QA Manager: _____
Signature/Date
Tom Johnston, PhD, Tetra Tech NUS, Inc.

Approval Signatures: _____
Signature/Date
Joe Rail, PE, NAVFAC Washington
Remedial Project Manager

Signature/Date
Dennis Orenshaw
US Environmental Protection Agency

Signature/Date
Navy Chemist
NAVFAC QA Review

SAP Worksheet #1 -- Title and Approval Page
(UFP-QAPP Manual Section 2.1)

INTERNAL-DRAFT
SAMPLING AND ANALYSIS PLAN
(FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN)
APRIL 2011

CERCLA GROUNDWATER REMEDIAL INVESTIGATION
UXO 32, Site 41 – SCRAP YARD
NAVAL SUPPORT FACILITY INDIAN HEAD
INDIAN HEAD, MARYLAND

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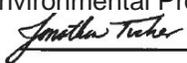
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Navy Chemist
NAVFAC QA Review

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EXECUTIVE SUMMARY

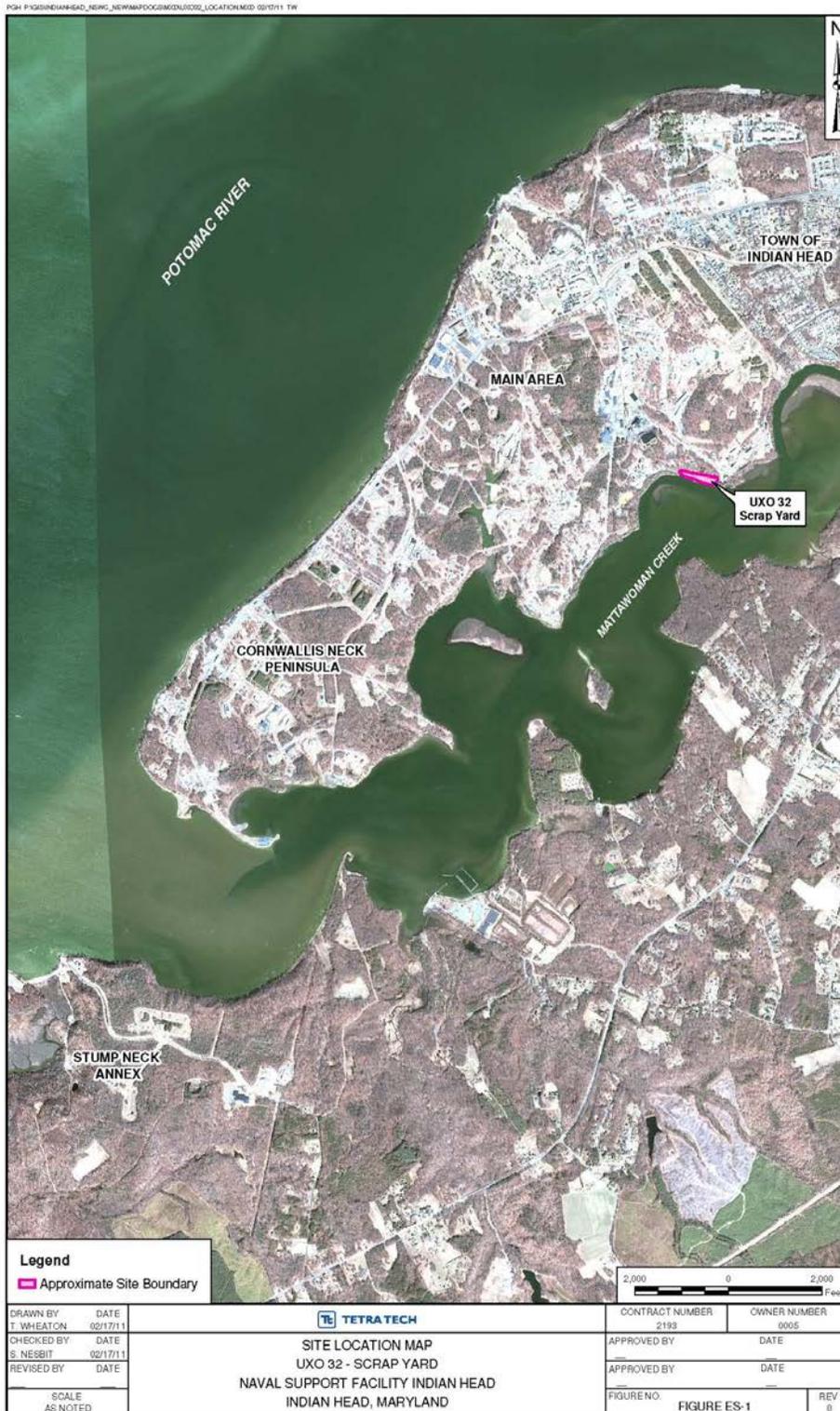
Tetra Tech NUS, Inc. (Tetra Tech) has prepared this Sampling and Analysis Plan (SAP) for a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Remedial Investigation (RI) of groundwater only at Unexploded Ordnance (UXO) 32, Scrap Yard, also known as Site 41, located at Naval Support Facility (NSF) Indian Head, Maryland. This SAP was developed under Contract Task Order (CTO) 047, Contract N62472-03-D-0057, Comprehensive Long-Term Environmental Action Navy (CLEAN). Figure ES-1 shows the locations of the NSF Indian Head (IH) installation and of UXO 32 within the installation perimeter.

UXO 32 is a fenced scrap yard approximately 750 feet long and 75 to 100 feet wide located in the southeastern portion of NSF-IH adjacent to Mattawoman Creek. A degraded concrete slab is present within most of the fenced area. The Scrap Yard is active and is used to store metal materials and scrap, including storage drums and furniture. The site was originally designated as Site 41 under the Installation Restoration program; however, due to the large quantity of munitions-related items identified during investigations at the site, the site was transferred to the Munitions Response Program (MRP) and designated UXO 32.

Previous environmental investigations were mainly focused on contamination and associated human health and ecological risks for soil at the site, but groundwater contamination was also detected. A soil removal action (RA) was completed in 2010 to reduce human health risks for industrial site workers and the environment to acceptable levels, but groundwater contamination has not been thoroughly investigated, and human health risks have not been fully evaluated for groundwater.

This groundwater RI will use groundwater sampling upgradient, sidegradient, and downgradient of UXO 32 to delineate the extent of groundwater contamination associated with the site. The data obtained from this investigation will also be used to identify if the source of UXO 32 groundwater contamination is related to the operation of the Scrap Yard and to assess human health risks from exposure to contaminated groundwater at UXO 32.

The appendices to this UFP-SAP include the following: Appendix A - Site-Specific Field Standard Operating Procedures, and Appendix B - Laboratory Standard Operating Procedures and Environmental Laboratory Accreditation Program (ELAP) Certification Documentation.



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Appendices

A – Site-Specific Field Standard Operating Procedures
B – Laboratory Standard Operating Procedures and ELAP Certification Documentation

ACRONYMS

AR	Administrative Record
ATV	All-terrain vehicle
BFB	Bromofluorobenzene
bgs	Below ground surface
°C	Degree Celsius
CA	Corrective Action
CAS	Chemical Abstracts Service
CCB	Continuing calibration blank
CCC	Calibration check compound
CCV	Continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
COC	Contaminant of concern
COPC	Chemical of potential concern
CSM	Conceptual Site Model
CTO	Contract Task Order
DL	Detection limit
DoD	Department of Defense
DPT	Direct-push technology
DQI	Data Quality Indicator
DQO	Data Quality Objective
DVM	Data Validation Manager
EDD	Electronic Data Deliverable
EE/CA	Engineering Evaluation/Cost Analysis
ELAP	Environmental Laboratory Accreditation Program
FOL	Field Operations Leader
FS	Feasibility Study
FTMR	Field Task Modification Request
GC/MS	Gas chromatography/mass spectroscopy
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HI	Hazard Index
HSM	Health and Safety Manager
ICAL	Initial Calibration
ICB	Initial Calibration Blank

Project-Specific SAP**Site Name/Project Name:** UXO 32/Groundwater RI
Site Location: NSF Indian Head, Maryland**Title:** SAP for UXO 32 (Site 41)**Revision Number:** 0**Revision Date:** June 2011

ICP-AES	Inductively Coupled Plasma-Atomic Emission Spectroscopy
ICV	Initial Calibration Verification
IDW	Investigation-derived waste
IH	Indian Head
IRP	Installation Restoration Program
IS	Internal Standard
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
LIMS	Laboratory Information Management System
LOD	Limit of Detection
LOQ	Limit of Quantitation
MCL	Maximum Contaminant Level
MDE	Maryland Department of the Environment
MPC	Measurement Performance Criterion
MRP	Munitions Response Program
MS	Matrix spike
MSD	Matrix spike duplicate
NA	Not Applicable
NAD	North American Datum
NAVFAC	Naval Facilities Engineering Command
NEDD	NIRIS Electronic Data Deliverable
NIRIS	Naval Installation Restoration Information Solution
NSF	Naval Support Facility
ORP	Oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
PAL	Project Action Limit
PCB	Polychlorinated biphenyl
PCE	Tetrachloroethene
PDF	Portable Document Format
PID	Photoionization detector
PIL	Performance Indicator Level
PM	Project Manager
POC	Point of Contact
PQL	Project Quantitation Limit
PQO	Project Quality Objective
PSL	Project Screening Level
PT	Performance Testing
QA	quality assurance
QAM	Quality Assurance Manager
QC	Quality control

Project-Specific SAP**Site Name/Project Name:** UXO 32/Groundwater RI
Site Location: NSF Indian Head, Maryland**Title:** SAP for UXO 32 (Site 41)**Revision Number:** 0**Revision Date:** June 2011

QSM	Quality Systems Manual
%R	Percent recovery
%RSD	Percent relative standard deviation
RA	Removal Action
RF	Response factor
RI	Remedial Investigation
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RRT	Relative Retention Time
RT	Retention Time
SAP	Sampling and Analysis Plan
SDG	Sample Delivery Group
SI	Site Inspection
SOP	Standard Operating Procedure
SPCC	System Performance Check Compound
SQL	Structured Query Language
SSO	Site Safety Officer
SVOC	Semivolatile organic compound
TAL	Target Analyte List
TBD	To be determined
TCE	Trichloroethene
TCL	Target Compound List
Tetra Tech	Tetra Tech NUS, Inc.
TPH	Total petroleum hydrocarbons
UFP-QAPP	Uniform Federal Policy for Quality Assurance Plan
UFP-SAP	Uniform Federal Policy for Sampling and Analysis Plan
µg/L	Microgram per liter
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency
UXO	Unexploded ordnance
VOA	Volatile organic analysis
VOC	Volatile organic compound

SAP Worksheet #2 -- SAP Identifying Information

(UFP-QAPP Manual Section 2.2.4)

Site Name/Number: Naval Support Facility (NSF) Indian Head (IH)/(UXO) 32 (Site 41)
 Scrap Yard
Operable Unit: Not Applicable (NA)
Contractor Name: Tetra Tech NUS, Inc. (Tetra Tech)
Contract Number: N62472-083-D-0057
Contract Title: Comprehensive Long-Term Environmental Action Navy (CLEAN)
Work Assignment Number: Contract Task Order (CTO) 047

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP)* (USEPA, 2005) and *EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, Quality Assurance Management System (2002)*.

2. Identify regulatory program: The Maryland Department of the Environment (MDE) and United States Environmental Protection Agency (USEPA), which implement and enforce the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and related state and federal laws and rules.

3. This SAP is a project-specific SAP.

4. List dates of scoping sessions that were held:

Scoping Session	Date
Data Quality Objective (DQO) Meeting – Participants included Tetra Tech with oversight by Naval Facilities Engineering Command (NAVFAC) Washington	2/7/2011
Completion of DQOs and finalization of SAP content	2/16/2011
Draft plan review	2/22/2011

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

Title	Date
None	

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

MDE (regulatory oversight), USEPA (regulatory oversight), NAVFAC Washington (property owner), NSF-IH (property owner), Tetra Tech (Navy contractor)

7. Lead organization: NAVFAC Washington

- 8. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:

There are no exclusions.

SAP Worksheet #3 -- Distribution List

(UFP-QAPP Manual Section 2.3.1)

Name of SAP Recipient	Title/Role	Organization	Telephone Number	E-Mail or Mailing Address
Joe Rail	Remedial Project Manager/ Manages project activities for NAVFAC Washington	NAVFAC Washington	202-685-3015	joseph.rail@navy.mil
Nicholas Carros	Installation Restoration Project Manager (RPM)/ Provides support for and manages this project and serves as the NSF-IH Point of Contact (POC)	NSF-IH	301-744-2263	nicholas.carros@navy.mil
Bonnie Capito (Final Letter Only)	Administrative Record (AR) Librarian/Manages AR for NAVFAC	NAVFAC Atlantic	757-322-4785	bonnie.capito@navy.mil
Dennis Orenshaw	USEPA RPM/Provides USEPA overnight	USEPA Region 3	215-814-3361	orenshaw.dennis@epa.gov
Curtis DeTore	State RPM/Provides state input	MDE	410-537-3791	cdetore@mde.state.md.us
Scott Nesbit ⁽¹⁾	Tetra Tech Project Manager (PM)	Tetra Tech	412-921-7134	scott.nesbit@tetrattech.com
TBD	Field Operations Leader (FOL)/ Manages Field Operation	Tetra Tech	TBD	TBD
Matt Soltis	Project Health and Safety Manager	Tetra Tech	412-921-8912	matt.soltis@tetrattech.com
Joe Samchuck	Data Validation Manager (DVM)	Tetra Tech	412-921-8856	joe.samchuck@tetrattech.com
Kelly Carper	Project Chemist	Tetra Tech	412-921-7273	kelly.carper@tetrattech.com
TBD	Site Safety Officer (SSO)/ Oversees site activities to ensure that safety requirements are met	Tetra Tech	TBD	TBD

Project-Specific SAP

Site Name/Project Name: UXO 32/Groundwater RI

Site Location: NSF Indian Head, Maryland

Title: SAP for UXO 32 (Site 41)

Revision Number: 0

Revision Date: June 2011

Name of SAP Recipient	Title/Role	Organization	Telephone Number	E-Mail or Mailing Address
Brian Richard	Laboratory PM/ Representative for laboratory and analytical issues	Empirical Laboratories, Inc. (Empirical)	1-877-345-1113, Ext 249	brichard@empirlabs.com

- 1 Scott Nesbit will supply copies of the SAP to other Tetra Tech personnel (e.g., Tetra Tech Database Manager) as needed.

SAP Worksheet #4 -- Project Personnel Sign-Off Sheet

[\(UFP-QAPP Manual Section 2.3.2\)](#)

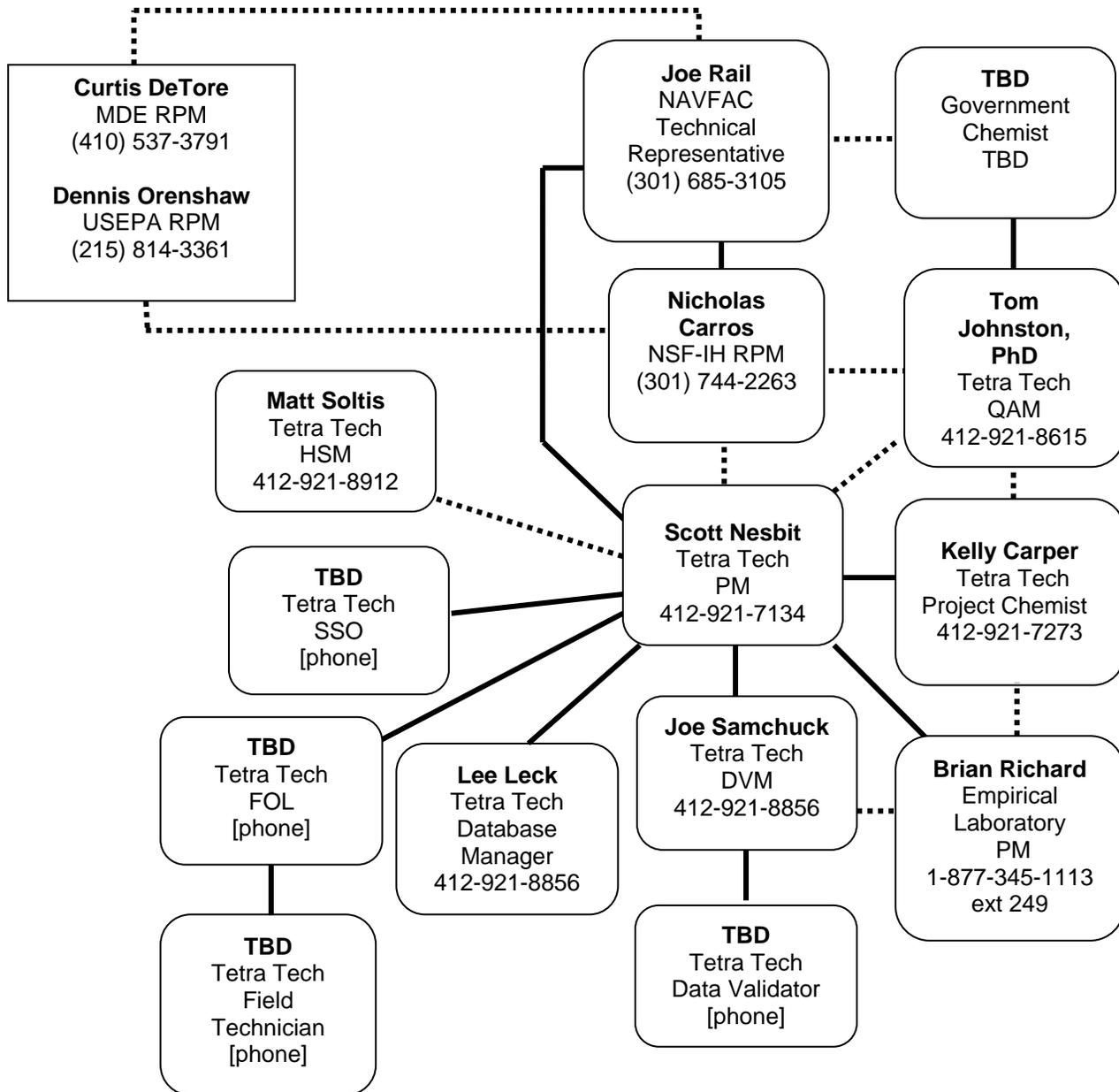
Key personnel will be instructed to read the SAP prior to attending an internal site-specific kick-off meeting for field activities. The Tetra Tech PM will track when the reviews have been completed, obtain signatures, and ensure that the completed sign-off sheet is included in the central project file.

Name	Organization/Title/Role	Telephone Number (optional)	Signature/E-Mail Receipt	SAP Section Reviewed	Date SAP Read
TBD	Tetra Tech FOL	TBD		All	
TBD	Tetra Tech SSO	TBD		All	
Kelly Carper (Electronic copy only)	Tetra Tech Project Chemist/Conducts data validation and reporting and provides support for laboratory- related issues	412-921-7273		All	
Matt Soltis, CIH, CSP [Health and Safety Plan (HASP) only]	Tetra Tech Project Health and Safety Manager (HSM)/ Oversees health and safety activities	412-921-8912		HASP	
Joe Samchuck (Electronic copy only)	Tetra Tech DVM/Oversees data validation activities	412-921-8510		Worksheet #s 12, 14, 15, 19, 20, 23-28, 30, and 34-37	
Brian Richard (Electronic copy only)	Laboratory PM/Manages project for Laboratory	1-877-345-1113 ext 249		Worksheet #s 12, 14, 15, 19, 20, 23-28, 30, and 34 to 36	

SAP Worksheet #5 -- Project Organizational Chart

(UFP-QAPP Manual Section 2.4.1)

Lines of Authority ————— Lines of Communication



SAP Worksheet #6 -- Communication Pathways

([UFP-QAPP Manual Section 2.4.2](#))

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-Mail	Procedure
Field mobilization	Tetra Tech FOL	TBD	TBD	At least 3 days prior to mobilization, the Tetra Tech FOL will verbally contact the NSF-IH POC to arrange for site access and utility clearance.
SAP amendments	Tetra Tech PM Tetra Tech FOL NAVFAC Washington RPM	Scott Nesbit TBD Joe Rail	412-921-7134 TBD 202-685-3105	Tetra Tech FOL will verbally inform Tetra Tech PM within 24 hours of realizing a need for an amendment/addendum. Tetra Tech PM will document the proposed changes via a Field Task Modification Request (FTMR) form within 5 days and send the Navy RPM a concurrence letter within 7 days of identifying the need for change. UFP-SAP amendments will be submitted by Tetra Tech PM to NAVFAC RPM for review and approval. Tetra Tech PM will send scope changes to Project Team via e-mail within 1 business day.

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-Mail	Procedure
Schedule changes	Tetra Tech PM NSF-IH RPM NAVFAC Washington RPM Tetra Tech FOL	Scott Nesbit Nicholas Carros Joe Rail TBD	412-921-7134 301-744-2263 202-685-3105 TBD	Tetra Tech FOL will verbally inform Tetra Tech PM on the day that the issue is discovered. Tetra Tech PM will verbally inform Navy RPM within 1 business day of discovery. Navy RPM will inform MDE RPM and USEPA RPM within 1 business day of discovery. Navy RPM will issue scope change (verbally or via e-mail), if warranted; scope change to be implemented before further work is executed. Tetra Tech PM will document the change via a FTMR form within 2 days of identifying the need for change and obtain required approvals within 5 days of initiating the form.
Field issues that require changes in field tasks	Tetra Tech FOL Tetra Tech PM NSF-IH RPM NAVFAC Washington RPM	TBD Scott Nesbit Nicholas Carros Joe Rail	TBD 412-921-7134 301- 744-2263 202-685-3105	Tetra Tech FOL informs PM verbally the day the issue is realized. PM informs the NAVFAC RPM of the issue verbally within 1 day of the FOL's notification. PM also sends a concurrence letter to NAVFAC within 7 days, if project scope is affected. The NAVFAC RPM will sign the letter within 5 days of receipt. Document changes on a FTMR form. Place the form in the project file, with signatures as determined by the PM.
Field issues that require changes in scope of field work	Tetra Tech FOL Tetra Tech PM NSF-IH RPM	TBD Scott Nesbit Nicholas Carros	TBD 412-921-7134 301-744-2263	Tetra Tech FOL informs PM verbally the day the issue is realized. PM informs the NAVFAC RPM of the issue verbally within 1 day of the FOL's notification. PM also sends a

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-Mail	Procedure
	NAVFAC Washington RPM	Joe Rail	202-685-3105	concurrence letter to the NAVFAC RPM within 7 days, if project scope is affected. The NAVFAC RPM will sign the letter within 5 days of receipt. Document changes on an FTMR form. Place the form in the project file, with signatures as determined by the PM.
Recommendations to stop work and then to initiate work upon corrective action implementation	Tetra Tech FOL Tetra Tech PM NSF-IH RPM NAVFAC Washington RPM Tetra Tech HSM Tetra Tech Quality Assurance Manager (QAM) Tetra Tech Project Chemist	TBD Scott Nesbit Nicholas Carros Joe Rail Matt Soltis Tom Johnston Kelly Carper	TBD 412-921-7134 301-744-2263 202-685-3105 412-921-8912 412-921-8615 412-921-7273	If Tetra Tech is the responsible party for a stop-work command, the Tetra Tech person recognizing the need to stop work will verbally or via e-mail, inform the PM who will inform project personnel, including subcontractor(s), Navy RPM, base POC, and the identified Project Team members within 1 hour (verbally or by e-mail). If a subcontractor is the responsible party, the subcontractor PM must inform the Tetra Tech FOL within 15 minutes of recognizing the need to stop work, and the Tetra Tech FOL will then follow the procedure listed above.
Field or laboratory data quality issues	Empirical Laboratory PM Tetra Tech FOL Tetra Tech PM Tetra Tech Project Chemist Tetra Tech DVM	Brian Richard TBD Scott Nesbit Kelly Carper Joe Samchuck	1-877-345-1113 ext 249 TBD 412-921-7134 412-921-7273 412-921-8510	The Laboratory PM will notify (verbally or via e-mail) the Tetra Tech Project Chemist within 1 business day of when an issue related to laboratory data is discovered. The Tetra Tech Project Chemist will notify (verbally or via e-mail) the data validation staff and the Tetra Tech PM within 1 business day. Tetra Tech DVM or Project Chemist will notify Tetra Tech PM or Tetra Tech

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or E-Mail	Procedure
				<p>FOL verbally or via e-mail within 48 hours of validation completion that a non-routine and significant laboratory quality deficiency has been detected that could affect this project and/or other projects. The Tetra Tech PM will verbally advise the NAVFAC RPM within 24 hours of notification from the Project Chemist or DVM.</p> <p>The NAVFAC RPM will take corrective action that is appropriate for the identified deficiency. Examples of significant laboratory deficiencies include data reported that have a corresponding failed tune or initial calibration verification. Corrective actions may include a consultation with the NAVFAC Chemist.</p>
Corrective action for field program	Tetra Tech QAM Tetra Tech PM	Tom Johnston Scott Nesbit	412-921-8615 412-921-7134	Tetra Tech QAM will notify (verbally or via e-mail) Tetra Tech PM within 1 business day that the corrective action has been completed. The Tetra Tech PM will then notify (verbally or via e-mail) the Navy RPM within 1 business day.

SAP Worksheet #7 -- Personnel Responsibilities and Qualifications Table

(UFP-QAPP Manual Section 2.4.3)

Name	Title/Role	Organizational Affiliation	Responsibilities
Joe Rail	NAVFAC Washington RPM/ Manages project activities for NAVFAC	NAVFAC Washington	Provides NSF-IH with Navy technical support. Oversees project scoping implementation, including data review and evaluation.
Curtis DeTore	MDE RPM/Provides state input	MDE	Participates in project scoping and implementation, including data review and evaluation.
Dennis Orenshaw	USEPA/Provides USEPA input	USEPA	Participates in project scoping and implementation, including data review and evaluation, and approves the SAP.
Nicholas Carros	NSF-IH RPM/Provides support and manages this environmental project as the base POC	NSF-IH	Oversees and coordinates site activities, participates in scoping, data review, and evaluation.
Scott Nesbit	Project Manager/Manages project activities on a daily basis	Tetra Tech	Oversees project, financial, schedule, and technical day-to-day management of the project.
TBD	FOL/Manages daily field operations	Tetra Tech	Supervises, coordinates, and performs field sampling activities.
TBD	SSO/Oversees site activities to ensure that safety requirements are met	Tetra Tech	Responsible for training and monitoring site conditions. Reports to the HSM and to the Tetra Tech PM. Details of the SSO's responsibilities are presented in the HASP.
Tom Johnston, PhD	QAM/Oversees program and project quality assurance (QA) activities	Tetra Tech	Reviews SAP, oversees preparation of laboratory scope of work, and conducts data quality reviews. Ensures that quality aspects of the Navy CLEAN program are implemented.
Joseph Samchuck	DVM/Oversees data validation activities	Tetra Tech	Manages data validation activities within Tetra Tech, including ensuring QA of data validation deliverables, providing technical advice on data usability, and coordinating and maintaining the data validation review schedule.
Matt Soltis	HSM/Oversees health and safety activities	Tetra Tech	Oversees Navy CLEAN Program Health and Safety Program.
Kelly Carper	Project Chemist/	Tetra Tech	Participates in project scoping, prepares laboratory scopes

Project-Specific SAP

Site Name/Project Name: UXO 32/Groundwater RI

Site Location: NSF Indian Head, Maryland

Title: SAP for UXO 32 (Site 41)

Revision Number: 0

Revision Date: June 2011

Name	Title/Role	Organizational Affiliation	Responsibilities
	Coordinates laboratory-related functions and conducts data validation and reporting		of work, and coordinates laboratory-related functions with laboratory. Conducts data quality reviews and QA of data validation deliverables.
Brian Richard	Laboratory PM/Manages project activities	Empirical	Coordinates analyses with laboratory chemists, ensures that scope of work is followed, provides QA of data packages, and communicates with Tetra Tech project staff.

SAP Worksheet #8 -- Special Personnel Training Requirements Table

[\(UFP-QAPP Manual Section 2.4.4\)](#)

Each site worker will be required to have completed appropriate Hazardous Waste Operations and Emergency Response (HAZWOPER) training specified in Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120 (e). Project-specific safety requirements are addressed in greater detail in the site-specific HASP.

SAP Worksheet #9 -- Project Scoping Session Participants Sheet

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

The following worksheets are specific for project scoping sessions related to the groundwater investigation SAP.

Project Name: UXO 32 (Site 41) Groundwater RI Projected Date(s) of Sampling: Prior to April 15, 2011 Project Manager: Scott Nesbit		Site Name: UXO 32 (Site 41) Site Location: NSF Indian Head			
Date of Session: 2/7/2011 Scoping Session Purpose: Initial scoping					
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Scott Nesbit	Project Manager	Tetra Tech	412-921-7134	Scott.Nesbit@tetrattech.com	Project Management
Kelly Carper	Project Chemist	Tetra Tech	412-921-7273	Kelly.Carper@tetrattech.com	Chemistry support
Tom Johnston	DQO Support	Tetra Tech	412-921-8615	Tom.Johnston@tetrattech.com	DQO facilitation

Comments/Decisions:

A DQO skeleton was developed and was completed during the next scoping session.

Action Items:

Scott will:

- Finish compiling Conceptual Site Model (CSM).
- Verify correct risk-based criteria with risk assessor.
- Verify reasonable analyte lists based on known exceedances of applicable current risk-based criteria and Maximum Contaminant Levels (MCLs).
- Verify whether ColorTec field analyses would be feasible given the low concentrations of chlorinated volatile organic compounds (VOCs) in groundwater. This was later verified not to be cost-effective.

Tom will compile DQO skeleton for further refinement.

Kelly will procure Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) approved laboratory based on tentative analyte lists and criteria to be verified by Scott.

Consensus Decisions:

Equipment rinsate blanks and source water blanks will not be needed to check for cross-contamination of sampling equipment because much of the equipment will be disposable, and the potential for cross-contamination is very low, especially if sampling occurs from least to most contaminated locations, which is the usual sampling progression.

SAP Worksheet #9 – Project Scoping Session Participants Sheet

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

Project Name: UXO 32 (Site 41) Groundwater RI Projected Date(s) of Sampling: Prior to April 15, 2011 Project Manager: Scott Nesbit		Site Name: UXO 32 (Site 41) Site Location: NSF Indian Head			
Date of Session: 2/21/2011 Scoping Session Purpose: Completion of DQOs and finalization of SAP content					
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Scott Nesbit	Project Manager	Tetra Tech	412-921-7134	Scott.Nesbit@tetrattech.com	Project Management
Fred Ramser	Field Geologist	Tetra Tech	412-921-8838	Fred.Ramser@tetrattech.com	Geology support
Tom Johnston	DQO Support	Tetra Tech	412-921-8615	Tom.Johnston@tetrattech.com	DQO facilitation
Leanne Ganser	Environmental Scientist	Tetra Tech	412-921-8148	Leanne.ganser@tetrattech.com	Risk Assessor

Comments/Decisions:

A draft SAP was prepared, and this meeting was used to finalize DQOs and field activities; the Tetra Tech PM, geologist, and risk assessor identified potential sampling locations to achieve the project objective.

Action Items:

Scott will discuss scope of investigation with Joe Rail so the SAP can be finalized for Navy Chemist review within the next 10 days. The plan was discussed with Joe on 2/22/11, and he was in agreement with the approach.

Consensus Decisions:

A groundwater investigation including the collection of data upgradient and downgradient of UXO 32 will be conducted to determine if previous contamination identified at the site is associated with the operation of the Scrap Yard or an upgradient source. The sampling program will be limited to the contaminants identified during prior investigations at UXO 32.

SAP Worksheet #9 -- Project Scoping Session Participants Sheet

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

Project Name: UXO 32 (Site 41) Groundwater RI Projected Date(s) of Sampling: Prior to April 15, 2011 Project Manager: Scott Nesbit		Site Name: UXO 32 (Site 41) Site Location: NSF Indian Head			
Date of Session: 2/22/2011 Scoping Session Purpose: Draft Plan Review					
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Scott Nesbit	Project Manager	Tetra Tech	412-921-7134	Scott.Nesbit@tetra tech.com	Project Management
Joe Rail	NAVFAC RPM	NAVFAC	202-685-3105	joseph.rail@navy. mil	Project Manager

Comments/Decisions:

The scope of the project was discussed and agreement reached on the approach for the groundwater investigation.

Action Items:

Scott will forward the draft monitoring well network figure to Remedial Action Contractor installing monitoring wells at the site as part of the removal action.

Consensus Decisions:

None.

SAP Worksheet #10 -- Conceptual Site Model

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

This worksheet summarizes the current CSM for UXO 32. Background information, including site location and description, site history, and a brief summary of site geology and hydrogeology are included. Further, summaries of environmental investigations and the limitations of previously collected data are provided.

10.1 SITE LOCATION AND DESCRIPTION

NSF-IH is located in northwestern Charles County, Maryland and is approximately 25 miles southwest of Washington, D.C. (**Figure 1**). NSF-IH is a military facility consisting of the Main Area on the Cornwallis Neck Peninsula and the Annex on Stump Neck. As shown on **Figure 2**, the Main Area is bounded by the Potomac River on the northwest, west, and south, Mattawoman Creek to the south and east, and the Town of Indian Head to the northeast. Stump Neck Annex is located across Mattawoman Creek and is not contiguous with the Main Area. The location of UXO 32 is shown on **Figure 2**.

The primary mission of NSF-IH is to:

- Provide services in energetics for all warfare centers through engineering, fleet and operation support, manufacturing technology, limited production, and industrial base support.
- Provide research, development, testing, and evaluation of energetic materials, ordnance devices and components, and other related ordnance engineering standards including chemicals, propellants and their propulsion systems, explosives, pyrotechnics, warheads, and simulators.
- Provide support to all warfare centers, military departments, and the ordnance industry for special weapons, explosive safety, and ordnance environmental issues.

UXO 32 is a fenced scrap yard approximately 750 feet long and 75 to 100 feet wide located in the southeastern portion of NSF-IH adjacent to Mattawoman Creek (**Figure 3**). A degraded concrete slab is present within most of the fenced area. Surface water on the slab generally infiltrates into the subsurface through cracks and holes in the concrete. The scrap yard is active and is used to store metal materials and scrap, including storage drums and furniture. The materials are eventually sold to be recycled or reused. The scrap yard has been cleared of all debris and cleaned as part of a Removal Action (RA) in 2010. The site is scheduled to be used as a scrap yard in the future.

The site was originally designated as Site 41 under the Installation Restoration program; however, due to the large quantity of munitions-related items identified during investigations at the site, it was transferred to the Munitions Response Program (MRP) and designated UXO 32.

NSF-IH was placed on the National Priorities List in September 1995.

10.2 SITE OPERATIONAL HISTORY

The site was the location of a coal storage facility dating from the turn of the 20th century but now is an active scrap yard. It was reported that electrical transformers that contained polychlorinated biphenyls (PCBs) were stored at the northwestern end of the scrap yard from the 1960s until 1988. During an inspection in 1981, 17 transformers were identified as either containing or contaminated with PCBs. These transformers were believed to have leaked and contaminated the soil in the western portion of the site. In addition, lead-acid batteries stored in the scrap yard may have released lead to the surface (Tetra Tech, 1999).

10.3 SITE PHYSIOGRAPHY

10.3.1 Soil and Geology

NSF-IH is located in the Atlantic Coastal Plain Physiographic Province and is underlain by unconsolidated sand, gravel, and clay. The soil in this area consists of silty and sandy loams, with minor amounts of gravel, and tends to have low permeability and low shrink-swell potential.

Subsurface soil conditions at UXO 32 were investigated via soil borings and installation of monitoring wells during the Site Inspection (SI) (ENSAFE/Allen & Hoshall, 1994). Subsurface materials generally consist of clayey sand interlayered with clayey gravel and sand lenses underlain by green-gray clay or brown sandy clay (ENSAFE/Allen & Hoshall, 1994). The clay was encountered at a depth of approximately 15 feet and extended to the total depths of the borings. Layers of slag and coal that were 2 to 5 feet thick were encountered at the ground surface at three locations south of the fenced area as well as beneath the concrete pad (Figures 4 and 5).

10.3.2 Hydrogeology, Hydrology, and Drainage

Shallow groundwater beneath the site occurs under unconfined (water-table) conditions. Shallow groundwater flows south-southeast toward and discharges into Mattawoman Creek (**Figure 6**). However, this creek is tidal, and during high tide the water table may be slightly elevated near the creek, potentially causing groundwater to flow in the opposite direction. Shallow groundwater is primarily recharged by downward migration of precipitation through the unsaturated zone to the water table. The depth to the water table ranges from 2 to 4 feet below ground surface (bgs). Groundwater from the shallow aquifer is not used as a potable water supply. Drinking water is obtained from deeper aquifers (Patapsco and Patuxent Formations of the Potomac Group, more than 190 feet deep). There is no known hydrogeologic connection between the shallow water-table aquifer and the deeper aquifers used for drinking water. The clay underlying the site at a depth of approximately 15 feet acts to impede the downward migration of shallow groundwater to deeper aquifers (Tetra Tech, 1999).

10.4 SUMMARY OF ENVIRONMENTAL WORK CONDUCTED

10.4.1 Previous Investigations

During a 1992 and 1993 SI, soil, shallow groundwater, and creek sediment samples were collected at UXO 32. A sample of ponded water within the scrap yard was also collected (E/A&H, 1994). The range of chemicals that could have been released at UXO 32 was considered to be large.; therefore, samples were analyzed for Target Compound List (TCL) VOCs, TCL semivolatile organic compounds (SVOCs), TCL pesticides/PCBs, Target Analyte List (TAL) metals, cyanide, total petroleum hydrocarbons (TPH), and explosive derivatives (energetics). The expectation was that the analyte list could be reduced if some of these potential chemicals were not detected at unacceptable concentrations. VOCs, SVOCs, pesticides, metals, and TPH were detected in surface soil and subsurface soil in excess of risk-based screening levels, with SVOCs typically associated with fuel oil found at the greatest concentrations. VOCs, SVOCs, metals, TPH, and energetics were detected in sediment; however, only SVOC concentrations exceeded screening levels. The SVOCs detected in sediment were similar in nature to those found in soil samples. VOCs and metals were the predominant groundwater contaminants. Trichloroethene (TCE) was only analyte detected in groundwater in excess of MCLs. Several inorganics were detected in excess of risk-based standards.

A Remedial investigation (RI) was conducted in October 1997 to supplement the results of the SI. The RI objectives were to delineate contamination and estimate human health and ecological risks from exposure to site-related contaminants. Nine surface soil samples were collected from within and adjacent to the Scrap Yard. Groundwater samples were collected from the three existing monitoring wells located within and outside (one within and two outside) of the Scrap Yard to determine current site conditions in the shallow aquifer. A nearby potable water well located northeast of the site was also sampled and was found not to have been affected by releases of contaminants from the site. Six surface water samples and eight sediment samples were collected to determine whether contaminants were migrating from the site to Mattawoman Creek (**Figure 3**). Soil, groundwater, and sediment samples were analyzed for TCL VOCs, TCL SVOCs, TCL pesticides/PCBs, explosives, TAL metals, and cyanide. Surface water samples were analyzed for TCL VOCs, TCL SVOCs, TAL metals, and cyanide. VOCs, SVOCs, PCBs, explosives, and metals were detected in soil, VOCs, SVOCs, and metals were detected in shallow groundwater and surface water, and VOCs, SVOCs, pesticides, explosives, and metals were detected in sediment. Constituents detected in surface water were determined not to pose an unacceptable level of risk to human health or the environment. Contamination identified in sediment adjacent to UXO 32 was investigated as part of a study of the entirety of Mattawoman Creek.

Additional sampling was performed in September 1999 as part of the RI to further delineate the extent of soil contamination. Soil samples were collected from 40 locations in and around the Scrap Yard at a

depth interval of 0 to 6 inches bgs, and soil samples were collected from 30 locations in and around the Scrap Yard at a depth interval of 12 to 18 inches bgs. Samples were analyzed for TCL pesticides/PCBs and select metals (arsenic, cadmium, iron, and lead). PCBs, lead, and arsenic were the primary risk drivers in surface and shallow subsurface soil located outside (south and east) of the Scrap Yard (Tetra Tech, 2001).

Although munitions were managed at the site during its operational life, explosives contaminants were never detected at the site at concentrations that pose unacceptable human health or ecological risk.

10.4.2 Removal Action

An Engineering Evaluation/Cost Analysis (EE/CA) and Action Memorandum for a non-time-critical RA were prepared in 2002. A non-time-critical RA for contaminated soil based on this EE/CA was initiated and completed in 2010. The objective of the RA was to remove surface soil contamination to render the scrap yard suitable for continued industrial use.

The RA included the following:

- Approximately 1,500 cubic yards of soil contaminated with PCBs, lead, arsenic, and PAHs were removed and transported to an off-site disposal facility. Soil sampling performed following the RA demonstrated that the soil excavation was successful in removing the surface and subsurface soil contamination.
- The concrete pad within the fenced area was cleared and munitions items were demilitarized and removed from the site. Residual soil present on the pad was also removed. The concrete pad was then inspected and sampled to determine PCB concentrations remaining in the concrete. No significant PCB contamination was found on the concrete pad and no unacceptable risk to human health and the environment is present as a result.

At the completion of the time-critical RA in the fall of 2010, soil, concrete, and groundwater samples were collected within and around the scrap yard. The soil and concrete samples were analyzed for the contaminants identified in soil at the site (arsenic, lead, and PCBs), whereas groundwater samples were analyzed for arsenic, beryllium, and TCE, the groundwater contaminants of concern (COCs) identified in the RI. In addition, coal material identified beneath portions of the concrete was sampled and analyzed for TAL metals. PCBs, lead, and arsenic were detected in soil at concentrations less than site-specific clean-up levels, and TCE was detected in groundwater in excess of its MCL in one of two temporary wells installed within the limits of the concrete pad. The levels of TCE contamination identified in groundwater were similar to that found during prior investigations at the site.

10.5 NATURE AND EXTENT OF CONTAMINATION

10.5.1 Soil

Widespread PCB, arsenic, and lead contamination was evident in surface and subsurface soil surrounding UXO 32 prior to the RA; however, the RA was successful at reducing surface and subsurface soil contaminant concentrations to levels suitable for continued industrial use of the storage yard. Also, the elevated levels of cadmium and SVOCs (polycyclic aromatic hydrocarbons) found during the RI were reduced to levels suitable for continued industrial use of the storage yard. TCE was not detected at concentrations that would pose a risk to human health and the environment in site soil.

Contamination was observed in the soil beneath the concrete pad at UXO 32, however the contamination was not observed at concentrations that are believed to impact groundwater in a way that would result in unacceptable risk for industrial use.

10.5.2 Groundwater

The COCs for shallow groundwater are arsenic and cobalt based on a human health risk assessment and exceedance of the MCL for arsenic, and TCE and beryllium based on exceedances of federal and state MCLs for drinking water, with TCE being the most prevalent contaminant at the site (Tetra Tech, 1999).

Groundwater contamination at UXO 32 has been identified in shallow water table wells located along the perimeter of the Scrap Yard in the western half of the site during the SI and RI, the investigation at adjacent Site 57, and following the RA. TCE was detected at downgradient locations 41MW01 (17 µg/L) and 41MW04 (33 µg/L) and upgradient locations 41MW03 (32 µg/L), S57MW023 (79 µg/L), and S57MW035 (28 µg/L). TCE was also detected in groundwater collected from a temporary well (TWS05 - 25 µg/L) beneath the concrete pad in the western end of the Scrap Yard. TCE has not been detected in permanent (41WM02) or temporary wells (STW17) on the eastern half of the Scrap Yard. The MCL for TCE is 5 µg/L.

The MCL for arsenic is 10 micrograms per liter (µg/L). Arsenic was detected at 37.6 µg/L at location S41MW02. The concentration of beryllium measured during the RI exceeded the MCL (4 µg/L) at location S41MW02 (4.3 µg/L) and location S41MW03 (4.8 µg/L), but all other concentrations were less than 4 µg/L. Cobalt was detected at location S41GW003 (248 µg/L) in excess of the risk-based screening criterion of 11 µg/L during the RI (Tetra Tech, 2001).

There is no apparent pattern or plume for the detections of the COCs in shallow groundwater.

The historical groundwater results are depicted on [Figure 7](#). This drawing also shows the location of S41PW07, which is a drinking water well screened in a deeper aquifer. Neither TCE nor other

contaminants were identified at levels that would pose any human health risk at this drinking water well (i.e., no detections exceeding MCLs or risk-based screening levels).

10.6 LIMITATIONS OF PREVIOUS DATA

Data collected during historical investigations at UXO 32 partially delineated the horizontal and vertical extent of contaminated groundwater. These historical investigations did not identify the COC source area for groundwater contamination.

10.7 CSM SUMMARY

The components of the UXO 32 CSM are discussed below, and an interpretive CSM is presented as **Figure 8**.

10.7.1 Contaminant Sources

Although COCs detected in groundwater at UXO 32 could be related to the operation of the Scrap Yard, potential COC sources from facility operations exist upgradient of the site. Insufficient data are available at the Scrap Yard to link the existing contamination solely with its operation.

Of the potential upgradient sources, Site 57 (Building 292 TCE Contamination) is a known source for TCE (a UXO 32 COC) in groundwater within 1,100 feet of the Scrap Yard. A remedial action is planned for implementation at Site 57 in spring 2011. Other industrial activities upgradient of UXO 32 may have resulted in releases of contaminants to groundwater; however, none were identified during prior investigations at NSF-IH.

Based on data collected to date and the completion of the RA, no continuing source of groundwater contamination has been identified on or within the concrete pad or in soil underlying or adjacent to the scrap yard. Nevertheless, exceedances of risk-based screening levels and the past risk assessment have shown that groundwater COC concentrations could pose an unacceptable level of risk to hypothetical residential users at the site. Given the presence of TCE contamination immediately upgradient of the scrap yard, the presence of a contaminant source from waste management operations at NSF-IH that are not related to the scrap yard is possible.

Contamination identified beneath the concrete pad at UXO 32 may serve as source for groundwater contamination in the future; however, it is anticipated that the concrete pad will be maintained as an effective cover limiting the potential for migration of contaminants to groundwater for the foreseeable future.

10.7.2 Contaminant Migration Pathways

Contaminant migration pathways potentially at UXO 32 consist of the following:

- Migration of VOCs from an unidentified source beneath or upgradient of the scrap yard.
- Migration of dissolved metals and VOCs in groundwater, with the direction of migration being influenced by groundwater flow and, if present, by preferential flow pathways.

Following the initial release of contaminants to soil (from storage of materials on the concrete slab and subsequent flushing from precipitation), the soil contaminants could leach to groundwater and the contaminant transport migration pathway would follow the predominant flow direction of groundwater. Groundwater eventually discharges into Mattawoman Creek (**Figure 6**).

10.7.3 Potential Receptors

The receptors that may be exposed to contaminated media at UXO 32 include site workers and hypothetical future residents via ingestion, inhalation, or dermal contact with contaminated groundwater. Future site use is uncertain, but it is anticipated to be industrial for the foreseeable future considering the base mission. If land use would become residential, a future resident would likely be more sensitive to site-related contamination because the resident would incur a higher level of exposure than site workers.

Because this investigation is limited to the characterization of groundwater at UXO 32, potential ecological risks are not evaluated because ecological receptors are assumed not to be exposed to this medium.

10.7.4 Exposure Pathways

The primary medium at the site through which receptors could be exposed to contaminants is groundwater. See **Figure 8** for a graphical representation of the CSM. Potential exposure routes for a site worker include dermal contact, ingestion, or inhalation during construction or maintenance activities at the site.

A hypothetical future resident may also be exposed through dermal contact, ingestion, or inhalation to contaminants in groundwater if the groundwater is used as a potable source.

10.8 SUMMARY

The vertical and horizontal extent of contamination in groundwater has not been fully delineated with the limited monitoring well network in place at the site. Site lithological data indicate the presence of a basal clay unit at approximately 15 feet bgs that likely prevents downward migration of contaminants from the shallow aquifer into deeper aquifers. Analytical data demonstrate that no detectable contamination has been identified in deeper groundwater. Potential risk may be associated with a site worker or hypothetical future resident exposed to shallow groundwater at the site.

SAP Worksheet #11 -- Project Quality Objectives/Systematic Planning Process Statements [\(UFP-QAPP Manual Section 2.6.1\)](#)

This section describes the development of Project Quality Objectives (PQOs) using USEPA's seven-step DQO/systematic planning process (USEPA, 2006).

11.1 PROBLEM DEFINITION

Based on the site history and CSM presented in Worksheet #10, the extent of VOC and metals contamination and the locations of COC contamination sources have not been established. Furthermore, risks to site workers or hypothetical future residents have not been characterized for groundwater. Therefore, the nature and extent of groundwater COC contamination and the risks for exposure of various receptors to groundwater must be established so that corrective action can be taken, if necessary, to reduce the risks to acceptable levels.

11.2 DECISION INPUTS

The following data are needed to resolve the problem as identified in Section 11.1:

- Groundwater total metals and VOC concentrations – To be compared to risk-based screening criteria for chemical of potential concern (COPC) selection and to be used to estimate carcinogenic and non-carcinogenic risks. See Worksheet #15 for a list of target analytes. The chlorinated VOCs are either a TCE parent compound (tetrachloroethene [PCE]) or they are potential biotic degradation products of TCE that are useful for establishing the nature of contamination or potential for degradation.
Note: Existing groundwater data are considered to be too old (i.e., not representative of current conditions) to be used in a risk assessment, so they will not be used for delineation of contamination or risk assessment. Historical groundwater elevation data will be used to characterize flow direction.
- Groundwater background metal concentrations – A groundwater background concentration is available for cobalt (15.6 ug/L) but not for arsenic or beryllium. Background concentrations are needed to evaluate the contribution of background levels to the total risk. The risk assessment must be conducted with and without consideration of background concentrations of cobalt to achieve this.
- Screening Criteria – To be used as reference points for selecting COPCs. See Worksheet #15 for these screening criteria.
- Risk thresholds – To represent an unacceptable level of carcinogenic and non-carcinogenic human health risks that would trigger an evaluation of remedial options or remedy selection to mitigate the risks. See Worksheet #15 for these thresholds.

- Groundwater quality parameters – To be used to establish that sampling conditions are stable and representative of the sampled aquifer before collecting samples. These parameters are dissolved oxygen, oxidation-reduction potential (ORP), pH, specific conductivity, temperature, and turbidity.
- Location Coordinates – To establish the location of sampling points in three-dimensional space. The datum used to document these coordinates will be North American Datum (NAD) of 1983, State Plane Coordinate System of Maryland. See Section 14.2.9 for detailed requirements.
- Quality control (QC) samples will be collected at the rates identified in Worksheet #12.

11.3 STUDY BOUNDARIES

To establish the nature and extent of contamination, two general groundwater populations must be represented with the data: contaminated groundwater and uncontaminated groundwater. The area to be represented by the data must span regions containing these populations so a boundary can be drawn to represent the line beyond which contaminated groundwater does not present an unacceptable level of risk. The aquifer of interest is the shallow aquifer; however, because Site 57 is approximately 30 feet higher in elevation than UXO 32 and Site 57 is a possible source of UXO 32 groundwater contamination, the depth bgs to be investigated in the Site 57 area must be deeper than in the UXO 32 area. The intent in this case is to collect groundwater data representing water that flows from Site 57 to the groundwater depths that are contaminated at UXO 32 to determine whether Site 57 is a UXO 32 groundwater contaminant source. If Site 57 is not a contaminant source for UXO 32, being able to demonstrate this with data will be an important aspect of this investigation. Shallow groundwater downgradient of UXO 32 is also of interest because associated groundwater flow patterns and contaminant concentration gradients may provide data to help identify the source of UXO 32 groundwater contamination.

All target analyte concentrations are anticipated to be relatively unchanged (stable) over the course of time needed to conduct the environmental investigations and into the foreseeable future. Groundwater level measurements must be made in a short enough time period that the levels can be assumed not to have changed. UXO 32 Phase I Groundwater RI field activities are scheduled for spring 2011 (see Worksheet #16). Phase II and Phase III activities, if deemed necessary, will be conducted in a timely manner after Phase I. A single round of data collection is expected to be sufficient for evaluating risks to the receptors identified in Section 10.7.2.

Tetra Tech must coordinate well installation with the Remedial Action Contractor scoped to install wells at UXO 32 as part of the RA.

11.4 DECISION RULES

The following decision rules were developed to govern data use for this investigation:

Decision Rule 1:

If the nature and extent of UXO 32 groundwater total metals and VOC contamination (see Worksheet #15 for COC list) (including the identification of significant contaminant sources) has not been delineated to the satisfaction of the Project Team, recommend additional investigation to delineate and characterize the nature and extent of the groundwater contamination.

The Project Team will use the measured COC concentration patterns, water quality parameters (pH, dissolved oxygen, and ORP) that support an initial evaluation of natural attenuation potential, and knowledge of groundwater flow directions to determine whether the nature and extent of contamination has been determined to the extent necessary to proceed to a risk assessment and FS. Collection of the planned data is expected to be sufficient to support a risk assessment. If the analyte concentration patterns indicate the presence of a non-UXO 32 source of groundwater contamination, however, the Project Team will evaluate whether the nature and extent of contamination need to be established more definitively. If delineation in response to detecting a non-UXO 32 contaminant source is needed, the Project Team will likely proceed with the risk assessment for UXO 32 and recommend delineation of the additional source(s) as part of a different investigation. USEPA natural attenuation guidance will be used to estimate whether TCE is degrading naturally (USEPA, 1998). These evaluations will require a comparison of measured COC concentrations upgradient of UXO 32 to COC concentrations downgradient of UXO 32 and a review of overall concentration patterns.

Decision Rule 2:

If risk to a future hypothetical residential receptor exposed to UXO 32 groundwater contamination is greater than 1×10^{-4} (incremental lifetime cancer risk) or if the Hazard Index (HI) is greater than or equal to 1 (common target organ/effect basis), then recommend conducting a Feasibility Study (FS) to evaluate remedial options; otherwise, proceed with development of a decision document to document that no further action is required.

Note: FSs include evaluations of remedies that have the potential to reduce risks for all receptors subject to unacceptable levels of risk. The industrial site worker and hypothetical future resident risks would be included in these FS evaluations.

11.5 PERFORMANCE CRITERIA

The sampling design for this investigation requires selection of shallow groundwater sampling locations that help confirm groundwater flow directions, characterize COC concentrations in groundwater, and

estimate risks to hypothetical future residents from exposure to UXO 32 groundwater. This requires biased sampling. The groundwater sampling depths were selected to support the project objectives. The Project Team, upon review of the data, will determine whether a sufficient amount of data of the appropriate type and quality have been collected to attain the stated objectives. The Project Team will consider the spatial contaminant patterns, groundwater flow directions, and other pertinent factors. The ideal condition will be to conclude that groundwater contamination is delineated when all samples on the sampling pattern perimeter indicate that target analyte concentrations are less than applicable risk-based screening criteria. Full attainment of this ideal condition may not be possible. In this case, the team will evaluate whether scientifically defensible inferences can be made concerning contaminant distributions to support a declaration that contaminant delineation is satisfactory. If contaminant delineation is satisfactory, the team will conclude that enough data are available to conduct a risk assessment. If the risk assessment results are not satisfactorily clear and defensible, the Project Team will evaluate the need for additional data collection to more accurately or precisely estimate the risks.

To support these evaluations, the data quality will be assessed using criteria and processes presented in Worksheet #s 34 through 37. If data quality deficiencies are identified, the Project Team will evaluate the magnitude, frequency, and type of quality deficiencies to determine whether precision, accuracy, or other significant quality deficiencies exist. If identified quality deficiencies are sufficient to cause rejection of data, the Project Team will evaluate whether additional data collection is necessary. The tendency will be to collect additional data as the number, magnitude, and significance of the quality deficiencies increase.

11.6 SAMPLING DESIGN AND RATIONALE

The sampling design is a biased design to ensure that groundwater samples representative of potential receptor exposures are obtained. Details are provided in Worksheet #17.

SAP Worksheet #12 -- Measurement Performance Criteria Table

(UFP-QAPP Manual Section 2.6.2)

Measurement Performance Criteria Table – Field QC Samples

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria (MPCs)	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Trip Blanks	VOCs	One per cooler containing VOC samples	Accuracy/bias/contamination	No analytes $\geq \frac{1}{2}$ Limit of Quantitation (LOQ), except common laboratory contaminants, which must be $< \text{LOQ}$.	S&A
Field Duplicates	VOCS and total metals	One per 10 field samples collected	Precision/contamination bias	Values $> 5X \text{ LOQ}$: Relative Percent Difference (RPD) $\leq 30\%^{1,2}$ (aqueous); $\leq 50\%^{1,2}$ (solid).	S&A
Cooler Temperature Indicators	VOCs	One per cooler	Representativeness	Temperature ≤ 6 degrees Celsius ($^{\circ}\text{C}$).	S

1 – If duplicate values for non-metals are $< 5x \text{ LOQ}$, the absolute difference should be $< 2x \text{ LOQ}$.

2 – If duplicate values for metals are $< 5x \text{ LOQ}$, the absolute difference should be $< 4x \text{ LOQ}$.

SAP Worksheet #13 -- Secondary Data Criteria and Limitations Table

[\(UFP-QAPP Manual Section 2.7\)](#)

Secondary Data	Data Source (originating organization, report title and date)	Data Generator(s) (originating organization, data types, data generation/collection dates)	How Data Will Be Used	Limitations on Data Use
None	NA	NA	NA	No secondary data will be used.

SAP Worksheet #14 -- Summary of Project Tasks

([UFP-QAPP Manual Section 2.8.1](#))

14.1 FIELD INVESTIGATION TASK PLAN

The field tasks are summarized below.

- Mobilization/demobilization
- Utility clearance
- Field monitoring equipment calibration
- Monitoring well installation
- Monitoring well sampling
- Water level measurements
- Investigation-derived waste (IDW) management
- Surveying
- Field equipment decontamination procedures
- Field documentation procedures
- Sample custody and shipment tasks

Additional project-related tasks include:

- Analytical tasks
- Data management
- Assessment and oversight
- Data review
- Project reports

A detailed description of these tasks is provided below.

14.2 FIELD TASKS

Project-specific Standard Operating Procedures (SOPs) for the field tasks are provided in Appendix A.

14.2.1 Mobilization/Demobilization

Mobilization will consist of the delivery of all equipment, materials, and supplies to the site, the complete assembly in satisfactory working order of all such equipment at the site, and the satisfactory storage at the site of all such materials and supplies. Tetra Tech will coordinate with the facility to identify locations for the storage of equipment and supplies and to facilitate acquisition of personnel and vehicle base

access badges. Site-specific health and safety training will be provided to all Tetra Tech site personnel and subcontractors as part of the site mobilization.

Demobilization will consist of the prompt and timely removal of all equipment, materials, and supplies from the site following completion of the work. Demobilization includes the cleanup and removal of IDW generated during the investigation.

14.2.2 Utility Clearance

The deep monitoring well drilling locations proposed for this field investigation will be placed within 5 feet of new shallow wells to be installed by another Navy contractor concurrently to or just prior to this investigation. Tetra Tech will coordinate with the Navy contractor and the NSF-IH to confirm that the utility clearance activities surrounding the shallow wells will include at least a 5-foot area for the deep wells.

14.2.3 Field/Monitoring Equipment Calibration

The field equipment will be calibrated in accordance with procedures provided in Worksheet # 22 or/and SOP-08 (Calibration and Care of Water Quality Meters).

14.2.4 Soil Borings and Lithologic Soil Sampling

Soil samples will be obtained for lithologic purposes from two soil borings using direct- push technology (DPT) dual-tube methods. The proposed soil boring locations are presented on [Figure 9](#). The DPT vehicle will be a track-mounted all-terrain vehicle (ATV). Soil cores will be collected continuously to the target depth at each location by advancing a macrocore sampler (4 or 5 feet long) to the basal clay layer/aquitard (expected at 30 to 35 feet bgs). The macrocore sampler will be withdrawn and the soil will be screened with a photoionization detector (PID) in accordance with the PID manufacturer's instructions and in accordance with SOP-04 (Lithologic Soil Sample Logging). When lithologic soil sampling is completed, the soil borings will be converted to monitoring wells.

14.2.5 Monitoring Well Installation

Two deep monitoring wells will be installed adjacent to existing shallow water table wells to determine groundwater conditions in the deeper portion of the surficial aquifer upgradient of UXO 32. Proposed locations are shown on [Figure 9](#). The proposed monitoring wells will be installed such that the screens are just above the basal clay layer. The monitoring wells will be installed using DPT dual-tube drilling methods and constructed with nominal 1-inch inside diameter pre-packed screens in accordance with

SOP-05 (Monitoring Well Installation), and each of the new monitoring wells will be developed in accordance with SOP-06 (Well Development).

14.2.6 Water Level Measurements

Prior to the start of sampling, and at least 48 hours after well development, a synoptic round of groundwater level measurements will be made in accordance with SOP-12 (Groundwater Levels). The water levels will be collected from existing wells 41MW01, 41MW02, S57MW023, and S57MW035 and new wells 41MW05, 41MW06, 41MW07, 41MW08, 41MW09, 41MW10, 41MW11, and 41MW12. This will provide data for generation of groundwater elevation contour maps and provide information on groundwater flow patterns and gradients. Water level measurements will be completed within the shortest time possible on the same day, and no sooner than 24 hours after a significant precipitation event to minimize precipitation effects on the data.

14.2.7 Groundwater Sampling

Groundwater samples will be collected from 12 monitoring wells using low-flow sampling procedures, in accordance with SOP-09 (Low Flow Purging) and SOP-10 (Groundwater Sampling). Existing wells proposed to be sampled will be inspected to determine their integrity in accordance with SOP-07 (Well Inspection).

14.2.8 IDW Management

Waste soil and water generated during monitoring well installation and groundwater sampling will be handled in accordance with SOP-11 (IDW Management).

14.2.9 Surveying

A surveyor licensed in the State of Maryland will be subcontracted by Tetra Tech to survey the horizontal location and vertical elevation of each of the newly installed monitoring wells. The horizontal measurements will be accurate to 0.1 foot, and the vertical elevation measurements will be accurate to 0.01 foot at the top of each monitoring well riser. Each of the locations will be surveyed in NAD of 1983, State Plane Coordinate System of Maryland (feet) relative to the coordinates of established site benchmarks or the nearest United States Geological Survey benchmark. Elevations will be referenced to Mean Sea level, North American Vertical Datum, 1988.

14.2.10 Field Equipment Decontamination

Decontamination of equipment will be conducted in accordance with SOP-03 (Decontamination). Decontamination fluids will be containerized and characterized for appropriate disposal with other IDW (SOP-11).

14.3 FIELD DOCUMENTATION PROCEDURES

Field documentation will be performed in accordance with the procedures described in this section. A summary of all field activities will be properly recorded in a bound logbook with consecutively numbered pages that cannot be removed. Logbooks will be assigned to field personnel and will be stored in a secured area when not in use. At a minimum, the following information will be recorded in the site logbook:

- Name of the person to whom the logbook is assigned.
- Project name.
- Project start date.
- Names and responsibilities of on-site project personnel including subcontractor personnel.
- Safety briefings.
- Arrival/departure of site visitors.
- Arrival/departure of equipment.
- Sampling activities and sample log sheet references.
- Description of subcontractor activities.
- Sample pick-up information, including chain-of-custody numbers, air bill numbers, carrier, time, and date.
- Descriptions of borehole or monitoring well installation activities and operations.
- Health and safety issues.

All entries will be written in indelible ink, and no erasures will be made. If an incorrect entry is made, striking a single line through the incorrect information will make the correction, and the person making the correction will initial and date the change. Boring logs, sampling forms, and other field forms will be used to document field activities.

14.4 SAMPLE COLLECTION DOCUMENTATION, HANDLING, TRACKING AND CUSTODY PROCEDURES

The following sections outline the procedures that will be used to document sample collection, handling, tracking, preservation, and custody procedures. Detailed and accurate documentation is necessary to ensure data integrity, authenticity, and defensibility.

14.4.1 Sample Collection Documentation

Samples will be labeled in accordance to SOP-01 (Sample Labeling). The sample identification nomenclature is provided in SOP-02 (Sample ID Nomenclature). The equipment used to collect each sample will be noted in the logbook. QC sample information will also be recorded in the logbook. The date and time of sampling, sampler's name, sample description, depth at which the sample was collected, depth to water, and the volume and number of containers collected will be documented on the sample log sheet (SOP-10). All instruments used to make measurements will be identified, along with the date of calibration.

The following standard log sheets will be used to record sampling data:

- Groundwater sample log
- Soil boring log
- Chain-of-custody record

Log sheets will include entries in every blank, with appropriate use of the abbreviations NA (not applicable) and NR (not recorded). All "NR" entries should be accompanied by an explanation. All entries on log sheets will be recorded in waterproof ink and signed and dated by the person making the entry. No erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark, the correct entry recorded, and the change initialed and dated by the person making the correction.

14.4.2 Sample Handling and Tracking System

The following subsections outline the procedures that will be used by field and laboratory personnel to document sample collection activities during the sampling event. Detailed and accurate documentation is necessary to ensure data integrity. For further guidance regarding the general sampling handling process from collection to laboratory disposal, refer to Worksheet #26, Sample Handling System.

14.4.3 Field Sample Custody Procedures

Following sample collection into the appropriate bottleware, all samples will be immediately placed on ice in a cooler. The glass sample containers will be enclosed in bubble wrap to protect bottleware during shipment. The cooler will be secured using strapping or clear packaging tape along with a signed custody seal. Sample coolers will be delivered to a local courier location for priority overnight delivery to the selected laboratory for analysis. Samples will be preserved as appropriate based on the analytical

method. Laboratories will provide pre-preserved sample containers for sample collection. Samples will be maintained at 4° C until delivery to the laboratory. Chain-of-custody protocols (described in Section 14.4.3.2) will be used throughout sample handling to establish the evidentiary integrity of sample containers. These protocols will be used to demonstrate that the samples were handled and transferred in a manner that would eliminate possible tampering.

14.4.3.1 Sample Delivery

The shipment of samples to the laboratory will be made by a shipping courier service (e.g., FedEx), unless the laboratory is close enough to the site to provide a pickup service. After samples have been collected, they will be sent to the laboratory within a reasonable time depending on the analyte holding time. Under no circumstances will sample holding times be exceeded.

14.4.3.2 Sample Custody

Chain-of-custody forms document sample possession and hence the integrity of a sample from collection through analysis and also provide assurance that data can confidently be related to the corresponding samples. Chain of custody begins at the time of sample collection.

A sample is under custody if:

- The sample is in the physical possession of an authorized person.
- The sample is in view of an authorized person after being in his/her possession.
- The sample is placed in a secure area by an authorized person after being in his/her possession.
- The sample is in a secure area, restricted to authorized personnel only.

A multi-part chain-of-custody form provided by the laboratory or Tetra Tech will be used. Each page of the form is signed and dated by the recipient of a sample or portion of a sample. The person releasing the sample and the person receiving the sample will each retain a copy of the form each time a sample transfer occurs.

Integrity of the samples collected during the site investigation will be the responsibility of identified persons from the time the samples are collected until the samples, or their derived data, are incorporated into the analytical report.

The FOL is responsible for the care and custody of the samples collected until they are delivered to the laboratory or are entrusted to a shipping courier. When transferring samples, the individuals relinquishing and receiving the samples will each sign the chain-of-custody form, and the date and time will be recorded to document the sample custody transfer from the sampler to the shipping courier and finally to

the laboratory. Upon arrival at the laboratory, internal sample custody procedures will be followed as defined in the laboratory SOPs included in [Appendix B](#).

14.5 ADDITIONAL PROJECT-RELATED TASKS

14.5.1 Analytical Tasks

Chemical analyses will be performed at Empirical Laboratories. Analyses will be performed in accordance with the analytical methods identified in Worksheet # 30. Project Screening Levels (PSLs) and Project Action Levels (PALs) for the target analytes specified in Worksheet # 15 will be met, with the exceptions noted in Worksheet #15footnotes. The laboratory will perform the chemical analyses following laboratory-specific SOPs (see Worksheet #s 19 and 23) that were developed based on the methods listed in Worksheet #s 19 and 30. Copies of laboratory SOPs that will be used for this project are included in [Appendix B](#).

14.5.2 Data Management

After the field investigation is completed, the field sampling log sheets will be organized by date and medium and filed in the project files. The field logbooks for this project will be used only for UXO 32 and will also be categorized and maintained in the project files after completion of the field program. Project personnel completing concurrent field sampling activities may maintain multiple field logbooks. When possible, logbooks will be segregated by sampling activity. The field logbooks will be titled on the basis of date and activity.

The data-handling procedures to be followed by the laboratory will meet the requirements of the laboratory technical specification. The laboratory electronic data will be automatically uploaded into the Tetra Tech database in accordance with proprietary Tetra Tech processes.

The Tetra Tech PM (or designee) is responsible for the overall tracking and control of data generated for the project, including the following:

- **Data Tracking** – Data are tracked from generation to archiving in the Tetra Tech project-specific files. The Tetra Tech Project Chemist (or designee) is responsible for tracking the samples collected and shipped to the laboratory. Upon receipt of the data packages from the laboratory, the Tetra Tech Project Chemist oversees the data validation effort, which includes verifying that the data packages are complete and that results for all samples have been delivered by the laboratory.
- **Data Storage, Archiving, and Retrieval** – The data packages received from the laboratory are tracked in the data validation logbook. After the data are validated under the oversight of the Tetra Tech

DVM, the data packages are entered into the Tetra Tech Navy CLEAN file system and archived in secure files. The field records including field logbooks, sample log sheets, chain-of-custody records, and field calibration logs are submitted by the Tetra Tech FOL to be entered into the Navy CLEAN file system prior to archiving in secure project files. The project files are audited for accuracy and completeness. At the completion of the Navy contract, the records are stored by Tetra Tech and ultimately sent to NAVFAC. Electronic data are loaded by Tetra Tech into the Naval Installation Restoration Information Solution (NIRIS) database after they are validated.

- **Data Security** – The Tetra Tech project files are restricted to designated personnel only. Records can only be borrowed temporarily from the project file using a sign-out system. The Tetra Tech Data Manager maintains the electronic data files. Access to the data files is restricted to qualified personnel only. File and data backup procedures are routinely performed.

Laboratory data package deliverables are described in the analytical specifications, data assessment documents and records are listed in Worksheet #29, and data recording formats are described in Worksheet #27.

14.5.3 Assessment and Oversight

Refer to Worksheet #32 for requirements governing assessment and corrective actions and to Worksheet #33 for QA management reports.

14.5.4 Data Review

Data verification requirements are described in Worksheet #34, data validation requirements are described in Worksheet #s 35 and 36, and data usability assessment requirements are described in Worksheet #37.

14.5.5 Project Report

A Groundwater RI Report will be prepared and submitted to the Navy and regulators (i.e., the Project Team) for review. The report will include a summary of the work performed in accordance the approved UFP-SAP, field modifications as documented by the Tetra Tech FOL, summary and analysis of the analytical results, updated CSM, baseline human health risk assessment, and conclusions and/or recommendations for the site.

Tetra Tech will respond to comments received on the draft report. The final version of the report will be submitted in hardcopy and electronic format to the project team.

SAP Worksheet #15 -- Reference Limits and Evaluation Table

(UFP-QAPP Manual Section 2.8.1)

Matrix: Groundwater

Analytical Group: Select VOCs and total metals

PALs for all matrices:

- Carcinogenic PAL = Incremental Lifetime Cancer Risk > 1×10^{-4}
- Non-carcinogenic (for chemicals affecting the same target organ) PAL = HI > 1

Chemical/Analyte	CAS Number	PSLs			Selected PSL ⁽⁴⁾⁽⁸⁾	PSL Reference ⁽⁵⁾	Project Quantitation Limit Goal ⁽⁶⁾	Empirical Laboratories, LLC ⁽⁷⁾		
		EPA Tapwater RSL ⁽¹⁾	Federal MCL ⁽²⁾	Residential RSL-Based Vapor Intrusion Screening Value ⁽³⁾				LOQ	LOD	DL
VOCs (µg/L)										
cis-1,2-Dichloroethene	156-59-2	7.3	70	371	7.3	EPA RSL	2	1.00	0.50	0.25
trans-1,2-Dichloroethene	156-60-5	11	100	371	11	EPA RSL	4	1.00	0.50	0.25
Tetrachloroethene	127-18-4	0.11	5	0.6	0.11	EPA RSL	0.04	0.50	0.25	0.10
Trichloroethene	79-01-6	2	5	3	2	EPA RSL	0.7	1.00	0.50	0.25
Vinyl Chloride	75-01-4	0.016	2	0.15	0.016	EPA RSL	0.005	1.00	0.50	0.25
Total Metals (µg/L)										
Total Arsenic	7440-38-2	0.045	10	<i>none</i>	0.045	EPA RSL	0.02	2.5	1.5	0.75
Total Cobalt⁽⁹⁾	7440-48-4	1.1	<i>none</i>	<i>none</i>	1.1	EPA RSL	0.4	3.125	2.5	0.80
Total Beryllium	7440-41-7	7.3	4	<i>none</i>	4	MCL	1.3	1.25	0.5	0.25 ⁽⁹⁾

µg/L – Micrograms per liter. CAS – Chemical Abstracts Service. LOD – Limit of Detection. DL – Detection limit.

Project-Specific SAP

Site Name/Project Name: UXO 32/Groundwater RI

Site Location: NSF Indian Head, Maryland

Title: SAP for UXO 32 (Site 41)

Revision Number: 0

Revision Date: June 2011

Note: In three of the four cases where the LOQ exceeds the PSL, the DL is less than or within 50 percent of, the PSL; therefore, data usability is not expected to be adversely affected. The target analytes will be detectable if not quantifiable. By including the analytes on the TCL and striving to quantify as low a concentration as possible with conventional analytical methods, the Project Team ensures that gross contamination will not be overlooked even though the PSL is less than the LOQ. Bold and shaded rows indicate that the PSL is less than the corresponding LOD. Additional scrutiny will be applied to all data with LOQs greater than the selected PSL to ensure that unacceptable risks are not potentially overlooked.

1. USEPA November 2010 Regional Screening Levels (RSLs) for tapwater. RSLs based on non-carcinogenic effects have been divided by 10 to account for exposure to multiple constituents.
2. Federal MCLs per National Primary Drinking Water Regulations.
3. Vapor Intrusion screening values for groundwater calculated using the USEPA (December 2009) RSLs for indoor air and methodology detailed in Appendix D of the USEPA (2002) Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils.
4. Selected PAL is the lowest (most conservative) of the evaluated PSLs.
5. PAL references indicate the source of the selected PSL from the evaluated PSL list (see Notes 1 through 4 above), or if the PAL is selected as a Performance Indicator Level (PIL) determined for chemicals and analytes in the "OTHER" category. The OTHER chemicals and analytes provide information about the aquifer conditions and have no inherent risk (except for nitrate, which has a USEPA RSL of 5,800 µg/L and MCL of 10,000 µg/L; however, the preferred PSL/PIL for nitrate is 1,000 µg/L to evaluate natural biodegradation potential in the aquifer). (Aluminum, chloride, copper, iron, manganese, silver, sulfate, and zinc have federal Secondary Drinking Water Standards, which are not evaluated herein).
6. Project Quantitation Limit (PQL) Goal is set at one-third the PSL.
7. The Laboratory LOQs, LODs, and DLs from the subcontracted laboratory are presented and are current as of January 2011. The LOQs, LODs and DLs are subject to change. The actual limits will be evaluated during the data usability assessment to ensure that the actual LOQs, LODs, and DLs are satisfactory to support the data evaluations.
8. Samples to be concentrated four times. This sample technique is referenced in USEPA Method 200.7. SW-846 sample preparation techniques will be used (3005/3010).
9. The NSF-IH specific background level for cobalt in groundwater (15.6 µg/L) will be used in the risk evaluation as necessary (see Section 11.2). Background groundwater levels are not available for TCE, arsenic, or beryllium.

SAP Worksheet #16 -- Project Schedule/Timeline Table (optional format)

[\(UFP-QAPP Manual Section 2.8.2\)](#)

Activity	Organization	Dates (MM/DD/YY)		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
DQO Meeting	Tetra Tech	02/07/2011	02/07/2011	NA	NA
Draft UFP-SAP	Tetra Tech	02/08/2011	04/11/2011	Draft UFP SAP	04/11/2011
Final UFP-SAP	Tetra Tech	05/02/2011	05/06/2011	Final UFP SAP	05/06/2011
Field Work – Groundwater Sampling	Tetra Tech	05/09/2011	05/13/2011	NA	05/13/2011
Draft RI Report	Tetra Tech	TBD	TBD	Draft RI Report	TBD
Final RFI Report	Tetra Tech	TBD	TBD	Final FI Report	TBD

SAP Worksheet #17 -- Sampling Design and Rationale

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

To further characterize groundwater contamination at UXO 32 and the potential risks associated with exposure to shallow groundwater, existing monitoring wells will be sampled and new monitoring wells will be installed and sampled. Analyses to be performed are presented in Worksheets #s15 and 18. To augment the existing well network, eight monitoring wells are proposed for installation, including six shallow (water table) wells and two deep wells. The selection of well locations, which includes wells upgradient of UXO 32, was based on filling data gaps regarding groundwater flow directions, COC concentrations in groundwater, and the potential for COC contamination sources in groundwater other than UXO 32 to be affecting UXO 32 groundwater quality. Wells upgradient of UXO 32 are designed to detect contamination from sources other than UXO 32, whereas wells downgradient of UXO 32 are sited to detect contamination that is from UXO 32 and other possible contaminant sources. Data from these two groups of wells will be useful for identifying contaminants attributable to UXO 32 alone, if contaminants are detected both upgradient and downgradient of UXO 32. Well locations and screened intervals were also selected to represent potentially contaminated and uncontaminated groundwater so as to establish the extent of contamination and to represent groundwater to which the potential human health receptors could be exposed. Ecological receptors are not exposed to groundwater; therefore, ecological risk evaluation was not a consideration for this investigation.

Following installation, the wells will be sampled and analyzed for site-specific COCs and also a biodegradation parent compound (PCE) and potential TCE degradation products. These additional data will support an evaluation of the viability of natural TCE degradation and to more definitively establish the nature of UXO 32-related contamination.

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

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

UXO 32
TABLE 18.1

Sampling Location	ID Number	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
41MW01	S41GW01mmyy	Groundwater	8.5 – 18.5	Select TCL VOCs (see Worksheet #15), total arsenic, beryllium, and cobalt	1	SOP-01, SOP-02, SOP-03, SOP-08, SOP-09, and SOP-10
41MW02	S41GW02mmyy	Groundwater	4.0 – 14.0	Select TCL VOCs (see Worksheet #15), total arsenic, beryllium, and cobalt	1	SOP-01, SOP-02, SOP-03, SOP-08, SOP-09, and SOP-10
41MW05 ⁽¹⁾	S41GW05mmyy	Groundwater	5 - 15	Select TCL VOCs (see Worksheet #15), total arsenic, beryllium, and cobalt	1	SOP-01, SOP-02, SOP-03, SOP-08, SOP-09, and SOP-10
41MW06 ⁽¹⁾	S41GW06mmyy	Groundwater	5 - 15	Select TCL VOCs (see Worksheet #15), total arsenic, beryllium, and cobalt	1	SOP-01, SOP-02, SOP-03, SOP-08, SOP-09, and SOP-10
41MW07 ⁽¹⁾	S41GW07mmyy	Groundwater	10 - 20	Select TCL VOCs (see Worksheet #15), total arsenic, beryllium, and cobalt	1	SOP-01, SOP-02, SOP-03, SOP-08, SOP-09, and SOP-10
41MW08 ⁽¹⁾	S41GW08mmyy	Groundwater	5 - 15	Select TCL VOCs (see Worksheet #15), total arsenic, beryllium, and cobalt	1	SOP-01, SOP-02, SOP-03, SOP-08, SOP-09, and SOP-10
41MW09 ⁽¹⁾	S41GW09mmyy	Groundwater	12 - 22	Select TCL VOCs (see Worksheet #15), total arsenic, beryllium, and cobalt	1	SOP-01, SOP-02, SOP-03, SOP-08, SOP-09, and SOP-10
41MW10 ⁽¹⁾	S41GW10mmyy	Groundwater	10 - 20	Select TCL VOCs (see Worksheet #15), total arsenic, beryllium, and cobalt	1	SOP-01, SOP-02, SOP-03, SOP-08, SOP-09, and SOP-10

Sampling Location	ID Number	Matrix	Depth (feet bgs)	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference
41MW11 ⁽¹⁾	S41GW11mmyy	Groundwater	20 - 30	Select TCL VOCs (see Worksheet #15), total arsenic, beryllium, and cobalt	1	SOP-01, SOP-02, SOP-03, SOP-08, SOP-09, and SOP-10
41MW12 ⁽¹⁾	S41GW12mmyy	Groundwater	20 -30	Select TCL VOCs (see Worksheet #15), total arsenic, beryllium, and cobalt	1	SOP-01, SOP-02, SOP-03, SOP-08, SOP-09, and SOP-10
S57MW023	S57GW023mmyy FDddmmyy01	Groundwater	10 - 20	Select TCL VOCs (see Worksheet #15), total arsenic, beryllium, and cobalt	2 (field duplicate)	SOP-01, SOP-02, SOP-03, SOP-08, SOP-09, and SOP-10
S57MW035	S57GW035mmyy FDddmmyy02	Groundwater	22 - 32	Select TCL VOCs (see Worksheet #15), total arsenic, beryllium, and cobalt	2 (field duplicate)	SOP-01, SOP-02, SOP-03, SOP-08, SOP-09, and SOP-10
IDW water	IDWddmmyy02	IDW water	NA	Select TCL VOCs (see Worksheet #15), total arsenic, beryllium, and cobalt	1 ⁽²⁾	SOP-01, SOP-02, and SOP-11
IDW soil	DWddmmyy01	IDW Drill cuttings	NA	TCLP inorganics and organics	1 ⁽²⁾	SOP-01, SOP-02, and SOP-11

1 Depths are estimated for proposed new wells, the actual depths may vary based on site conditions. Shallow well screens will be placed across the first water-bearing zone (i.e., water table wells), and deep well screens will be installed just above the basal clay unit at approximately 5 feet below sea level in elevation.

2 Sample will be a composite from multiple drums if more than one drum of waste per matrix is generated.

SAP Worksheet #19 -- Analytical SOP Requirements Table

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

Matrix	Analytical Group	Analytical and Preparation Method/ SOP Reference	Sample Size	Containers (number, size, and type)	Preservation Requirements	Maximum Holding Time (preparation/analysis)
Groundwater and aqueous QC samples	VOCs	SW-846 5030/8260B, Empirical SOP-202	5 mL	Three 40-milliliter (mL) glass vials	Hydrochloric acid (HCl) to pH<2; Cool to ≤ 6 °C; no headspace	14 days to analysis
Groundwater	Total arsenic, beryllium and cobalt	SW-846 3010A/6010C, Empirical SOP-100/105	50 mL	One 500-mL plastic bottle	Nitric acid to pH <2; Cool to ≤ 6 °C	180 days to analysis

SAP Worksheet #20 -- Field Quality Control Sample Summary Table

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

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equip. Blanks	No. of VOA Trip Blanks	No. of PT Samples	Total No. of Samples to Lab
Groundwater	VOCs	12	2	1	0	0	1 ¹	0	16
	Arsenic, beryllium and cobalt	12	2	1	0	0	0	0	15

1 One per cooler.

MS/MSD – Matrix spike/matrix spike duplicate.

VOA - Volatile organic analyte.

PT – Performance Testing.

SAP Worksheet #21 -- Project Sampling SOP References Table

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

Reference Number	Title, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
SOP-01	Sample Labeling Rev. 0, February 2011	Tetra Tech	NA	N	Project-specific SOP included in Appendix A
SOP-02	Sample Nomenclature Rev. 0, February 2011	Tetra Tech	NA	N	Project-specific SOP included in Appendix A
SOP-03	Decontamination of Field Equipment Rev. 0, February 2011	Tetra Tech	Decontamination equipment (scrub brushes, phosphate free detergent, de-ionized water)	N	Project-specific SOP included in Appendix A
SOP-04	Sample Logging, Rev 0, February 2011	Tetra Tech	NA	N	Project-specific SOP included in Appendix A
SOP-05	Monitoring Well Installation, Rev. 0, February 2011	Tetra Tech	NA	N	Project-specific SOP included in Appendix A
SOP-06	Monitoring Well Development, Rev. 0, February 2011	Tetra Tech	Surge blocks, pumps, bailers	N	Project-specific SOP included in Appendix A
SOP-07	Monitoring Well Inspection, Rev. 0, February 2011	Tetra Tech	NA	N	Project-specific SOP included in Appendix A
SOP-08	Calibration and Care of Water Quality Meters, Rev. 0, February 2011	Tetra Tech	YSI multiparameter instruments and turbidity meters	N	Project-specific SOP included in Appendix A
SOP-09	Low-Flow Well Purging and Stabilization, Rev. 0, February 2011	Tetra Tech	YSI multiparameter instruments and turbidity meters	N	Project-specific SOP included in Appendix A
SOP-10	Groundwater Sampling, Rev. 0, February 2011	Tetra Tech	Pumps, YSI multiparameter instruments, and turbidity meters	N	Project-specific SOP included in Appendix A
SOP-11	Management of Investigation-Derived Waste Rev. 0, February 2011	Tetra Tech	NA	N	Project-specific SOP included in Appendix A
SOP-12	Measurement of Water Levels in Monitoring Wells, Rev. 0, February 2011	Tetra Tech	Electronic water level meter	N	Project-specific SOP included in Appendix A
CT-05 ⁽¹⁾	Database Records and Quality Assurance Rev. 2, January 29, 2001	Tetra Tech	NA	N	SOP included in Appendix A
DV-02 ⁽¹⁾	Data Validation – Non-CLP Organics for Solid Matrices, Rev. 0, August 13, 2001	Tetra Tech	NA	N	SOP included in Appendix A
DV-04 ⁽¹⁾	Data Validation – Non-CLP Inorganics for Solid and Aqueous Matrices	Tetra Tech	NA	N	SOP included in Appendix A

Project-Specific SAP

Site Name/Project Name: UXO 32/Groundwater RI

Site Location: NSF Indian Head, Maryland

Title: SAP for UXO 32 (Site 41)

Revision Number: 0

Revision Date: June 2011

Reference Number	Title, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
	Rev. 0, August 13, 2001				

1 Tetra Tech SOPs are currently in review. Tetra Tech will review, update, or revise these SOPs on a periodic basis. (e.g., every 2 to 3 years).

NA – Not applicable

CLP – Contract Laboratory Program.

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

(UFP-QAPP Manual Section 3.1.2.4)

Field Equipment	Activity ⁽¹⁾	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference ⁽²⁾	Comments
Water Quality Meter	Visual inspection Calibration/ verification	Daily Beginning and end of day	Manufacturer's guidance	Operator correction or Replacement	FOL	SOP-09	None
Turbidity Meter	Visual inspection Calibration/ verification	Daily Beginning and end of day	Manufacturer's guidance	Operator correction or Replacement	FOL	SOP-09	None
Water Level Indicator	Visual inspection Field checks as per manufacturer	Daily Once upon receiving from vendor	0.01 foot accuracy	Operator correction or Replacement	FOL	SOP-12	None
PID	Visual inspection Calibration/ verification	Daily Beginning and end of day	Manufacturer's guidance	Operator correction or Replacement	FOL	Operation according to manufacturer's instructions	None

1 Activities may include calibration, verification, testing, maintenance, and/or inspection.

2 Specify the appropriate reference letter or number from the Project Sampling SOP References table (Worksheet #21).

Field Equipment	Activity ⁽¹⁾	Frequency	Acceptance Criteria	Corrective Action	Resp. Person	SOP Reference ⁽²⁾	Comments
DPT Rig	Inspection	Daily	Equipment inspection sheet criteria.	Replace	Tetra Tech FOL or designee	NA, HASP	located in HASP

1 Activities may include calibration, verification, testing, maintenance, and/or inspection.

2 Specify the appropriate reference letter or number from the Project Sampling SOP References table (Worksheet #21).

SAP Worksheet #23 -- Analytical SOP References Table

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

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work? ⁽¹⁾
Empirical SOP-100	Metals Digestion/ Preparation, Methods 3005A/ USEPA CLP ILMO 4.1 Aqueous, 3010A, 3030C, 3050B, USEPA CLP ILMO 4.1 (Soil/Sediment), 200.7, Standard Methods 3030C (Revision 20, 04/27/10)	Definitive	Groundwater, and aqueous QC samples/ Arsenic, Beryllium and Cobalt Digestion	None/Preparation	Empirical	Yes – 4x concentration for beryllium
Empirical SOP-105	Metals by Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES) Technique, SW-846 Methods 6010B, 6010C, USEPA Method 200.7, Standard Methods 19 th Edition 2340B, USEPA CLP ILMO 4.1 (Revision 16, 04/11/10)	Definitive	Groundwater, and aqueous QC samples/ Arsenic, Beryllium and Cobalt	ICP-AES	Empirical	N
Empirical SOP-202	Gas Chromatography/Mass Spectroscopy (GC/MS) Volatiles using USEPA Method 624 and SW846 Method 8260B, Including Appendix IX Compounds (Revision 23, 09/09/10)	Definitive	Groundwater, and aqueous QC samples/ VOCs	GC/MS	Empirical	N

SAP Worksheet #24 -- Analytical Instrument Calibration Table

(UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference ⁽¹⁾
GC/MS VOCs	Bromofluorobenzene (BFB) Tune	Prior to each Initial Calibration (ICAL) and at the beginning of each 12-hour period.	Must meet the ion abundance criteria required by the method (SW8260B; Section 7.3.1; Table 4).	Retune and/or clean or replace source. No samples may be accepted without a valid tune.	Analyst/ Supervisor	Empirical SOP-202
	ICAL – a minimum of a 5-point calibration is prepared for all target analytes	Upon instrument receipt, for major instrument changes, or when continuing calibration verification (CCV) does not meet criteria.	The average response factor (RF) for System Performance Check Compounds (SPCCs) must be ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane, ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. The percent relative standard deviation (%RSD) for RFs for calibration check compounds (CCCs) must be $\leq 30\%$; and %RSD for each target analyte must be $\leq 15\%$, or the linear regression correlation coefficient (r) must be ≥ 0.995 ; or the coefficient of determination (r^2) must be ≥ 0.99 (six points are required for second order).	Correct problem then repeat ICAL. No samples may be run until ICAL has passed.	Analyst/ Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference ⁽¹⁾
	Retention Time (RT) Window Position Establishment	Once per ICAL for each analyte and surrogate.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	NA.	Analyst / Supervisor	
	Evaluation of Relative Retention Times (RRTs)	With each sample.	RRT of each target analyte must be within ± 0.06 RRT units.	Correct problem, then rerun ICAL.	Analyst / Supervisor	
	Initial Calibration Verification (ICV) – Second Source	Once after each ICAL, prior to beginning a sample run.	The percent recovery (%R) for all target analytes must be within 80-120% of true values.	Correct problem and verify ICV. If that fails, correct problem and repeat ICAL. No samples may be run until ICV has been verified.	Analyst/ Supervisor	
	CCV	Perform one per 12-hour analysis period after tune and before sample analysis.	The minimum RF for SPCCs must be ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane, ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. The percent difference or percent drift (%D) for all target analytes and surrogates must be $\leq 20\%$.	Correct problem and rerun CCV. If that fails, repeat ICAL and reanalyze all samples analyzed since the last successful CCV.	Analyst/ Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference ⁽¹⁾
ICP-AES Arsenic, Beryllium, and Cobalt	ICAL - a one-point calibration per manufacturer's guidelines is prepared for all target analytes	At the beginning of each day, or if the QC is out of criteria, prior to sample analysis.	None; only one high standard and a calibration blank must be analyzed. If more than one calibration standard is used, r must be ≥ 0.995 .	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data.	Analyst/ Supervisor	Empirical SOP- 100/105
	ICV – Second Source	Following ICAL, prior to the analysis of samples.	The %R of all target analytes must be within 90-110% of true value.	Investigate reasons for failure, reanalyze once. If still unacceptable, correct problem and repeat ICAL.	Analyst/ Supervisor	
	CCV	At the beginning and end of the sequence and after every 10 samples.	The %R of all target analytes must be within 90-110% of true value.	Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze all affected samples.	Analyst/ Supervisor	
	Initial Calibration Blank (ICB)	Before beginning a sample sequence.	No target analytes detected > LOD.	Correct the problem, then re-prepare and reanalyze.	Analyst/ Supervisor	
	Continuing Calibration Blank (CCB)	After the initial CCV, after every 10 samples, and at the end of the sequence.	No target analytes detected > LOD.	Correct the problem, then re-prepare and reanalyze calibration blank and all affected samples.	Analyst/ Supervisor	
	Low-Level Check Standard (if using one-point ICAL)	Daily after one-point ICAL and before samples.	The %R of all target analytes must be within 80-120% of true value.	Investigate and perform necessary equipment maintenance. Recalibrate and reanalyze all affected samples.	Analyst/ Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference ⁽¹⁾
	Interference Check Standards (ICS – ICS A and ICS B)	At the beginning of an analytical run.	The absolute value of ICS A recoveries for non-spiked analytes must be < LOD; and ICS B recoveries must be within 80-120 %R of true value.	Terminate analysis; locate and correct problem; reanalyze ICS.	Analyst/Supervisor	

- 1 Laboratory SOPs are subject to revision and updates during duration of the project; the laboratory will use the most current revision of the SOP at the time of analysis.

SAP Worksheet #25 -- Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table
 (UFP-QAPP Manual Section 3.2.3)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action (CA)	Responsible Person	SOP Reference
GC/MS	Check pressure and gas supply daily. Bake out trap and column, manual tune if BFB not in criteria, change septa as needed, cut column as needed, change trap as needed. Other maintenance specified in laboratory Equipment Maintenance SOP.	VOCs	Ion source, injector liner, column, column flow, purge lines, purge flow, trap.	Prior to ICAL and/or as necessary.	Acceptable ICAL and CCV.	Correct the problem and repeat ICAL or CCV.	Analyst/ Supervisor	Empirical SOP-202

Project-Specific SAP

Site Name/Project Name: UXO 32/Groundwater RI

Site Location: NSF Indian Head, Maryland

Title: SAP for UXO 32 (Site 41)

Revision Number: 0

Revision Date: June 2011

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action (CA)	Responsible Person	SOP Reference
ICP-AES	Clean torch assembly and spray chamber when discolored or when degradation in data quality is observed. Clean nebulizer, check argon, and replace peristaltic pump tubing as needed. Other maintenance specified in laboratory Equipment Maintenance SOP.	Arsenic, Beryllium and Cobalt	Torch, nebulizer chamber, pump, pump tubing.	Prior to ICAL and as necessary.	Acceptable ICAL and CCV.	Correct the problem and repeat ICAL or CCV.	Analyst, Department Manager	Empirical SOP-100/105

SAP Worksheet #26 -- Sample Handling System

(UFP-QAPP Manual Appendix A)

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): FOL or designee / Tetra Tech
Sample Packaging (Personnel/Organization): FOL or designee / Tetra Tech
Coordination of Shipment (Personnel/Organization): FOL or designee / Tetra Tech
Type of Shipment/Carrier: Overnight courier service (FedEx)
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Custodian / Empirical
Sample Custody and Storage (Personnel/Organization): Sample Custodian / Empirical
Sample Preparation (Personnel/Organization): Preparation laboratory staff / Empirical
Sample Determinative Analysis (Personnel/Organization): Laboratory analysts / Empirical
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 60 days from submittal of final report
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 60 days from submittal of final report
Biological Sample Storage (No. of days from sample collection): Not applicable
SAMPLE DISPOSAL
Personnel/Organization: Sample Custodian / Empirical

SAP Worksheet #27 – Sample Custody Requirements Table

[\(UFP-QAPP Manual Section 3.3.3\)](#)

27.1 FIELD SAMPLE NOMENCLATURE, DOCUMENTATION, HANDLING, AND TRACKING

The laboratory will provide pre-preserved sample containers for sample collection. Tetra Tech personnel will collect the samples. The samplers will take care not to contaminate samples through improper handling. Refer to Worksheet #14, Sections 14.3 and 14.4, for detailed procedures regarding field sample custody, nomenclature, documentation, handling, and tracking.

27.2 LABORATORY CUSTODY PROCEDURES

Laboratory sample custody procedures (receipt of samples, archiving, and disposal) will be used according to Empirical SOPs. Coolers are received and checked for proper temperature and preservation. A sample cooler receipt form will be filled out to note conditions and any discrepancies. The chain-of-custody form will be checked against the sample containers for accuracy. Samples will be logged into the Laboratory Information Management System (LIMS) and given a unique log number which can be tracked through processing. The Laboratory PM will notify the Tetra Tech FOL verbally or via e-mail of any problems on the same day that an issue is identified.

SAP Worksheet #28.1 -- Laboratory QC Samples Table

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

Matrix: Groundwater and Aqueous QC Blanks

Analytical Group: VOCs

Analytical Method/SOP Reference: SW-846 8260B / Empirical SOP-202

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	DQIs	MPCs
Method Blank	One per preparatory batch of 20 or fewer samples	All target analytes must be $\leq \frac{1}{2}$ LOQ, except common lab contaminants, which must be < LOQ.	Investigate source of contamination and rerun method blank prior to analysis of samples, if possible. Evaluate the samples and associated QC, if blank results are above LOQ, then report sample results that are <LOQ or >10X the blank concentration. Re-prepare and reanalyze blank and those samples that were >LOQ and <10X the blank.	Analyst, Supervisor, Data Validator	Bias/Contamination	Same as QC Acceptance Limits
Laboratory Control Sample (LCS)	One per preparatory batch of 20 or fewer samples of similar matrix	%Rs must meet the DoD Quality Systems Manual (QSM) Version 4.1 limits as per Appendix G of the DoD QSM.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Contact Client if samples cannot be reprepared within hold time.	Analyst, Supervisor, Data Validator	Accuracy/Bias	Same as QC Acceptance Limits

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	Corrective Action (CA)	Person(s) Responsible for CA	DQIs	MPCs
MS/MSD	One per preparatory batch of 20 or fewer samples of similar matrix	%Rs must meet the DoD Quality Systems Manual (QSM) Version 4.1 limits as per Appendix G of the DoD QSM. The RPD between MS and MSD should be $\leq 30\%$.	CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met unless RPDs indicate obvious extraction/analysis difficulties, then re-prepare and reanalyze MS/MSD.	Analyst, Supervisor, Data Validator	Accuracy/Bias / Precision	Same as QC Acceptance Limit
Internal Standards (ISs)	Every field sample, standard, and QC sample - three per sample- Fluorobenzene Chlorobenzene-d5 1,4-dichlorobezene-d4	RTs must be within ± 30 seconds and the response areas must be within -50% to +100% of the ICAL midpoint standard for each IS.	Inspect mass spectrometer and gas chromatograph for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst, Supervisor, Data Validator	Accuracy	Same as QC Acceptance Limits
Surrogates	All field and QC samples - four per sample- Dibromofluoro-methane 1,2-dichloroethane-d4 Toluene-d8 BFB	%Rs must meet the DoD QSM Version 4.1 limits as per Appendix G of the DoD QSM.	If sample volume is available, then re-prepare and reanalyze sample for confirmation of matrix interference when appropriate.	Analyst, Supervisor, Data Validator	Accuracy/Bias	Same as QC Acceptance Limits
Results between DL and LOQ	NA	Apply "J" qualifier to results detected between DL and LOQ.	None	Analyst, Supervisor, Data Validator	Accuracy	Same as QC Acceptance Limits

SAP Worksheet #28.2 -- QC Samples Table
[\(UFP-QAPP Manual Section 3.4\)](#)

Matrix: Groundwater and Aqueous QC Blanks

Analytical Group: Total Arsenic, Beryllium, and Cobalt

Analytical Method/SOP Reference: SW-846 6010C, Empirical SOP105

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQIs	MPCs
Method Blank	One per preparatory batch of 20 or fewer samples of similar matrix	All target analytes must be $\leq \frac{1}{2}$ LOQ.	Reanalyze to confirm the positive value. Notify the PM for further action. Re-prepare the samples associated with the Blank. Noncompliance report will be required for data reported	Analyst, Supervisor, Data Validator	Accuracy/Bias	Same as QC Acceptance Limits
LCS	One per preparatory batch of 20 or fewer samples of similar matrix	%R must be within 80-120%.	Evaluate and reanalyze, if possible. If the LCS recoveries are high, but the sample results are < LOQ, then narrate. Otherwise, redigest and reanalyze all associated samples for failed target analyte(s).	Analyst, Supervisor, Data Validator	Accuracy/Bias	Same as QC Acceptance Limits
MS	One per preparatory batch of 20 or fewer samples of similar matrix	%R should be within 80-120% (if sample is < 4x spike added).	Flag results for affected analytes for all associated samples with "N".	Analyst, Supervisor, Data Validator	Accuracy/Bias	Same as QC Acceptance Limits
Sample Duplicate	One per preparatory batch of 20 or fewer samples of similar matrix	The RPD should be $\leq 20\%$ for duplicate samples for both water and soils.	Narrate any results that are outside control limits.	Analyst, Supervisor, and Data Validator	Precision	Same as QC Acceptance Limits

QC Sample	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQIs	MPCs
Serial Dilution	One per preparatory batch with sample concentration(s) >50x LOD	The 5-fold dilution result must agree within $\pm 10\%$ D of the original sample result if result is >50x LOD.	Perform post-spike addition.	Analyst, Supervisor, Data Validator	Accuracy/Bias	Same as QC Acceptance Limits
Post-Digestion Spike	One is performed when serial dilution fails or target analyte concentration(s) in all samples are < 50x LOD	The %R must be within 75-125% of expected value to verify the absence of an interference. Spike addition should produce a concentration of 10-100x LOQ.	Flag results for affected analytes for all associated samples with "J."	Analyst, Supervisor, Data Validator	Accuracy/Bias	Same as QC Acceptance Limits
Results between DL and LOQ	Not known at this time	Apply "J" qualifier to results between DL and LOQ.	None	Analyst, Supervisor, Data Validator	Accuracy	Same as QC Acceptance Limits

SAP Worksheet #29 -- Project Documents and Records Table

[\(UFP-QAPP Manual Section 3.5.1\)](#)

Document	Where Maintained
Field Documents Field Logbook Field Sample Forms Chain-of-Custody Records Air Bills Sampling Instrument Calibration Logs Sampling Notes Photographs FTMR Forms This SAP HASP	Field documents will be maintained in the project file located in the Tetra Tech Pittsburgh, Pennsylvania, office.
Laboratory Documents Sample receipt, custody, and tracking records Equipment calibration logs Sample preparation logs Analysis Run logs Corrective Action forms Reported field sample results Reported results for standards, QC checks, and QC samples Extraction/clean-up records Sample Disposal Records Raw data Data Package Completeness Checklists	Laboratory documents will be included in the hardcopy and Portable Document Format (PDF) deliverables from the laboratory. Laboratory data deliverables will be maintained in the Tetra Tech Pittsburgh project file and in long-term data package storage at a third-party professional document storage firm. Electronic data results will be maintained in a database on a password protected Structured Query Language (SQL) server.
Assessment Findings Field Sampling Audit Checklist (if conducted) Analytical Audit Checklist (if conducted) Data Validation Memoranda (includes tabulated data summary forms)	All assessment documents will be maintained in the Tetra Tech Pittsburgh office.
Reports RI/FS Report	All reports will be stored in hardcopy in the Tetra Tech Pittsburgh project file and electronically in the server library.

SAP Worksheet #30 -- Analytical Services Table

[\(UFP-QAPP Manual Section 3.5.2.3\)](#)

Matrix	Analytical Group	Sample Locations/ ID Numbers	Analytical Method	Data Package Turnaround Time	Laboratory/ Organization	Backup Laboratory/ Organization
Groundwater, and Aqueous QC Blanks	VOCs (including low level for aqueous samples)	See Worksheet #18	SW-846 8260B	21 calendar days	Brian Richard Empirical Laboratories, LLC 621 Mainstream Dr., Suite 270 Nashville, TN 37228 (615) 345-1115	N/A
	Total Arsenic, Beryllium, and Cobalt		SW-846 6010C			

SAP Worksheet #31 -- Planned Project Assessments Table

[\(UFP-QAPP Manual Section 4.1.1\)](#)

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment (title and organizational affiliation)	Person(s) Responsible for Responding to Assessment Findings (title and organizational affiliation)	Person(s) Responsible for Identifying and Implementing CA (title and organizational affiliation)	Person(s) Responsible for Monitoring Effectiveness of CA (title and organizational affiliation)
Laboratory System Audit ⁽¹⁾	Every 2 years	External	DoD ELAP Accrediting Body	DoD ELAP Accrediting Body Auditor	Laboratory QAM or Laboratory Manager, Empirical	Laboratory QAM or Laboratory Manager, Empirical	Laboratory QAM or Laboratory Manager, Empirical

Empirical has successfully completed the laboratory evaluation process required as part of the DoD QSM. A copy of the DOD ELAP accreditation letter is included in Appendix B.

SAP Worksheet #32 -- Assessment Findings and Corrective Action Responses

[\(UFP-QAPP Manual Section 4.1.2\)](#)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (name, title, organization)	Time Frame of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA Response (name, title, organization)	Time Frame for Response
Laboratory System Audit	Written audit report	Marcia McGinnity, QAM, Empirical	Specified by DoD ELAP Accrediting Body	Letter	DoD ELAP Accrediting Body	Specified by DoD ELAP Accrediting Body

SAP Worksheet #33 -- QA Management Reports Table

[\(UFP QAPP Manual Section 4.2\)](#)

Type of Report	Frequency	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation	Report Recipient(s)
Data Validation Report	Per Sample Delivery Group (SDG)	Within 3 weeks of receipt of laboratory data package	Tetra Tech DVM or designee	Tetra Tech PM and project file
Project Monthly Progress Report	Monthly for duration of project	Monthly	Tetra Tech PM	Navy RPM; Tetra Tech QAM, Program Manager, and project file
Laboratory QA Report	When significant plan deviations result from unanticipated circumstances	Immediately upon detection of problem (on the same day)	Laboratory PM, Empirical	Tetra Tech PM and project file

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

(UFP-QAPP Manual Section 5.2.1)

Verification Input	Description	Internal/ External	Responsible for Verification (name, organization)
Chain-of-custody forms	The Tetra Tech FOL or designee will review and sign the chain-of-custody form to verify that all samples listed are included in the shipment to the laboratory and that the sample information is accurate. The forms will be signed by the sampler ,and a copy will be retained for the project file, Tetra Tech PM, and Tetra Tech Data Validators.	Internal	Tetra Tech Sampler and FOL
	The Laboratory Sample Custodian will review the sample shipment for completeness and integrity and will sign accepting the shipment. The Tetra Tech Data Validators will check that the chain-of-custody form was signed and dated by the Tetra Tech FOL or designee relinquishing the samples and also by the Laboratory Sample Custodian receiving the samples for analyses.	Internal and External	1 – Laboratory Sample Custodian, Empirical 2 – Tetra Tech Data Validators
SAP Sample Tables/ Chain-of-Custody Forms	Verify that all proposed samples listed in the SAP tables have been collected.	Internal	Tetra Tech FOL or designee
Sample Log Sheets	Verify that information recorded in the log sheets is accurate and complete.	Internal	Tetra Tech FOL or designee
Sample Coordinates	Verify that actual sample locations are correct and in accordance with the SAP proposed locations. Document any discrepancies in the final report.	Internal	Tetra Tech PM, FOL, or designee
SAP/Field Logs/ Analytical Data Packages	Ensure that all sampling SOPs were followed. Verify that MPCs have been achieved. Particular attention should be given to verify that samples were correctly identified, that sampling location coordinates are accurate, and that documentation establishes an unbroken trail of documented chain of custody from sample collection to report generation. Verify that the correct sampling and analytical methods/SOPs were applied. Verify that the sampling plan was implemented and carried out as written and that any deviations are documented.	Internal/External	Laboratory QAM, Empirical/Tetra Tech PM or designee

Verification Input	Description	Internal/ External	Responsible for Verification (name, organization)
SAP/Laboratory SOPs/ Raw Data/Applicable Control Limits Tables	Ensure that all laboratory SOPs were followed. Verify that the correct analytical methods/SOPs were applied. Establish that all method QC samples were analyzed and in control as listed in the analytical SOPs. If method QA is not in control, the Laboratory QAM will contact the Tetra Tech PM via telephone or e-mail for guidance prior to report preparation.	External	Laboratory QAM, Empirical
SAP/Chain-of-Custody Forms	Check that field QC samples listed in Worksheet #20 were collected as required.	Internal	Tetra Tech FOL or designee
Analytical Data Packages	All analytical data packages will be verified internally for completeness by the laboratory performing the work. The Laboratory QAM will sign the case narrative for each data package.	External	Laboratory QAM, Empirical
Audit reports	Audit checklists and narratives noting any deficiencies (if an audit is performed).	Internal	Tetra Tech PM, QAM, and FOL

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

(UFP-QAPP Manual Section 5.2.2) (Figure 37 UFP-QAPP Manual) (Table 9 UFP-QAPP Manual)

Step II /IIb	Validation Input	Description	Responsible for Validation
IIa	Chain-of-Custody Forms	Custody - Ensure that the custody and integrity of the samples was maintained from collection to analysis and that custody records are complete and any deviations are recorded. Review that the samples were shipped and stored at the required temperature and sample pH for chemically preserved samples meet the requirements listed in Worksheet #19 . Ensure that the analyses were performed within the holding times listed in Worksheet #19 .	Tetra Tech Project Chemist or Data Validators
IIa/IIb	SAP/ Laboratory Data Packages/ Electronic Data Deliverables (EDDs)	<p>Ensure that the laboratory QC samples listed in Worksheet #28 were analyzed and that the MPCs listed in Worksheet #12 were met for all field samples and QC analyses. Check that specified field QC samples were collected and analyzed and that the analytical QC criteria set up for this project were met.</p> <p>Check field sampling precision by calculating RPDs for field duplicate samples. Check laboratory precision by reviewing RPDs or percent difference values from laboratory duplicate analyses, MS/MSDs, and LCS/laboratory control sample duplicates (LCSs), if available.</p> <p>Check that the laboratory recorded the temperature of each sample at sample receipt and the pH of each chemically preserved sample to ensure sample integrity from sample collection to analysis.</p> <p>Review the chain-of-custody forms generated in the field to ensure that the required analytical samples have been collected, appropriate sample identifications have been used, and correct analytical methods have been applied. The Tetra Tech Data Validator will verify that elements of the data package required for validation are present, and if not, the laboratory will be contacted and the missing information will be requested. Validation will be performed as per Worksheet #36.</p>	Tetra Tech Project Chemist or Data Validators
IIb	SAP/ Laboratory Data Packages/ EDDs	<p>Ensure that the LOQs listed in Worksheet #15 were achieved.</p> <p>Discuss the impact of matrix interferences or sample dilutions performed because of high concentrations of one or more other contaminants on the other target analytes reported as non-detected.</p> <p>Summarize deviations from methods, procedures, or contracts in the Data Validation Report. If possible, determine the impact of any deviation from sampling or analytical methods and SOP requirements and matrix interferences effect on the analytical results. Qualify data results based on method or QC deviation and explain all the data qualifications.</p> <p>Ensure that the LOQs listed in Worksheet #15 were achieved.</p>	Tetra Tech Project Chemist or Data Validators

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

[\(UFP-QAPP Manual Section 5.2.2.1\)](#)

Step IIa/IIb	Matrix	Analytical Group	Validation Criteria	Data Validator
IIa and IIb	Groundwater and Aqueous QC Blanks	VOCs	Validation will be performed using SW-846 8260B, RSK SOP 175, SW-846 8330B, and SW-846 6850 method-specific criteria, and those criteria listed in Worksheet #s 12, 15, 24, and 28 . The logic outlined in USEPA Region 3 Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses (1994) should be used to apply qualifiers to data to the extent possible.	Tetra Tech Data Validation Specialist
IIa and IIb	Soil, Groundwater, and Aqueous QC Blanks	Total Arsenic , Beryllium, and Cobalt	Validation will be performed using SW-846 6010C method specific criteria, and those criteria listed in Worksheet #s 12, 15, 24, and 28 . The logic outlined in USEPA Region 3 Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Inorganic Analyses (1993) should be used to apply qualifiers to data to the extent possible.	Tetra Tech Data Validation Specialist

SAP Worksheet #37 -- Usability Assessment

([UFP-QAPP Manual Section 5.2.3](#))

Data Usability Assessment

The usability of the data generated during the RI directly affects whether project objectives can be achieved. The following characteristics will be evaluated at a minimum, and the results of these evaluations will be included in the project report. The characteristics will be evaluated for multiple concentration levels if the evaluator determines that this is necessary. To the extent required by the type of data being reviewed, the evaluator will consult with other technically competent individuals to render sound technical assessments of these DQI characteristics:

- **Completeness**

For each matrix that was scheduled to be sampled, the Tetra Tech FOL acting on behalf of the Project Team will prepare a table comparing planned samples/analyses to collected samples/analyses. If deviations from the scheduled sample collection or analyses are identified, the Tetra Tech PM and Project Risk Assessor will determine whether the deviations compromise the ability to meet project objectives. If they do, the Tetra Tech PM will consult with the Navy RPM and other Project Team members, as necessary (determined by the Navy RPM), to develop appropriate corrective actions.

- **Precision**

The Tetra Tech Project Chemist acting on behalf of the Project Team will determine whether precision goals for field duplicates and laboratory duplicates were met. This will be accomplished by comparing duplicate results to precision goals identified in [Worksheet #s 12 and 28](#). This will also include a comparison of field and laboratory precision, with the expectation that laboratory duplicate results will be no less precise than field duplicate results. If the goals are not met, or if data have been flagged as estimated (J qualifier), limitations on the use of the data will be described in the project report.

Accuracy

The Tetra Tech Project Chemist acting on behalf of the Project Team will determine whether the accuracy/bias goals were met for project data. This will be accomplished by comparing %Rs of LCS, LCSD, MS, MSD, and surrogate compounds to accuracy goals identified in [Worksheet No. 28](#). This assessment will include an evaluation of field and laboratory contamination, instrument calibration variability, and analyte recoveries for surrogates, MSs, and LCSs. If the goals are not met, limitations on the use of the data will be described in the project report. Bias of the qualified results and a description of the impact of identified non-compliances on a specific data package or on the overall project data will also be described in the project report.

- **Representativeness**

A Tetra Tech Project Scientist identified by the Tetra Tech PM and acting on behalf of the Project Team will determine whether the data are adequately representative of intended populations, both spatially and temporally. This will be accomplished by verifying that samples were collected and processed for analysis in accordance with the SAP, by reviewing spatial or temporal data variations, and by comparing these characteristics to expectations. The usability report will describe the representativeness of the data for each matrix and analytical fraction. This will not require quantitative comparisons unless the Project Scientist indicates that a quantitative analysis is beneficial.

- **Comparability**

The Tetra Tech Project Chemist acting on behalf of the Project Team will determine whether the data generated under this project are sufficiently comparable to historical site data generated by different methods and for samples collected using different procedures and under different site conditions. This will be accomplished by comparing overall precision and bias among data sets for each matrix and analytical fraction. This will not require quantitative comparisons unless professional judgment of the Tetra Tech Project Chemist indicates that such quantitative analysis is required.

- **Sensitivity**

The Tetra Tech Project Chemist acting on behalf of the Project Team will determine whether project sensitivity goals listed in [Worksheet No. 15](#) were achieved. The overall sensitivity and LOQs from multiple data sets for each matrix and analysis will be compared. If sensitivity goals are not achieved, the limitations on the data will be described in the project report. The Tetra Tech Project Chemist may enlist the help of the Project Risk Assessor to evaluate deviations from planned sensitivity goals.

- **Project Assumptions and Data Outliers**

The Tetra Tech PM and designated team members will evaluate whether project assumptions are valid. This will typically be a qualitative evaluation but may be supported by quantitative evaluations. The type of evaluation depends on the assumption being tested. Quantitative assumptions include those related to data distributions (e.g., normal or log-normal) and estimates of data variability. Potential data outliers will be removed if a review of the associated data indicates that the results have an assignable cause that renders them inconsistent with the remainder of the data. During this evaluation, the team will consider whether outliers could be indications of unanticipated site conditions.

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

After the completion of data validation, the data and data quality will be reviewed to determine whether sufficient data of acceptable quality are available for decision making. In addition to the evaluations described above, a series of inspections and statistical analyses will be performed to estimate these DQI characteristics. The statistical evaluations will include simple summary statistics for target analytes, such as maximum concentration, minimum concentration, number of samples with non-detected results, number of samples with detected results, and the proportion of samples with detected and non-detected results. The Project Team members identified by the Tetra Tech PM will assess whether the data collectively support the attainment of project objectives. The Project Team will consider whether any missing or rejected data have compromised the ability to make decisions or to make decisions with the desired level of confidence. The data will be evaluated to determine whether missing or rejected data can be compensated for by other data. Although rejected data will generally not be used, there may be reason to use them in a weight-of-evidence argument, especially when they supplement data that have not been rejected. If rejected data are used, their use will be supported by technically defensible rationales.

For statistical comparisons and mathematical manipulations, non-detected values will be represented by a concentration equal to one-half of the sample-specific reporting limit. Duplicate results (original and duplicate) will not be averaged for the purpose of representing the range of concentrations; however, the average of the original and duplicate samples will be used to represent the concentration at a particular sampled location.

Identify the personnel responsible for performing the usability assessment:

The Tetra Tech PM, Project Chemist, FOL, Risk Assessor and Project Scientist will be responsible for conducting the listed data usability assessments. The data usability assessment will be reviewed with the NSF-IH, Navy RPM, MDE RPM, and USEPA RPM. If deficiencies affecting the attainment of project objectives are identified, the review will take place either in a face-to-face meeting or teleconference, depending on the extent of identified deficiencies. If no significant deficiencies are identified, the data usability assessment will simply be documented in the project report and reviewed during the normal document review cycle.

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

The data will be presented in tabular format, including data qualifications such as estimation (J, UJ) or rejection (R). Written documentation will support the non-compliance estimated or rejected data results. The project report will identify and describe the data usability limitations and suggest resampling or other corrective actions, if necessary.

REFERENCES

ENSAFE/Allen & Hoshall, 1994. Final Site Inspection Report, Phase II Indian Head Division, Naval Surface Warfare Center, March 4.

Tetra Tech (Tetra Tech NUS, Inc.), 1999. Remedial Investigation Report, Site 12 – Town Gut Landfill, Site 41 – Scrap Yard, Site 42 – Olsen Road Landfill, Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland, July.

Tetra Tech, 2001. Feasibility Study for Site 12 – Town Gut Landfill, Site 41 – Scrap Yard, Site 42 – Olsen Road Landfill, Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland, January.

USEPA (United States Environmental Protection Agency), 1993. Region III Modifications to the National Functional Guidelines for Evaluating Inorganic Analyses, April.

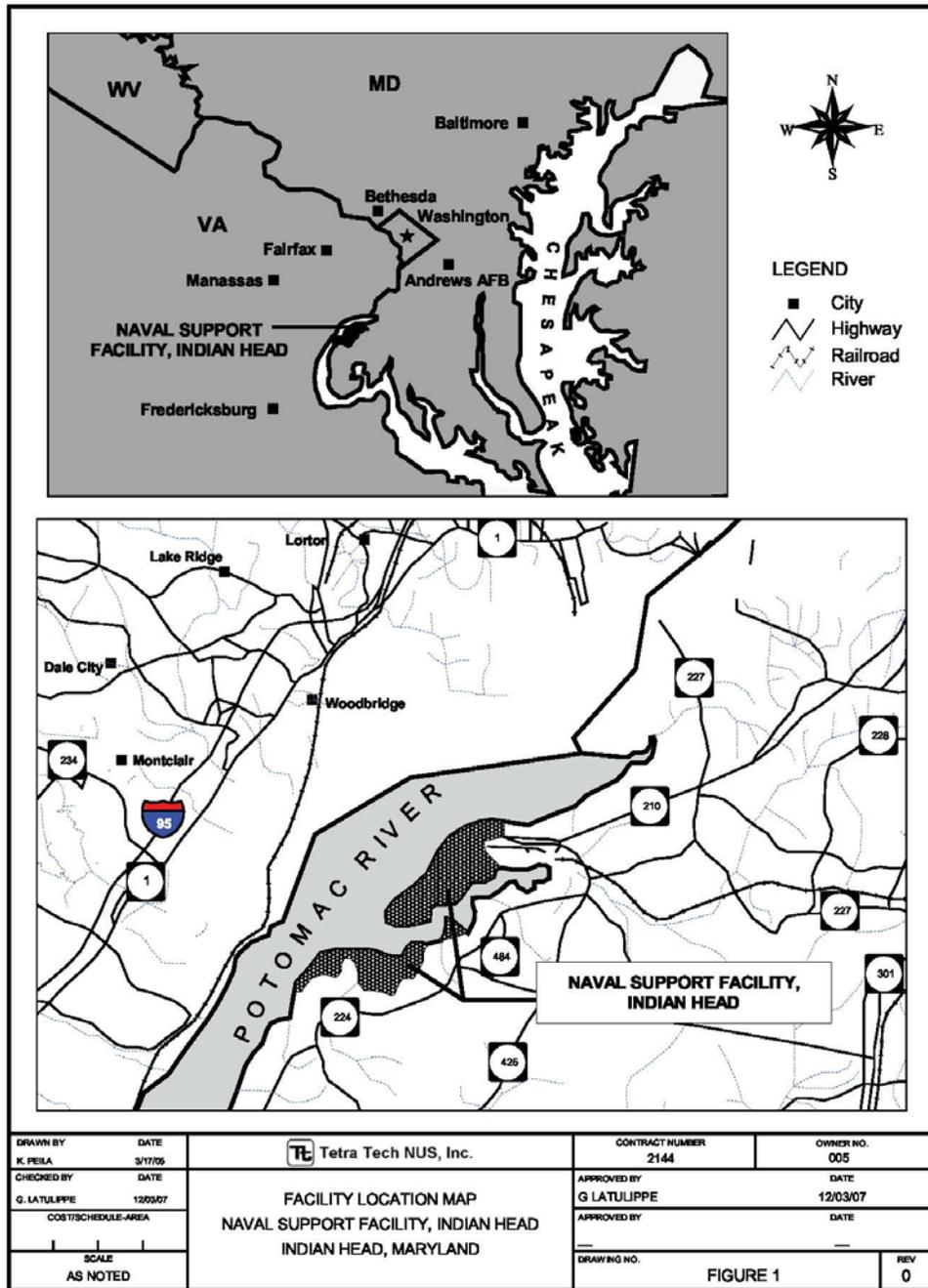
USEPA, 1994. . Region III Modifications to the National Functional Guidelines for Organic Data Review, Multi-Media, Multi-Concentration, September.

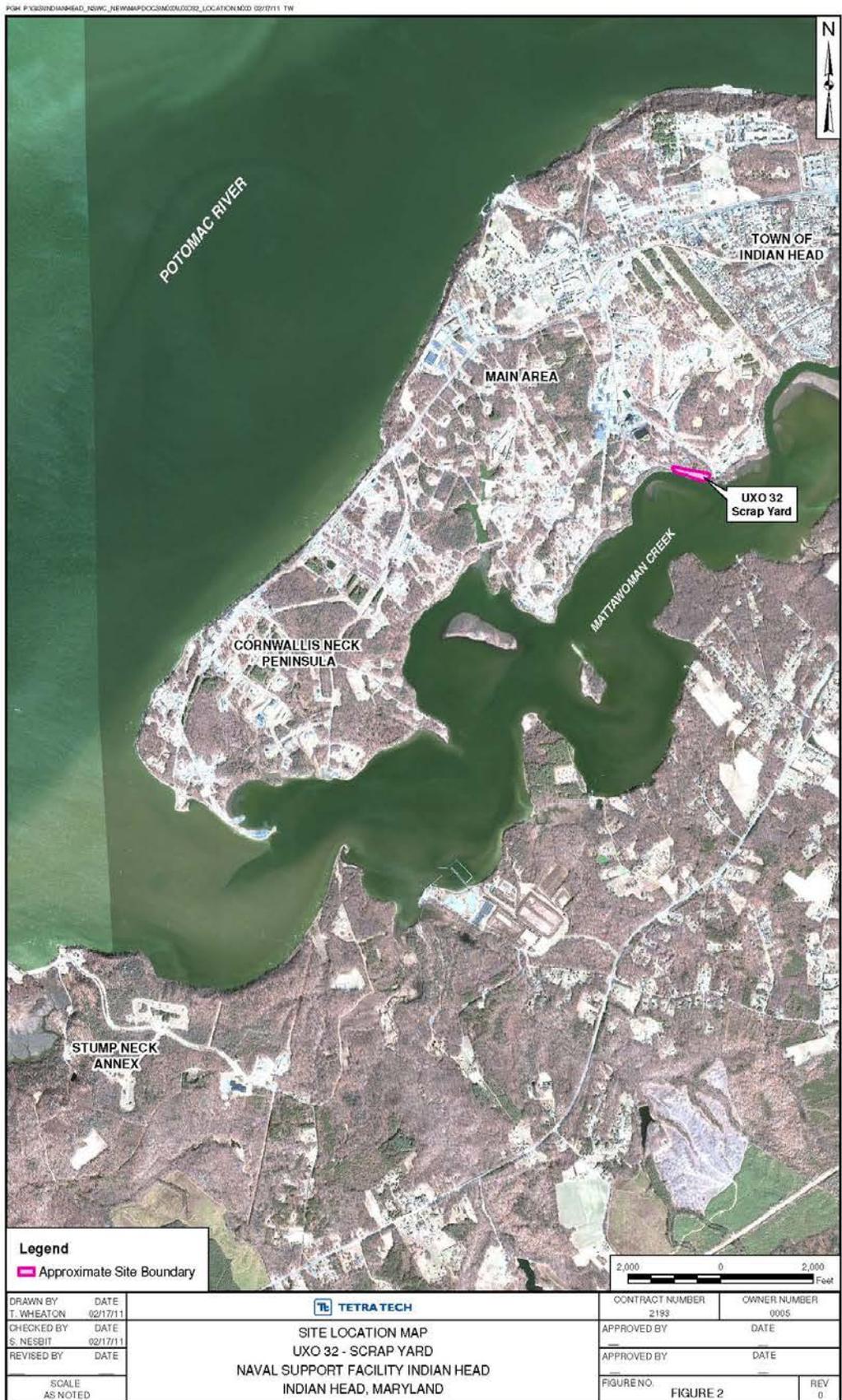
USEPA, 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater, EPA/600/R-98/128, September.

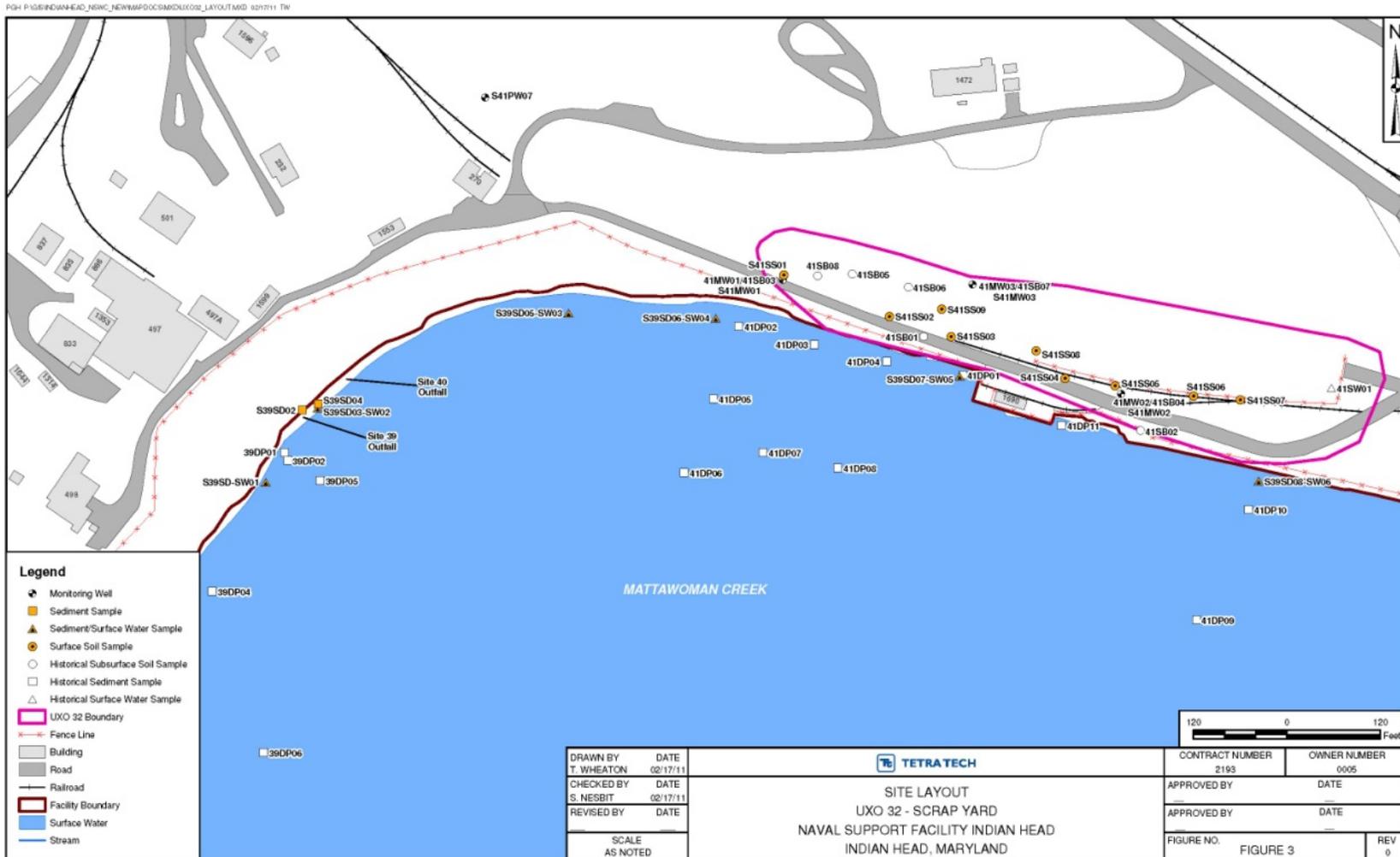
USEPA, 2005. Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP), Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs (Final Version 1), EPA-505-B-04-900A. March.

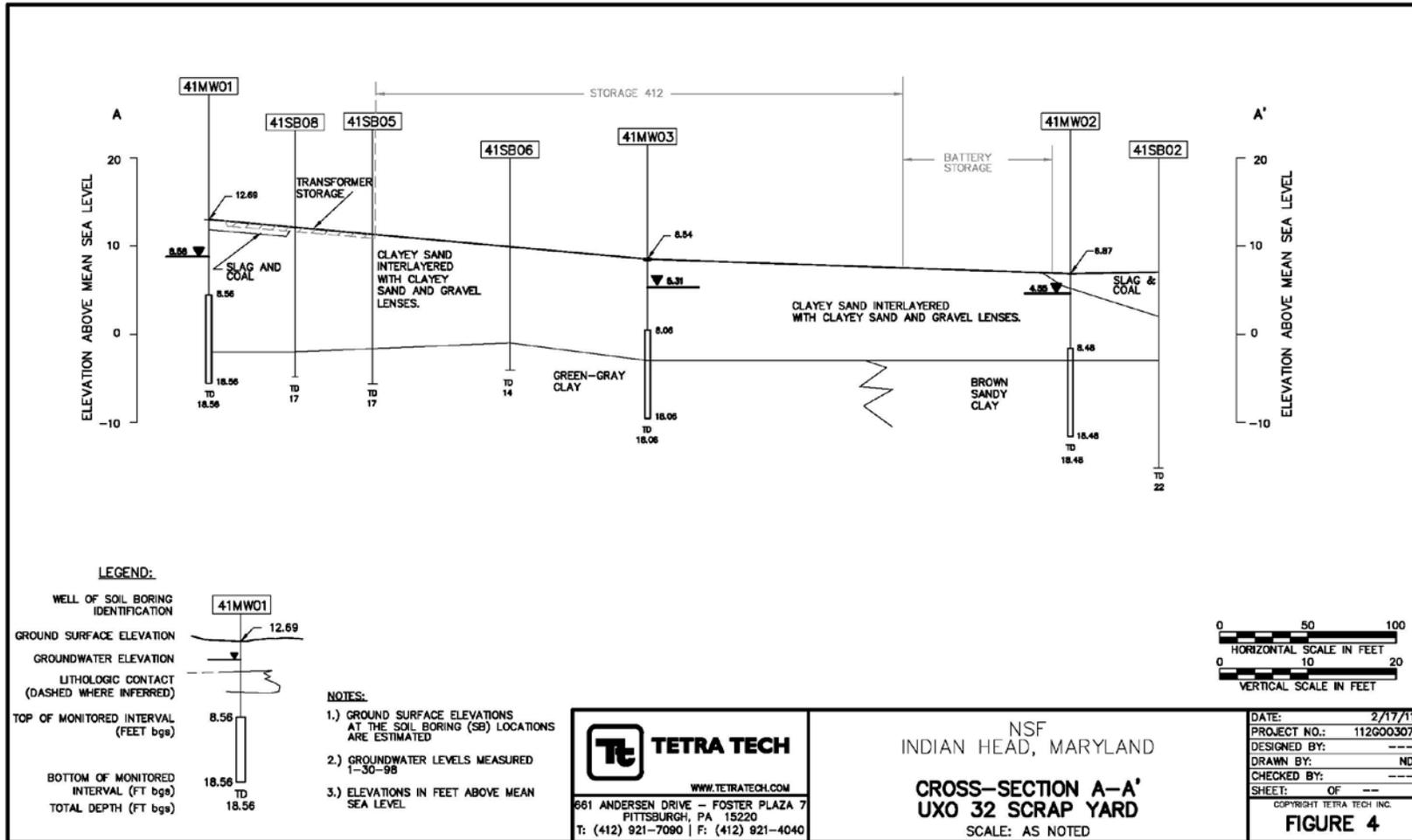
USEPA, 2006. Guidance on the Systematic Planning using the Data Quality Objectives Process, EPA QA/G-4, EPA/240/B-06/001 , February.

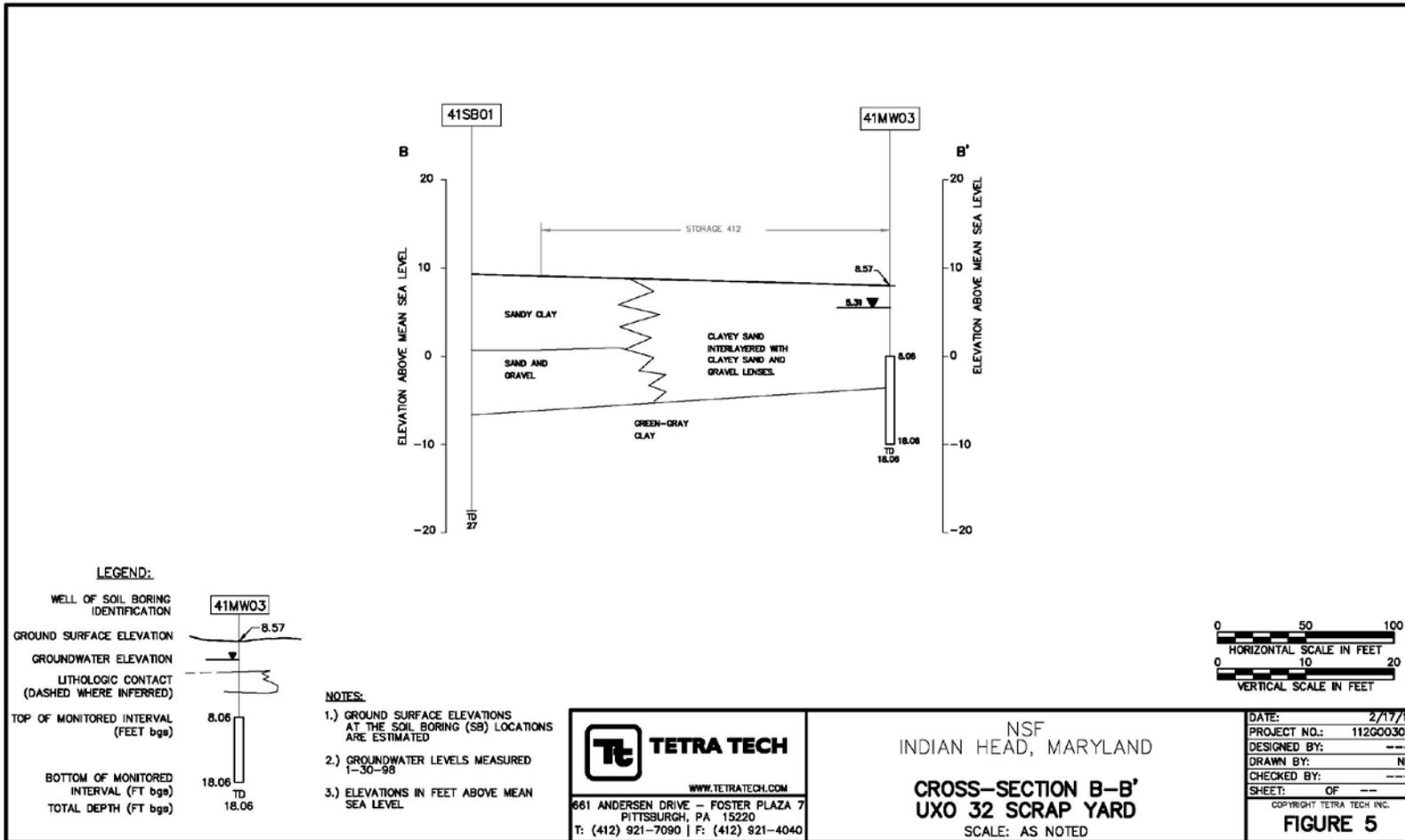
FIGURES

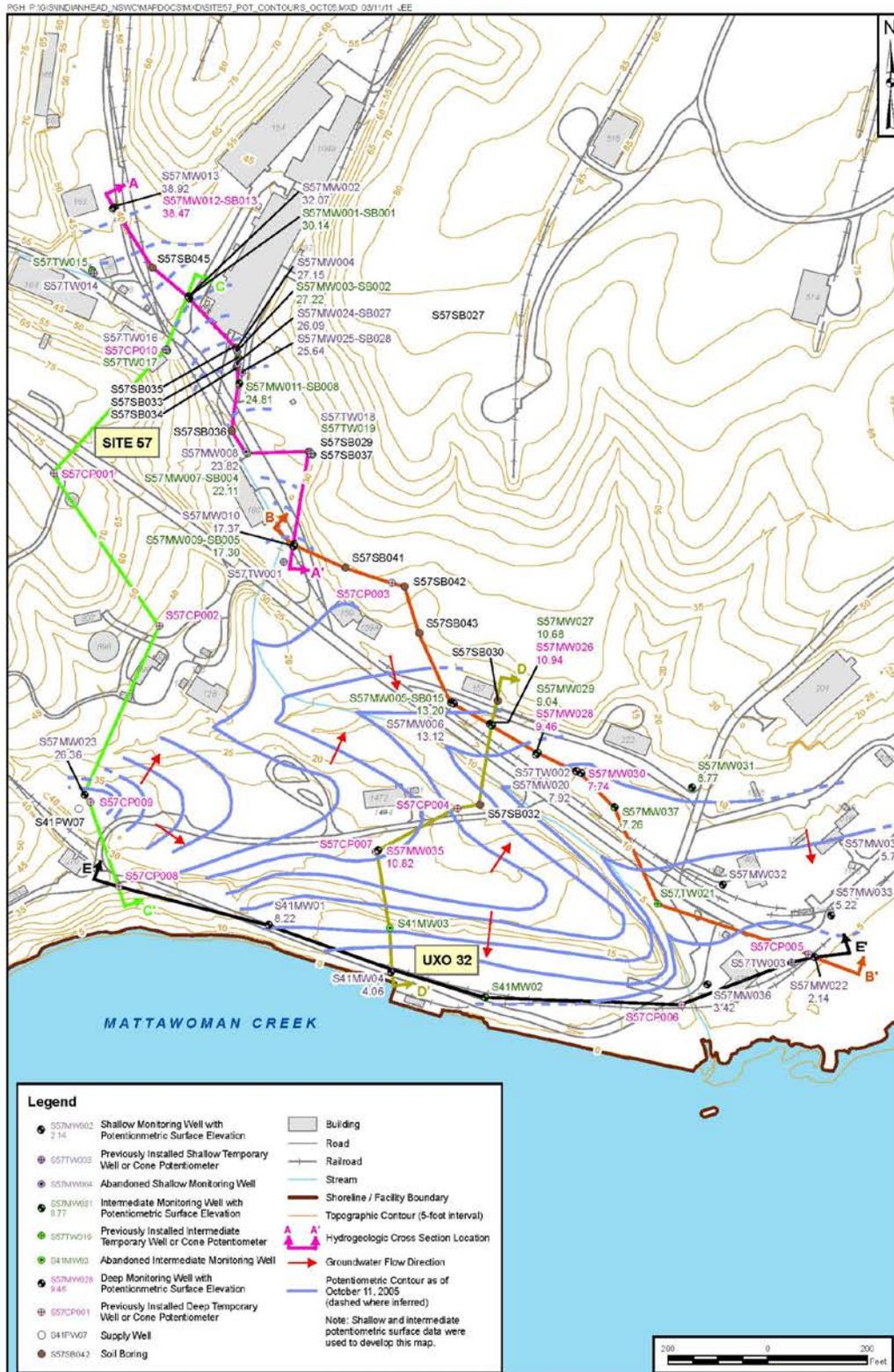




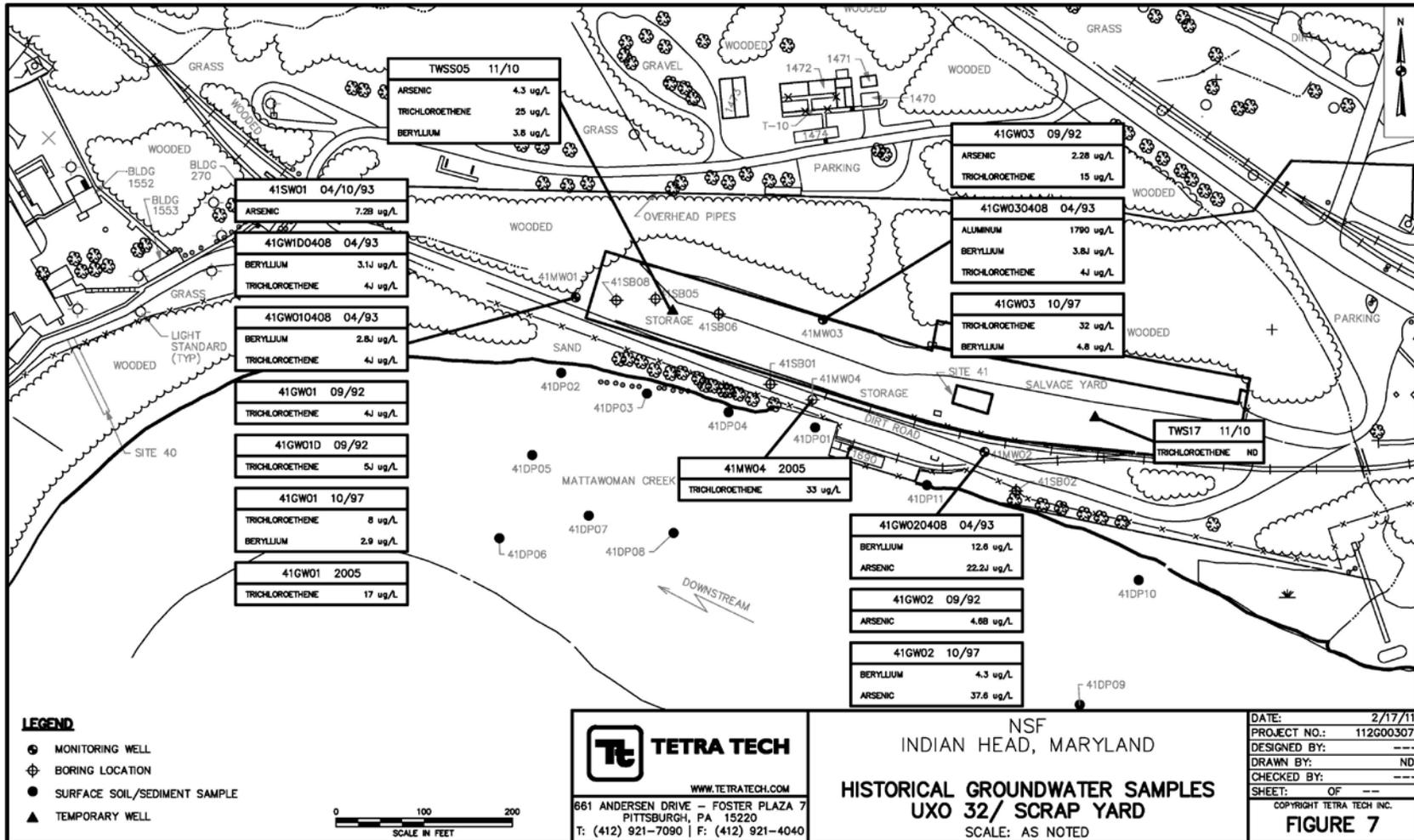


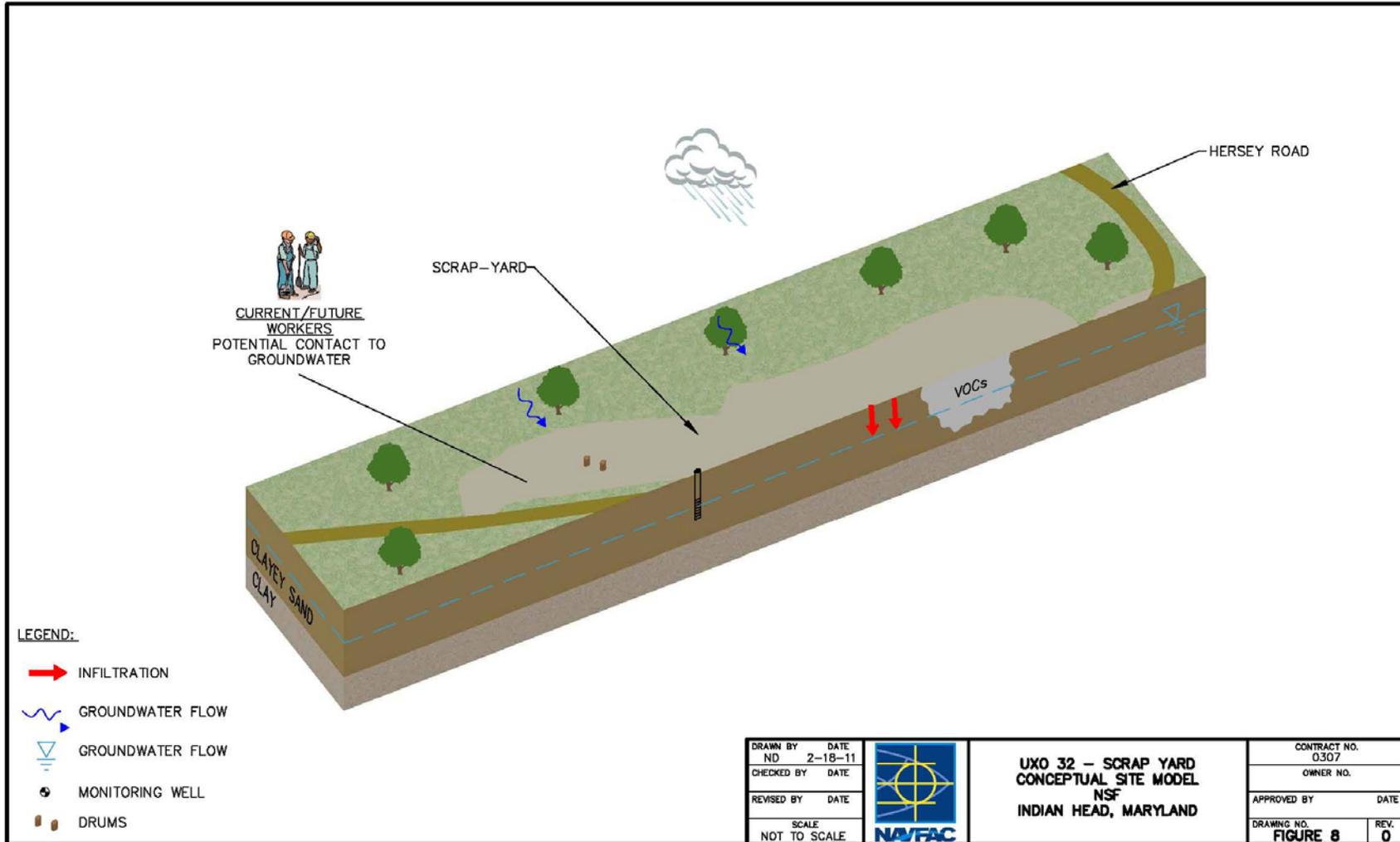




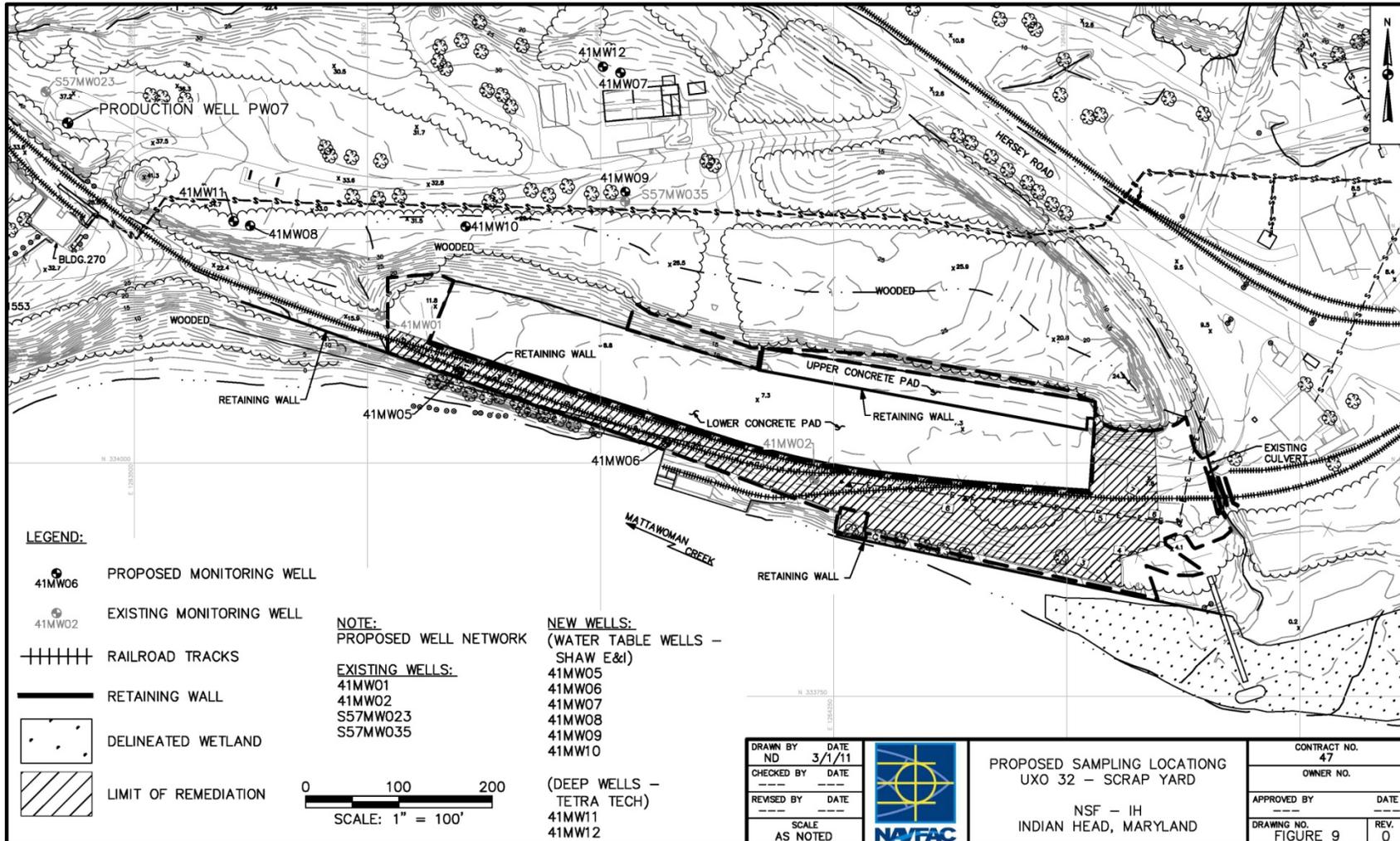


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SCALE AS NOTED				FIGURE NO. FIGURE 6	REV 0
<p>POTENTIOMETRIC SURFACE CONTOURS UXO 32 AND SITE 57 NAVAL SUPPORT ACTIVITY, INDIAN HEAD INDIAN HEAD, MARYLAND</p>					





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APPENDIX A

SOP TABLE OF CONTENTS

SOP-01	Sample Labeling
SOP-02	Sample Identification Nomenclature
SOP-03	Decontamination of Field Sampling Equipment
SOP-04	Lithologic Soil Sample Logging
SOP-05	Monitoring Well installation
SOP-06	Monitoring Well Development
SOP-07	Well Inspection
SOP-08	Calibration and Care of Water Quality Meter
SOP-09	Low-Flow Well Purging and Stabilization
SOP-10	Groundwater Sampling
SOP-11	Management of Investigation-Derived Waste
SOP-12	Measurement of Water Levels in Monitoring Wells

STANDARD OPERATING PROCEDURE NUMBER SOP-01

SAMPLE LABELING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the procedures to be used for labeling sample containers. Sample labels are used to document the sample ID, date, time, analysis to be performed, preservative, matrix, sampler, and the analytical laboratory. A sample label will be attached to each sample container. The label for each container will contain identical information.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Writing utensil (indelible ink black pen)

Disposable medical-grade gloves (e.g. latex, nitrile)

Sample logsheets

Required sample containers: All sample containers for analysis by fix-based laboratories will be supplied and deemed certified clean by the laboratory.

Preprinted sample labels

Chain-of-custody records

Sealable polyethylene bags

Heavy-duty cooler

Ice

3.0 PROCEDURES

3.1 The following information will be electronically printed on each sample label prior to the field activities.

- Contract Task Order number (CTO 047)
- Project location (NSF Indian Head)
- Sample location
- Preservative
- Analysis to be performed

- Matrix type
- Laboratory name

- 3.2 Complete the label by filling in the sample ID and time of collection at the well head during sample collection event. Also log this information on the proper documentation as detailed in SOP – 03.
- 3.3 Select the containers that are appropriate for a given sample. Complete the associated sample label and affix to the sample container.
- 3.4 Fill the appropriate containers with sample material. Securely close the container lids without overtightening.
- 3.5 Check to determine if the information printed on the label is correct.
- 3.6 Place the sample container in a Ziplock plastic bag and place in a cooler containing ice.

Example of a sample label is attached at the end of this SOP.

4.0 ATTACHMENTS

1. Sample Label

ATTACHMENT 1 SAMPLE LABEL

Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, 15220 (412)921-7090		Project:	Location:	CTO:
Sample No:			Matrix:	
Date:	Time:	Preserve:		
Analysis:				
Sampled by:			Laboratory	

STANDARD OPERATING PROCEDURE

SOP-02

SAMPLE IDENTIFICATION NOMENCLATURE

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to establish a consistent sample nomenclature system that will facilitate subsequent data management at the Naval Support Facility Indian Head. The sample nomenclature system has been devised such that the following objectives can be attained.

- Sorting of data by site, location, or matrix
- Maintenance of consistency (field, laboratory, and database sample numbers)
- Accommodation of all project-specific requirements
- Accommodation of laboratory sample number length constraints
- Ease of sample identification

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Writing utensil (preferably black pen with indelible ink)

Sample container labels

3.0 SAMPLE IDENTIFICATION NOMENCLATURE

3.1 Samples

All samples will be properly labeled with a sample label affixed to the sample container. Each sample will be assigned a unique sample tracking number.

3.1.1 Sample Numbering Scheme

Use a sample tracking number consisting of a four- or five-segment alpha-numeric code that identifies the sample's associated Unexploded Ordnance (UXO) site, sample type, location, and for aqueous samples, where applicable, whether a sample is filtered, and/or the sample round number. For soil samples (not planned for the Phase I groundwater RI), use the final four digits of the tracking number to identify the

depth in units of feet below ground surface (bgs) at which the sample was collected. For sediment samples (not planned for the Phase I groundwater RI), use the final four digits of the tracking number to identify the depth in units of inches bgs at which the sample was collected.

The alphanumeric coding to be used is explained in the following diagram and subsequent definitions:

ANN	AA	NNN or NN	MMYY
Site Number	Matrix	Sample Location Number	Date, month and year sample collected

Character Type:

A = Alpha
N = Numeric

UXO Number (ANN):

Site 57 = S57
Site 41 = S41

Matrix Code (AA):

GW = Groundwater Sample

Location Number (NNN or NN):

Well identification number i.e. well 42MW02 = 02

Date (mmyy):

This code section will be used to record the date when the sample is collected, month and year. This is utilized in lieu of a sample round designation

3.1.2 Examples of Confirmation Sample Nomenclature

A groundwater sample collected from Site 41, well 41MW13, on April 19 2011 would be labeled as "S41GW130411.

3.2 Field Quality Assurance/Quality Control (QA/QC) Sample Nomenclature

Field QA/QC samples are described in this UFP SAP. They will be designated using a different coding system than the one used for regular field samples.

3.2.1 QC and IDW Sample Numbering

Use the QC and IDW code consisting of a three- to four-segment alpha-numeric code that identifies the sample QC type, the date the sample was collected, and the number of this type of QC sample collected on a particular date.

AA or AAA	NNNNNN	NN
QC Type or IDW	Date	Sequence Number (per sampling event or round)

Character Type:

- A = Alpha
- N = Numeric

QC Types:

- FD = Field Duplicate
- TB = Trip Blank
- IDW = investigation derived waste

Record the time of sampling on the Chain-of-Custody Form, labels, and tags for field duplicate samples with 5 minutes added to the parent sample collection time so that the samples are "blind" to the laboratory. Record notes detailing the sample number, time, date, and type on the sample log sheets and document the location of the duplicate sample (sample log sheets are not provided to the laboratory).

3.2.2 Examples of Field QA/QC Sample Nomenclature

The first duplicate of the round at Site 41 for groundwater sample collected on April 24, 2011 would be designated as FD04241101.

The second trip blank collected during the sampling event associated with samples collected on April 25, 2011 would be designated as TB04251102.

The first IDW sample collected from soil waste collected on April 30, 2011 would be designated as IDW04301101, second IDW sample collected the same day from water waste would be designated as IDW04301102.

STANDARD OPERATING PROCEDURE NUMBER SOP-03

DECONTAMINATION OF FIELD SAMPLING EQUIPMENT

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures to be followed when decontaminating non-dedicated field sampling equipment during the field investigations at the Naval Support Facility Indian Head.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Waterproof pens

Non-latex rubber or plastic gloves

Cotton gloves

Field logbook

Potable water

Deionized water

LiquiNox detergent

Brushes, spray bottles, paper towels, etc.

55-gallon drum or other container to collect and transport decontamination fluids

3.0 DECONTAMINATION PROCEDURES

- 3.1 Don non-latex and/or cotton gloves and decontaminate sampling equipment (in accordance with the following steps) prior to field sampling and between samples.
- 3.2 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container. For heavy drilling equipment, the subcontractor will use high pressure steam rinse to decontaminate drilling tools. For these larger tools skip to Step 3.6 of this SOP; otherwise continue with the next step for smaller drilling tools used for soil sampling.
- 3.3 Wash the equipment with a solution of LiquiNox detergent. Prepare the LiquiNox wash solution in accordance with the instructions on the LiquiNox container. Collect the LiquiNox wash solution

into a container. Use brushes or sprays as appropriate for the equipment to remove debris. If oily residue has accumulated on the sampling equipment, remove the residue with an isopropanol wash and repeat the Liquinox wash.

- 3.4 Rinse the equipment with potable water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. Collect the potable water rinsate into a container.
- 3.5 Rinse the equipment with deionized water. Rinsing may be conducted by spraying with water from a spray bottle or by dipping. To collect a rinsate blanks, collect the deionized water rinsate into the appropriate sample container.
- 3.6 Remove excess water by air drying, shaking, or by wiping with paper towels as necessary.
- 3.7 Document decontamination by recording it in the field logbook.
- 3.8 Containerize decontamination solutions in accordance with the procedures described in UFP-SAP.

STANDARD OPERATING PROCEDURE NUMBER SOP-04

LITHOLOGIC SOIL SAMPLE LOGGING

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the standard procedures and technical guidance on the logging of soil cores collected at the Naval Support Facility Indian Head facility.

2.0 FIELD FORMS AND EQUIPMENT

Knife

Ruler (marked in tenths and hundredths of feet)

Boring Log: An example of this form is attached.

Writing utensil

3.0 RESPONSIBILITIES

A field geologist or engineer is responsible for supervising all boring activities and assuring that each borehole is properly and completely logged.

4.0 PROCEDURES FOR BOREHOLE AND SAMPLE LOGGING

To maintain a consistent classification of soil, it is imperative that the field geologist understands and accurately uses the field classification system described in this SOP. This identification is based on visual examination and manual tests.

4.1 USCS Classification

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Figure 1 (attached to this SOP).

This method of classification identifies soil types on the basis of grain size and cohesiveness.

Fine-grained soils, or fines, are smaller than the No. 200 sieve and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors. Organic material (O) is a common component of soil but has no distinguishable size range; it is recognized by its composition. The careful study of the USCS will aid in developing the competence and consistency necessary for the classification of soils.

Coarse-grained soils will be divided into categories: rock fragments, sand, or gravel. The terms "sand" and "gravel" not only refer to the size of the soil particles but also to their depositional history. To insure accuracy in description, the term "rock fragments" will be used to indicate angular granular materials resulting from the breakup of rock. The sharp edges that are typically observed indicate little or no transport from their source area; and therefore, the term provides additional information in reconstructing the depositional environment of the soils encountered. When the term "rock fragments" is used, it will be followed by a size designation such as "(1/4 inch Φ -1/2 inch Φ)" or "coarse-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

4.2 Color

Describe soil colors utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray." Because color can be utilized in correlating units between sampling locations, it is important for color descriptions to be consistent from one boring to another.

Colors must be described while the sample is still moist. Break or split soil samples vertically to render the colors clearly visible. Samplers tend to smear the sample surface, creating color variations between the sample interior and exterior.

Use the term "mottled" to indicate soils irregularly marked with spots of different colors. Mottling in soils usually indicates poor aeration and lack of good drainage.

4.3 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist is to first identify the soil type. Granular soils contain predominantly sands and gravels. They are noncohesive (particles do not adhere well when compressed). Finer-grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

Granular soils are given the USCS classifications GW, GP, GM, SW, SP, SM, GC, or SC (see Figure 1).

The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in the following table.

CONSISTENCY FOR COHESIVE SOILS

Consistency	Standard Penetration Resistance (Blows per Foot)	Unconfined Compressive Strength (Tons/Sq. Foot by pocket penetration)	Field Identification
Very soft	0 to 2	Less than 0.25	Easily penetrated several inches by fist.
Soft	2 to 4	0.25 to 0.50	Easily penetrated several inches by thumb.
Medium stiff	4 to 8	0.50 to 1.0	Can be penetrated several inches by thumb with moderate effort.
Stiff	8 to 15	1.0 to 2.0	Readily indented by thumb but penetrated only with great effort.
Very stiff	15 to 30	2.0 to 4.0	Readily indented by thumbnail.
Hard	Over 30	More than 4.0	Indented with difficulty by thumbnail.

Cohesive soils are given the USCS classifications ML, MH, CL, CH, OL, or OH (see Figure 1).

The consistency of cohesive soils is determined by hand by determining the resistance to penetration by the thumb. The thumb determination methods are conducted on a selected sample of the soil, preferably the lowest 0.5 foot of the sample. Break the sample in half and push the thumb into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, classify it as a soft decomposed rock rather than a hard soil. Use one of the other methods in conjunction with it. The designations used to describe the consistency of cohesive soils are shown in the above-listed table.

4.4 Weight Percentages

In nature, soils consist of particles of varying size and shape and are combinations of the various grain types. The following terms are useful in the description of soil:

Terms of Identifying Proportion of the Component	Defining Range of Percentages by Weight
Trace	0 - 10 percent
Some	11 - 30 percent
Adjective form of the soil type (e.g., sandy)	31 - 50 percent

Examples:

- Silty fine sand: 50 to 69 percent fine sand, 31 to 50 percent silt.
- Medium to coarse sand, some silt: 70 to 80 percent medium to coarse sand, 11 to 30 percent silt.
- Fine sandy silt, trace clay: 50 to 68 percent silt, 31 to 49 percent fine sand, 1 to 10 percent clay.
- Clayey silt, some coarse sand: 70 to 89 percent clayey silt, 11 to 30 percent coarse sand.

4.5 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgment. A suggested approach for this would be to call a soil wet if rolling it in the gloved hand or on a porous surface liberates water (i.e., dirties or muddies the surface). Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire field activity.

4.6 Classification of Soil Grain Size for Chemical Analysis

To determine the gross grain size classification (e.g., clay, silt, and sand) from the USCS classification described above, use the following table.

Gross Soil Grain Size Classification	USCS Abbreviation	Description
Clay	CL	inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays,.
	CH	inorganic clays of high plasticity, fat clays.
	OH	organic clays of medium to high plasticity, organic silts.
Silt	ML	inorganic silts and very fine sands, rock four, silty or clayey fine sands with slight plasticity.
	OL	organic silts and organic silty clays of low plasticity..
	MH	inorganic silts, micaceous or diatomaceous fine sand or silty soils.

Gross Soil Grain Size Classification	USCS Abbreviation	Description
Sand	SW	well graded sands, gravelly sands, little or no fines.
	SP	poorly graded sands, gravelly sands, little or no fines.
	SM	silty sands, sand-silt mixtures.
	SC	clayey sands, sand-clay mixtures.

4.7 Summary of Soil Classification

In summary, soils will be classified in a similar manner by each geologist/engineer at a project site. The hierarchy of classification is as follows:

- Density and/or consistency
- Color
- Plasticity (optional)
- Soil types
- Moisture content
- Other distinguishing features
- Grain size
- Depositional environment

4.0 ATTACHMENTS

1. Figure 1 - Unified Soil Classification System
2. Boring Log

ATTACHMENT 1

FIGURE 1 - UNIFIED SOIL CLASSIFICATION SYSTEM

Unified Soil Classification System			
Coarse Grained Soils (more than half of soil > No. 200 sieve)	Gravels (More than half of coarse fraction > no. 4 sieve size)		GW Well graded gravels or gravel-sand mixtures, little or no fines
			GP Poorly graded gravels or gravel-sand mixtures, little or no fines
			GM Sandy gravels, gravel-sand-silt mixtures
			GC Clayey gravels, gravel-sand-silt mixtures
	Sands (More than half of coarse fraction < no. 4 sieve size)		SW Well graded sands or gravelly sands, little or no fines
			SP Poorly graded sands or gravelly sands, little or no fines
			SM Silty sands, sand-silt mixtures
			SC Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
Fine Grained Soils (more than half of soil < No. 200 sieve)	Silts and Clays LL = < 50		ML Inorganic silts and very fine sands, rock flour, silty fine sands or clayey silts with slight plasticity
			CL Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, lean clays
			OL Organic silts and organic silty clays of low plasticity
	Silts and Clays LL = > 50		MH Inorganic silts, micaceous or diatomaceous fine sand or silty soils, elastic silts
			CH Inorganic silts of high plasticity, fat clays
	OH Organic clays of high plasticity, organic silty clays, organic silts		
Highly Organic Soils			Pt Peat and other highly organic soils

Grain Size Chart

Classification	Range of Grain Sizes	
	U.S. Standard Sieve Size	Grain Size In Millimeters
Boulders	Above 12"	Above 305
Cobbles	12" to 3"	305 to 76.2
Gravel	3" to No. 4	76.2 to 7.76
	3" to 3/4"	76.2 to 4.76
Sand	3/4" to No. 4	19.1 to 4.76
	No. 4 to No. 200	4.76 to 0.074
Sand	coarse	4.76 to 2.00
	medium	2.00 to 0.420
	fine	0.420 to 0.074
Silt and Clay	Below No. 200	Below 0.074

Relative Density (SPT)

SANDS AND GRAVELS	BLOWS/FOOT
VERY LOOSE	0 - 4
LOOSE	4 - 10
MEDIUM DENSE	10 - 30
DENSE	32 - 50
VERY DENSE	OVER 50

Consistency (SPT)

SILTS AND CLAYS	BLOWS/FOOT
VERY SOFT	0 - 2
SOFT	2 - 4
MEDIUM STIFF	4 - 8
STIFF	8 - 16
VERY STIFF	16 - 22
HARD	OVER 32

STANDARD OPERATING PROCEDURE NUMBER SOP-05

MONITORING WELL INSTALLATION

1.0 PURPOSE

This procedure provides general guidance and information pertaining to proper design and installation of ground water monitoring wells. The methods described herein are specific for monitoring well construction at the Naval Support Facility Indian Head facility.

2.0 RESPONSIBILITIES

Driller - The driller provides adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of performing all phases of proper monitoring well installation and construction in accordance with State of Maryland and Charles County regulations. The drilling contractor personnel must have all the health and safety training required to perform the work, as specified in the health and safety plan. The driller is also responsible for obtaining, in advance, any required permits for drilling and monitoring well installation and construction.

Field Geologist - The field geologist supervises and documents well installation and construction performed by the driller and ensures that the screen interval for each monitoring well is properly placed to provide representative groundwater data from the monitored interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

Site Safety Officer – The site safety officer is responsible for clearing the drill site for underground and overhead utilities or other potentially hazardous obstructions.

3.0 REQUIRED EQUIPMENT/ITEMS

The following list includes equipment and items required for monitoring well installation:

Health and safety equipment as required by the HASP and the site safety officer.

Well drilling and installation equipment with associated materials (supplied by the driller).

Hydrogeologic equipment (weighted engineer's tape, water-level indicator, retractable engineer's rule, electronic calculator, clipboard, mirror and flashlight for observing downhole activities, paint and ink marker for marking monitoring wells, well installation forms, and a field notebook).

4.0 WELL DESIGN AND CONSTRUCTION

4.1.1 Sample the monitoring well borings continuously to the termination depth using dual tube DPT MacroCore™ sampling techniques. Decontamiate all downhole drilling equipment between each drilling location as per SOP-03.

4.1.2 Construct the monitoring wells of 1-inch inside diameter (ID), Schedule 40, flush-joint, PVC riser pipe and flush-joint, factory-slotted nominal ID of 1 inch pre-packed well screen. Well screens will be 10 feet in length, with a 0.01-inch slot size. The monitoring wells will be installed through DPT drill casing of a nominal 3-inch ID using the following procedure. The well riser and screen will be joined and lowered to the desired depth within the well boring, inside the DPT drill casing.

4.1.3 While the casing is being withdrawn from the ground, fill the annular space around and above the pre-pack screen with silica sand to at least 1 to 2 feet above the screen.

Note: Bentonite (see next two steps) expands by absorbing water and provides a seal between the screened interval and the overlying portion of the annular space and formation. Cement-bentonite grout is placed on top of the bentonite pellets extending to the surface. The grout effectively seals the well and eliminates the possibility for surface infiltration reaching the screened interval. Grouting also replaces material removed during drilling and prevents hole collapse and subsidence around the well. A tremie pipe should be used to introduce grout from the bottom of the hole upward to prevent bridging and to provide a better seal. However, in shallow boreholes that do not collapse, it may be more practical to pour the grout from the surface without a tremie pipe.

4.1.4 Using only 100 percent certified pure sodium bentonite grout, install a bentonite seal up to 2 feet thick and allow the seal to hydrate for at least one hour prior to grout installation. Continually monitor the depths of backfill materials during well installation using a weighted stainless-steel or fiberglass tape measure.

4.1.5 With a 20:1 cement/bentonite grout, backfill to the surface the remaining annulus above the hydrated bentonite seal using a tremie pipe, i.e., the drill casing,. A maximum of 10 gallons of water per 94-pound bag of Type 1 cement may be used. The grout mixture should be blended in an above-ground rigid container or mixer to produce a thick lump-free mixture.

4.1.6 When the well is completed and grouted to the surface, place a protective steel surface casing over the top of the well riser pipe. Ensure the finished well casing extends at least 30 inches above the ground level and fit tThis casing with a cap that can be locked to prevent vandalism. Ensure a vent hole is provided in the cap to allow venting of gases and mainteance of atmospheric pressure as water levels rise or fall in the well. The protective casing has a larger diameter than the riser pipe and is set into the wet cement grout over the well upon completion. Ensure the protective casings extends 3 feet below the ground surface and that it has at least one drain hole positioned approximately 0.5 feet above the ground surface.

4.1.7 Construct a concrete apron measuring 3 feet by 3 feet by 0.5 feet deep equally portioned around the casing of each well.

4.1.8 Install one bumper post (4-inch nominal diameter, 7-feet length) in each of the four corners of the concrete apron and paint the posts glow-orange color.

4.1.9 Apply well Identification (ID) tags in accordance with state regulations.

5.0 DOCUMENTATION OF FIELD ACTIVITIES

A critical part of monitoring well installation is recording of significant details and events in the site logbook, on field forms, and in a field logbook. Detailed requirements for borehole logging are contained in SOP - 05.

6.0 ATTACHMENTS

1. Overburden Monitoring Well Sheet

ATTACHMENT 1
OVERBURDEN MONITORING WELL SHEET



Tetra Tech NUS, Inc. **OVERBURDEN MONITORING WELL SHEET**

BORING NO.: _____

PROJECT:	NIROP FRIDLEY	DRILLING Co.:	BORING No.:
PROJECT No.:	7842 CTO 0057	DRILLER:	DATE COMPLETED:
SITE:	ANOKA PARK	DRILLING METHOD:	NORTHING:
GEOLOGIST:	_____	DEV. METHOD:	EASTING:

ELEVATION OF TOP OF SURFACE CASING: _____

STICK -UP TOP OF SURFACE CASING: _____

ELEVATION OF TOP OF RISER PIPE: _____

RISER STICK-UP ABOVE GROUND SURFACE: _____

I.D. OF SURFACE CASING: _____

TYPE OF SURFACE CASING: _____

GROUND ELEVATION: _____

TYPE OF SURFACE SEAL: _____

RISER PIPE I.D.: 2"

TYPE OF RISER PIPE: CARBON STEEL

BOREHOLE DIAMETER: _____

TYPE OF SEAL: _____

ELEVATION / DEPTH OF SEAL: _____ /

TYPE OF SEAL: BENTONITE CHIPS

ELEVATION / DEPTH TOP OF FILTER PACK: _____ /

ELEVATION / DEPTH TOP OF SCREEN: _____ /

TYPE OF SCREEN: CARBON STEEL

SLOT SIZE X LENGTH: 10 SLOT x

I.D. OF SCREEN: 2"

TYPE OF FILTER PACK: SILICA SAND
(No. 10-20 U.S. STANDARD SEIVE SIZE)

ELEVATION / DEPTH BOTTOM OF SCREEN: _____ /

ELEVATION / DEPTH BOTTOM OF FILTER PACK: _____ /

TYPE OF BACKFILL BELOW WELL: _____

ELEVATION / DEPTH OF BOREHOLE: _____ /

STANDARD OPERATING PROCEDURE SOP-06

MONITORING WELL DEVELOPMENT

1.0 PURPOSE

This procedure provides general guidance and information pertaining to proper development of new and existing monitoring wells. The methods described herein are specific for monitoring wells located at the NSF Indian Head facility.

2.0 RESPONSIBILITIES

The drilling contractor or TtNUS personnel shall provide adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of developing monitoring wells. The field personnel must have all the health and safety training required to perform the work, as specified in the health and safety plan (HASP).

3.0 REQUIRED EQUIPMENT/ITEMS

The following list includes equipment and items required for monitoring well development:

Health and safety equipment as required by the HASP and the site safety officer.

Well development equipment with associated materials (supplied by the driller or TtNUS).

Hydrogeologic equipment (water-level indicator, electronic calculator, clipboard, paint and ink marker for marking existing monitoring wells, well development forms, and a field notebook).

4.0 WELL DEVELOPMENT METHODS

Do not develop new monitoring wells until at least 24 hours after the well has been installed and grouted. This time is required so that the grout in the annulus can set and harden. The purpose of well development is to stabilize and increase the permeability of the sand pack and the well screen and to

restore the permeability of the formation that may have been reduced by drilling operations. Wells are typically developed until all fine material and drilling water, if any, is removed from the well.

Develop wells by bailing and surging, and/or by pumping and surging, as determined by the TtNUS field geologist. The subcontractor may provide the surge block and pump used during development. The wells will be developed until the discharge water is visibly clear or as determined by the TtNUS field geologist. The TtNUS field geologist will record field parameters, such as pH, temperature, conductivity, and turbidity during development. Containerize all development water in 55-gallon drums in accordance with SOP-11.

A surge block or a stainless steel bailer that is approximately the same diameter as the well casing may be used to agitate the water, causing it to move in and out of the screens. This movement of water pulls fine materials into the well, where they may be removed by any of several methods, and prevents bridging of sand particles in the gravel pack.

Development should proceed until the following criteria are met:

- The well water is clear to the unaided eye.
- When field parameters become stable +/- 10%.

or

- A minimum removal of three times the standing water volume in the well (to include the well screen and casing plus saturated borehole annulus, assuming 30% annular porosity).

If for any reason the above criteria cannot be met, the site geologist should document the event in writing and consult with the Task Order Manager regarding an alternate plan of action.

Complete the well development at least 24 hours before well sampling. The intent of this hiatus is to provide time for the groundwater surrounding the newly developed well to sufficiently equilibrate to static conditions.

5.0 WELL DEVELOPMENT FOR SHALLOW WELL DEPTHS LESS THAN 25 FEET

Development of the shallow wells will be accomplished using either peristaltic pump or submersible pump and PE tubing.

- 5.1 Insert the intake end of a length of PE tubing to the bottom of the screen point and attach a length of silicon tubing (approximately 1 foot) to the discharge end of the PE tubing. The silicon tubing will be threaded around the rotor of the pump and out of the pump.
- 5.2 The PE tubing will be lifted and lowered slightly while the pump is operating. The maximum pump rate will be approximately 2 liters per minute during development. However, the yield of the formation will dictate the pumping rate.
- 5.3 The pH, specific conductance, turbidity, dissolved oxygen, ORP, and temperature shall be recorded every 5 to 10 minutes during the development process using a water quality meter and flow-through cell. Complete the shallow wells development based on the well development criteria described in Section 4.0

6.0 WELL DEVELOPMENT FOR DEEPER WELL DEPTHS GREATER THAN 25 FEET

Develop the deeper wells using the airlift method and/or submersible pump, and PE tubing in the same manner as described in Section 5 to meet the well development criteria presented in Section 4.

7.0 ATTACHMENTS

1. Monitoring Well Development Record

STANDARD OPERATING PROCEDURE

SOP-07

INSPECTION OF EXISTING MONITORING WELLS

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes procedures for the inspection and repair of existing monitoring wells at the NSF Indian Head – Stump Neck Annex facility.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following equipment and field forms are required for inspection of existing monitoring wells.

Monitoring well inspection form: A copy of the monitoring well inspection form is attached.

Writing utensil with indelible ink

Bound field logbook

Well keys

Disposable medical-grade gloves (e.g., latex, nitrile)

Electronic water-level indicator

Steel rod (about 1 inch in diameter with eye bolt at one end)

100 feet of nylon rope

Internal pipe cutter

File, v notch

3.0 INSPECTION PROCEDURES

- 3.1 Record the well identification information (ID), date, and time on the Monitoring Well Inspection Form.
- 3.2 Record the condition of the well ID tag. If the tag is not in place and legible, note the discrepancies on the Monitoring Well Inspection Form.

- 3.3 Record the condition of the protective casing, caps, and lock. For example, has the casing, cap, and/or lock been tampered with or damaged? Has the well been damaged in any way or does it show signs of deterioration?
- 3.4 Record the condition of the concrete or gravel pads, if a pad is present. Check the condition of the pad (or the area around the well if no pad exists) and note any abnormalities. For example, are concrete pads cracking or heaving? If a gravel pad is present, is there any erosion or plant growth in the pad area?
- 3.5 Record the condition of the cement seal surrounding the protective casing. For example, has the seal cracked or pulled away from the protective casing? Record any visible signs of deterioration in the area of the seal.
- 3.6 Record the presence of depressions and/or standing water around the casing or pad.
- 3.7 Unlock the well cap and open the protective cover, if one exists.
- 3.8 Inspect and record the condition of the polyvinyl chloride (PVC) riser pipe and the surveyed reference point. The surveyed reference point is a V-notch on the top of the PVC riser pipe.
- 3.9 Measure the height of the protective casing and riser pipe above the ground surface. Record these readings on the inspection form to the nearest 0.01foot.
- 3.10 Check the existing well log to verify the total original depth of the monitoring well being inspected.
- 3.11 Lower the electronic water-level indicator probe down the well casing. If an obstruction is encountered, record the depth of the obstruction and whether the obstruction is partial or complete.
- 3.12 If no obstruction is encountered, continue lowering the water-level indicator down the well casing until ground water is encountered. Measure the depth to water to the nearest 0.01 foot (see SOP-12) and record the depth on the Inspection Log.
- 3.13 Continue lowering the indicator probe down the casing until a solid bottom is reached or an obstruction is encountered. Record the depth to the bottom of the well (from top of casing) on the Inspection Log.

- 3.14 If an obstruction is encountered in the casing before the well bottom is reached, record the depth of obstruction on the Inspection Log and whether the obstruction is partial or complete.
- 3.15 Remove the water-level indicator from the well.
- 3.16 If an obstruction was encountered during steps 3.11 or 3.13, lower a heavy steel rod slowly down the well casing until the obstruction is encountered. Attempt to loosen the obstruction by raising and dropping the steel rod, letting it hit the obstruction with gradually increasing force. Record whether the obstruction could be loosened.
- 3.17 If step 3.16 is performed, remove the steel rod from the well and measure the depth to the obstruction. If the obstruction has been knocked loose and settles to the bottom, then the well shall be redeveloped (see SOP-06) prior to ground water sampling.
- 3.18 Close the well cap and lock, if lock is present.
- 3.19 Decontaminate the water-level indicator and steel rod, if used, per SOP-03.
- 3.20 Make recommendations on the Inspection Log, if necessary, for repair of the monitoring well. Replace lock, if needed, as soon as possible.
- 3.21 Perform repair of well as soon as possible.

4.0 Field Repairs to Monitoring Wells

Field repairs to monitoring wells, for the most part, will be limited to the repair of the PVC riser (inter case). If a monitoring well is damaged beyond the repair capabilities of the field crew and the monitoring well integrity is believed to be compromised then notify the TtNUS project manager and NSF Indian Head Environmental personnel regarding the condition of the well. A decision will be made to either repair or replace the well using a drilling contractor.

5.0 ATTACHMENTS

- 1. Monitoring Well Inspection Sheet

**ATTACHMENT 1
 MONITORING WELL INSPECTION SHEET**

MONITORING WELL INSPECTION SHEET

Well ID: _____

Time: _____

Date: _____

Inspector's Name: _____

Inspection Item	Types of Problems	Status		Observation
		S	U	
Well Tag	Is it in-place, legible			
Well security	Condition protective case, cap, lock			
Well pad	Concrete or gravel & condition			
Well seal	Condition of...			
Area immediately around well pad	Record any evidence of/or standing water in area of well			
Dedicated sampling equipment	Condition of...			
PVC Riser	Condition of riser & survey reference point			

Comments:

Signature(s) _____

Note: S= Satisfactory, U= Unsatisfactory
 Check one. If unsatisfactory explain

MSB-NLON
 Field Form
 Revision: 1
 January, 1999

STANDARD OPERATING PROCEDURE NUMBER SOP-08

CALIBRATION AND CARE OF WATER QUALITY METERS

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedures for the calibration and maintenance of field instruments used to measure water quality and for the proper documentation of calibration and maintenance at the NSF Indian Head – Stump Neck Annex facility. The YSI 556 MPS Environmental Monitoring System will be used to measure pH, temperature, oxidation-reduction potential (ORP), specific conductance (SC), and dissolved oxygen (DO). The turbidity in water will be measured using a LaMotte 2020e or equivalent. The procedures for the YSI 556 MPS are provided in Section 3 and Section 4 provides the procedures for the LaMotte 2020e.

2.0 FIELD FORMS AND EQUIPMENT LIST

The following logbooks, forms, equipment, and supplies are required:

Site logbook

Equipment calibration log sheet

YSI Model 556 MPS with on board barometer and Sonde: multi-parameter water-quality meter with flow through cell.

LaMotte 2020e Turbidity Meter

Equipment manuals

Calibration kits

Deionized water, paper towels, spray bottle, etc.

Disposable medical-grade gloves (e.g., latex, nitrile)

3.0 YSI PROCEDURES

This section describes the calibration procedure for the YSI Model 556 MPS. The meter is supplied with an instruction manual. The manual will be on site and will be used as the calibration guidance document

for the meter's calibration. This procedure will list requirements for frequency of calibration and checks to be performed on the meter.

The YSI Model 556 MPS and Sonde is a multi-parameter, water-quality meter that with the flow through cell attached, the meter has the ability to measure water-quality parameters in ground water via a pump discharge line. By performing the measurements in the discharge line coming directly from the well, the parameters are measured before the ground water comes in contact with the atmosphere. The parameters measured by the YSI for this field effort are as follows:

- DO
- Conductivity
- Temperature
- pH
- ORP

3.1 Documentation

The Equipment Calibration Log is used to document calibration of measuring equipment used in the field. The Equipment Calibration Log documents that the manufacturer's instructions were followed for calibration of the equipment, including the frequency of calibration, type of standards used, and checks performed on calibration during the course of using the equipment. An Equipment Calibration Log must be maintained for each measuring device that requires calibration. Entries must be made for each day the equipment is used. A blank Equipment Calibration Log form is attached at the end of this SOP.

3.2 Calibration

The following YSI parameters DO, conductivity, and pH must be calibrated prior to the start of each day of use. Calibration and calibration checks will be documented in the field logbook and on the Equipment Calibration Log. The name, lot number, and expiration date for all calibration buffers and standards used will be recorded on the Equipment Calibration Log. The meter's model, serial number, and name of rental company will also be recorded on the equipment calibration form.

3.3 Tips for Good Calibration

- The DO calibration is a water-saturated air calibration. Make certain to loosen the calibration cup seal to allow pressure to equilibrate before calibrating.

- Make certain that sensors are completely submersed in solution and readings are stable when calibration values are entered.
- Use a small amount of calibration solution (previously used solution may be used, then discarded for this purpose) to pre-rinse the sonde.
- Fill a bucket with ambient temperature water to rinse the sonde between calibration solutions.
- Make sure to rinse and dry the probe between calibration solutions. This will reduce carry-over contamination and increase the accuracy of the calibration.

3.4 MAINTENANCE

The YSI Meter will be rented for the duration of field effort. Therefore, little field maintenance will be required. For any maintenance other than the routine cleaning, calibrating, or battery charging, the instrument should be returned to the vendor and a replacement sent immediately to the job site.

3.4.1 Meter Storage

For this field effort, the meter storage will be short term, [i.e. over night or between work shifts (4-day break)]. During these breaks, charge the meter. Place one-half inch of tap or distilled water in the meter calibration cup thread the cup onto the sonde. The key for short-term storage of probes is to use a minimal amount of water so the calibration cup will remain at 100 percent humidity. The water level must be low enough so that none of the probes are actually immersed. Proper storage of the sonde between usages will extend its life and will also ensure that the unit is ready for use as quickly as possible for the next application.

Multi-parameter short term storage key points:

- Use enough water to provide humidity but not enough to cover the probe surfaces.
- Make sure the storage vessel is sealed to minimize evaporation.
- Check periodically to make certain that water is still present.

3.4.2 Probe Cleaning

- Rinse the probe thoroughly with potable water.
- Rinse and soak the probe in deionized water.
- If stronger cleaning is required, Wash the probe in a mild solution of Liquinox and water and wipe with paper towels and/or cotton swabs.

Note: Reagents that are used to calibrate and check the YSI may be hazardous. Review the health and safety plan, Appendix D of the equipment manual, and Material Safety Data Sheets (MSDSs), all of which are on file in the field trailer.

4.0 LAMOTTE TURBIDITY METER PROCEDURES

This section describes the calibration procedure for the LaMotte 2020e turbidity meter. The meter is supplied with an instruction manual. The manual will be on site and will be used as the calibration guidance document for the meter's calibration.

4.1 Calibrate the LaMotte 2020e prior to the start of each day of use.

4.2 Document the calibration in the field logbook and on the Equipment Calibration Log. Record on the Equipment Calibration Log the name, lot number, and expiration date for all calibration standards used.

4.3 Record the meter's model, serial number, and name of rental company on the equipment calibration form.

ATTACHMENTS

1. Equipment Calibration Log

STANDARD OPERATING PROCEDURE

SOP-09

LOW-FLOW WELL PURGING AND STABILIZATION

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for well purging and stabilization utilizing low-flow techniques.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for low-flow purging.

Low-Flow Purge Data Sheet: A copy of this form is attached at the end of this SOP.

Bound field logbook

Writing utensil

Well key

Electronic water-level indicator: The water-level indicator must have a cable of sufficient length to reach the water surface and be capable of measurements of 0.01 foot (see SOP-12).

Submersible Bladder Pump: QED Sample Pro or equivalent using twin bonded ¼-inch PE tubing.

Electronic Programmable Controller, MP-10: This controller regulates air flow in a bladder pump.

Cylinder of compressed nitrogen with regulator: Compressed gas serves as the power source for the bladder pump.

Peristaltic Pump: Using siliclastic tubing and ¼-inch PE tubing

Water-quality meters: These unit measures and displays field parameters measured in the field including turbidity, pH, dissolved oxygen, oxidation-reduction potential (ORP), temperature, and specific conductance (see SOP-08).

Flow-through cell adapter for water-quality meter

Purge water containers

Graduated cylinder and stopwatch: Used to calculate flow rate.

Decontamination supplies: SOP-03 describes required decontamination supplies.

Disposable medical-grade gloves (e.g., latex, nitrile)

3.0 PROCEDURES FOR WELL PURGING

- 3.1 Prior to mobilizing to the site, clean, check for proper operation, and calibrate above equipment in accordance with manufacturer requirements as necessary.
- 3.2 Follow the steps outlined in SOP-12 to obtain a static water-level measurement of the well to be purged. Record the information on the Groundwater Sample Log Sheet (see SOP-10) and the Low-Flow Purge Data Sheet.
- 3.3 Purge wells using either a submersible bladder pump or surface peristaltic pump. For wells with depths to water level exceeding the capacity (about 27 ft to water) of the peristaltic pump use a submersible bladder pump to purge and sample the well. Follow steps 3.5 through 3.9 for bladder pump procedures; skip to 3.10 for peristaltic pump procedures.
- 3.4 Connect the pump controller to the well pump air supply (at the well cap) by following the instructions in the pump control manual. The pump controller must be turned off when it is being connected.
- 3.6 Connect the nitrogen cylinder to the pump controller. The nitrogen cylinder valve must be closed and the regulator line pressure set at zero pounds per square inch (psi) when it is being connected.
- 3.7 Following the instructions found in the water-quality meter manual, connect the flow-through cell to the pump discharge line (at the well cap).
- 3.8 Place the discharge tubing from the flow-through cell to direct the purge water discharge into the graduated cylinder or purge water container.
- 3.9 Following the instructions in the pump controller manual, start pumping water from the well.
- 3.10 Peristaltic pump may also be used to purge and sample groundwater monitoring wells. Attach well tubing to the input side of the pump via the siliclastic tubing and the out from the pump to the input side of the flow through cell.
- 3.11 Start with the initial pump rate set at approximately 0.1 liters per minute. Use the graduated cylinder and stopwatch to measure the pumping rate. Adjust pumping rates as necessary (the

pumping rate shall not exceed 0.5 liters per minute) to prevent drawdown from exceeding 0.3 foot during purging. Slow recovering wells will be identified and purged at the beginning of the workday. If possible, samples will be collected from these wells within the same 8-hour workday. If the well goes dry during the purge process allow it to recover 80% then proceed to sample the well in accordance with SOP 10.

The time to sample any given well may vary greatly due to the many variables associated with low flow purging and sampling:

- Stabilization of parameters
- Possible drawdown

Normally, the time from the start of purging to the end of sampling will be between 1 and 4 hours.

- 3.12 Measure the well water level using the water-level meter every 5 to 10 minutes pending the pumping rate. Typically, higher the flow rate the shorter the time period between measurements. Record the well water level on the Low-Flow Purge Data Form (attached at the end of this SOP).
- 3.13 Every 5 to 10 minutes, record on the Low-Flow Purge Data Form the water-quality parameters (pH, specific conductance, temperature, turbidity, oxidation-reduction potential, and dissolved oxygen) measured by the water-quality meter and turbidity meter. If the cell needs to be cleaned during purging operations, continue pumping (allow the pump to discharge into a container) and disconnect the cell. Rinse the cell with distilled water. After cleaning is completed, reconnect the flow-through cell and continue purging. Document the cell cleaning on the Low-Flow Purge Data Form.
- 3.14 Measure the flow rate using a graduated cylinder. Remeasure the flow rate any time the pump rate is adjusted.
- 3.15 During purging, check for the presence of bubbles in the flow-through cell. The presence of bubbles is an indication that connections are not tight. If bubbles are observed, check for loose connections.
- 3.16 Stabilization is achieved and sampling can begin when three consecutive readings, taken at 5- to 10-minute intervals, are within the following limits:

- pH \pm 0.1 standard units
- Specific conductivity \pm 5%
- Temperature \pm 10%
- Turbidity less than 10 NTUs
- Dissolved oxygen \pm 10%

If the above conditions have still not been met after the well has been purged for 3 hours, purging will be considered complete and sampling can begin.

Record the final well stabilization parameters from the Low-Flow Purge Data Form onto the Groundwater Sample Log Form.

If there is a need to leave a well during purging, there are two options:

- One, if the sampler must move for 30 minutes or less but still has a clear line of sight to the well; the sampler may leave the pump running and watch the well from a distance until he or she is able to return to the well.
- Two, if for whatever reason, the sampler must stop purging for an extended period of time or a clear line of sight cannot be maintained, the pump and cell will be shut down. All equipment and supplies will be loaded into the sample vehicle, and the well will be secured before the sampler departs.

In both cases, the time purging was stopped and restarted will be noted on the Low-Flow Purge Data Form.

- 3.17 Rinse the flow-through cell, the water-quality meter probes, and the turbidity cell with analyte-free water and pack the cell and meters for transport.

4.0 ATTACHMENTS

1. Low-Flow Purge Data Sheet

STANDARD OPERATING PROCEDURE SOP-10

GROUNDWATER SAMPLING

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes the procedure for collecting groundwater samples from monitoring wells. Low-flow sampling techniques will be used for groundwater sampling at the NSF Indian Head facility.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following field forms and equipment are required for low-flow sampling of monitoring wells:

Writing utensil (preferably black ink)

Groundwater Sample Log Form: A copy of this form is attached at the end of this SOP

Bound field log book

Chain-of-Custody Form

Bladder pump: With accessories: twin bonded PE ¼-inch tubing, MP-10 control box, nitrogen gas cylinder, and nitrogen regulator (also used to purge the well see SOP 09).

Peristaltic pump: Silicon and ¼-inch PE tubing (also used to purge the well see SOP 09).

Required sample containers with appropriate preservative: All sample containers for analysis by fixed-base laboratories will be supplied and deemed certified clean by the laboratory.

Surgical gloves

Water-level indicator

0.45-micron filter cartridge: If the metal analysis requires field filtering.

Bucket: to collect development/purge water

Calculator, wristwatch, and timer

Stainless steel clamps

Plastic storage bags

Shipping containers with ice

3.0 SAMPLING PROCEDURES FOR MONITORING WELLS

- 3.1 Groundwater sampling may be initiated when the monitoring well has been purged and stabilized in accordance with SOP-09.
- 3.2 Record the sample start time (using military time) on the Groundwater Sample Log Sheet. Record the field measurements for pH, oxidation-reduction potential (ORP), specific conductivity, temperature, dissolved oxygen, and turbidity.
- 3.3 With the pump continuing to run, disconnect the flow-through cell from the pump discharge tube and immediately start filling sample bottles directly from the pump discharge. All sample containers will be supplied by the laboratory, and the laboratory will pre-preserve all sample containers, where appropriate.
- 3.4 Allow the pump discharge to flow gently down the inside of the container with minimal turbulence when filling sample containers. Avoid immersing the discharge tube into the sample as the sample container is being filled. Sample containers for volatile constituents (VOCs) must be completely filled so that no headspace exists in the container. The VOC vials will be filled to the top so that a convex meniscus is formed. Gently secure the cap, turn the vial upside down, and check to see if any air has been trapped inside the vial. If so, open the cap, reform the meniscus, and attempt again to secure the lid without trapping air in the sample. All other sample containers can have air space included when the container lid is secured.
- 3.5 Cap each container immediately after filling.

- 3.6 Record the sample time on the Groundwater Sample Log Form, and the sample label.
- 3.7 Place the tagged sample container into a plastic storage bag and then into a cooler containing ice.
- 3.8 Enter the proper information on the Chain-of-Custody Form for each sample container.
- 3.9 Repeat steps 3.3 through 3.9 for each sample container collected.
- 3.10 The pump rate should not be adjusted after sampling has commenced. If it becomes necessary to adjust the pump rate, document the change on the Groundwater Sample Log Form.
- 3.11 Collect all samples into pre-preserved bottles (if required) supplied by an approved laboratory. All samples will be collected in the following sequence (where applicable):
 - Volatile organic compounds (VOCs)
 - Other organics
 - Metals
 - Other Inorganics
 - Filtered Metals

Note: Only select VOCs and total metals analyses are required for the Phase I groundwater Remedial Investigation.

- 3.12 Filtered aliquots of groundwater may be collected and analyzed for dissolved metals. Without turning off the pump, attach a disposable, inline, 0.45-um filter cartridge at the end of the discharge tube. Flush the filter with sample until at least 100 mL of sample has passed through the filter, then fill sample containers marked for dissolved metals so that the laboratory knows that these aliquots are distinct sample fractions and that the results should be reported as dissolved analytes.
- 3.13 Repeat steps 3.5 through 3.9 for the filtered sample containers then proceed to Step 3.14..

- 3.14 After completion of sample collection, remove the bladder pump (if bladder pump is used for sampling) from the well, disassemble as per manufacture instructions and decontaminate the pump following the procedures in SOP-03 and reassemble for the next use. Leave dedicated tubing inside the well for possible future sampling events.
- 3.15 Replace the outer protective well cap and lock the well.
- 3.16 All equipment should be cleaned and packed into the sample vehicle, along with the sample cooler for transport. Disposable gloves and other equipment should be placed in a plastic trash bag and handled as investigation-derived waste (SOP-11).

4.0 ATTACHMENTS

1. Groundwater Sample Log Sheet

STANDARD OPERATING PROCEDURE NUMBER SOP-11

MANAGEMENT OF INVESTIGATION-DERIVED WASTE

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes how investigation-derived waste (IDW) will be collected, and managed during the field investigations at the at the NSF Indian Head facility. The following types of IDW will be generated during this investigation:

- Residual soil remaining from subsurface DPT drilling activities
- Well development water and purge water related to monitoring well installation and sampling
- Decontamination solutions
- Personal protective equipment and clothing (PPE)
- Miscellaneous trash and incidental items

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

Health and safety equipment (with PPE)

Decontamination equipment

Field logbook and indelible ink pen

Plastic sheeting and/or tarps

55-gallon drums with sealable lids

IDW labels for drums

Wastewater container tanks

Plastic garbage bags

3.0 PROCEDURES

Management of IDW includes the collection, segregation, temporary storage, classification, final disposal, and documentation of the waste-handling activities.

3.1 Liquid and Soil Wastes

Liquid wastes that will be generated during the site activities include well development water, well purge water (collected during low-flow sampling), and decontamination solutions from drilling and sampling equipment.

3.1.1 Transfer wastewaters, including monitoring well purge water, to 55-gallon drums. Purge water will be collected at the well using 5-gallon spill proof containers which will then be used to transport the waste water to the 55-gallon drums marshaled at a central location on the NSF Indian Head facility for proper disposal.

3.1.2 Place residual waste soils in 55-gallon drums marshaled at the same location as the waste water drums. The location and number of drums used for the completion of work will be documented in the field note book. Each drum will be labeled and the following information will be placed on the label

- Contents (soil or water)
- Site i.e. Site 41 UXO 32
- Location (NSF Indian head)
- The drum volume
- The date and time the waste was placed in the drum
- The NSF Indian Head program manager name and contact phone number

3.2 PPE, Pump Discharge Tubing, Direct-Push Technology (DPT) Sample Liners, and Incidental Trash

All PPE wastes, pump discharge tubes, DPT sample liners, and incidental trash materials (e.g., wrapping or packing materials from supply cartons, waste paper) must be decontaminated (if contaminated), double bagged, securely tied shut, and placed in a designated waste receptacle at NSF Indian Head.

STANDARD OPERATING PROCEDURE

SOP-12

MEASUREMENT OF WATER LEVELS IN MONITORING WELLS

1.0 PURPOSE

This Standard Operating Procedure (SOP) establishes procedures for determining water levels in monitoring wells.

2.0 REQUIRED FIELD FORMS AND EQUIPMENT

The following equipment and field forms are required for determining water levels in monitoring wells.

Ground Water Level Measurement Form: A copy of the Ground Water Level Measurement Form is attached.

Bound field logbook

Well key

Writing utensil

Electronic water-level indicator: The water-level indicator must have a cable of sufficient length to reach the water surface and be capable of measurements of 0.01 foot.

Decontamination supplies: SOP-03 describes decontamination procedures including decontamination supplies.

3.0 WATER-LEVEL MEASUREMENT PROCEDURES

- 3.1 Check the operation of the electronic water-level indicator or interface meter.
- 3.2 Record the well identification (ID), date, and time (using military time) on the Ground Water-Level Measurement Form.
- 3.3 Unlock the well and remove the well cap.
- 3.4 Place the well cap on a clean surface.

- 3.5 Slowly lower the probe into the well riser pipe until an audible and/or visible signal is produced, indicating contact with the water surface.
- 3.6 Read the ground water-level measurement from the top of the inner casing at the surveyed reference point (sometimes marked with a "V" notch or black ink marker) to the nearest 0.01 foot.
- 3.7 Record the water-level measurement on the Ground Water Level Measurement Form.
- 3.8 Wind the meter cable measuring tape back onto the spool.
- 3.9 Replace the well cap and lock.
- 3.10 Decontaminate the meter's probe and cable following the procedures outlined in SOP-03.
- 3.11 Containerize any decontamination fluids and PPE in accordance with the procedures described in SOP-11.

4.0 ATTACHMENTS

1. Ground Water Level Measurement Sheet

APPENDIX B

**LABORATORY STANDARD OPERATING PROCEDURES
AND ELAP CERTIFICATION DOCUMENTS**

APPENDIX B

**LABORATORY STANDARD OPERATING PROCEDURES
AND ELAP CERTIFICATION DOCUMENTS**

**EMPIRICAL LABORATORIES, LLC
STANDARD OPERATING PROCEDURE**

ORGANICS: SOP 202

REVISION #: 23

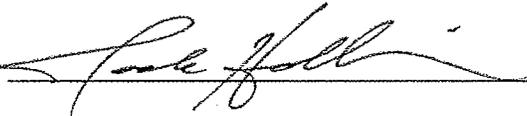
EFFECTIVE DATE: 20100909

**GC/MS VOLATILES BY EPA METHOD E624 & SW846 METHOD 8260B
INCLUDING APPENDIX IX COMPOUNDS**

APPROVALS:

Lab Director:  Date: 9/9/10

Data Quality Manager:  Date: 9/9/10

Section Supervisor:  Date: 9/9/10

Changes Summary

Revision 23, 09/09/10

- This SOP is an update from Revision 22 dated 09/30/09.
- Tables 1 and 2 have been updated with appropriate reference updates.
- Tables 5-7 have been added.

Revision 22, 9/30/09

- The SOP is an update from Revision 21 dated 09/11/08
- The SOP is formatted to include all 22-elements required per the NELAC standards
- The laboratory's revision of all technical SOPs now includes a Table of Contents that provides the map of the technical information contained within the SOP.
- Additional requirements, based upon the DoD QSM 4.1, have been integrated into the routine sample flow; however, if the requirement is different from routine sample flow, then the requirement is outlined and documented as such to be followed only when DoD samples are analyzed.

Table of Contents

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1. Identification of the Test Method

1.1 This SOP is compliant with methods – EPA Method 624 and SW-846 Method 8260B

2. Applicable Matrix or Matrices

2.1 This SOP is applicable to – The analysis of volatile organic compounds in a variety of matrices including but not limited to soils, sediments, ground and surface waters, aqueous sludge, oily wastes, etc.

3. **Detection Limit:** See **Table 1** of this SOP.

4. Scope of Application, Including components to be Analyzed

4.1 This SOP is based primarily on SW-846 Method 8260B. Methods SW-846 Method 8000B; *Federal Register* Method 624; and CLP Method for Volatiles have also been used in the development of this SOP. The analyses by these various methods are clearly defined in the respective regulatory manuals. A good understanding of these different methods is essential to the performance of each method. Each parameter that is analyzed and reported under the scope of this SOP is listed in **Table 1** of this SOP. When applicable, surrogate and Internal Standard Analytes are listed and indicated as such within this table.

5. Summary of the Test Method

5.1 After sample preparation, the sample is introduced into the GC/MS generally using purge and trap but sometimes using direct injection (see SW-846 Methods 5030B, 5035 and 3585 for preparation). In purge and trap, the analytes are stripped from the sample using helium and trapped on an adsorbent tube. The tube is heated while being backflushed with helium to carry the analytes to the GC/MS system. The analytes are separated in the gas chromatograph by a combination of the temperature program and the capillary column. The analytes are then detected by the mass spectrometer. Analytes are identified by comparing the mass spectra of known standards with the mass spectra of the sample. Analytes are quantitated relative to known standards using the internal standard method.

6. Definitions

6.1 Laboratory Quality System SOP QS08 “Technical / Operational Definitions, Minimum Essential Quality Control Elements, and Laboratory Calibration Procedures” provides information on the commonly used definitions.

7. Interferences

7.1 Section 3.0 of SW-846 Method 8260B details interferences and potential problems which may be encountered when dealing with volatile analyses.

8. Safety

- 8.1 Laboratory SOP QS13 "Safety Program & Chemical Hygiene Plan" discusses the safety program that is to be followed labwide.

9. Equipment & Supplies

- 9.1 GC : HP 5890 or 6890, temperature programmable, suitable for split or splitless injection.
- 9.2 Column: DB-VRX 60 meter x 0.25 mm I.D. 1.4 μm film thickness or 20 meter x 0.18 mm ID 1.0 μm film thickness silicon coated fused silica capillary column or equivalent.
- 9.3 M.S.: HP 5971, 5972 or 5973 capable of scanning 35 to 500 amu every one second or less, using 70 volts electron energy in electron impact ionization mode. The MS is capable of producing a mass spectrum for p-Bromofluorobenzene, BFB, which meets all tuning criteria for EPA methods [when 1 μL (50 ng) of the GC/MS tuning standard is introduced to the GC.]
- 9.4 Purge and Trap Unit
 - 9.4.1 Concentrators: Tekmar LSC 2000 or Tekmar/Dohrmann 3000/3100 Sample Concentrator equipped with Supelco trap number 2-1066-U or 2-4920-U VOCARB 3000 providing good delivery for all target compounds.
 - 9.4.2 Autosamplers: Varian Archon 51 position programmable autosampler with 5ml to 25ml water and heated soil capability.
- 9.5 Acquisition Software: HP chemstation system interfaced to the GC/MS. The system acquires and stores data throughout the chromatographic programs.
- 9.6 Data Processing Software: TargetDB on Windows NT data system interfaced to the HP Chemstation. The system accepts and stores acquired data. It plots by extracted ion current profile (EICP). The system is also capable of integrating the abundances of any EICP between specified time or scan-number limits. NBS75K mass spectral library is installed.
- 9.7 Microsyringes – 1.0, 5.0, 10, 25, 100, 250, 500 and 1000 μL .
- 9.8 Syringes – 5, 25 and 50 mL, gas-tight with Luer end.
- 9.9 Balance - analytical, 0.0001 g; top-loading, 0.01 g.
- 9.10 Disposable pasteur pipets.
- 9.11 Volumetric flasks, Class A - 2 mL, 5 mL, 10 mL, 50 mL, 100 mL and 250 mL with ground-glass stoppers.
- 9.12 Spatula - stainless steel.
- 9.13 Glass scintillation vials - 20mL with screw caps.
- 9.14 Nitrile Gloves
- 9.15 pH paper (measures pH from 0-14).

10. Reagents and Standards

- 10.1 The laboratory's LIMS system allows for complete documentation and for the traceability of reagents and standards used within the laboratory. The following information relates to the specific reagents and standards used for the performance of the method:
- 10.2 Organic-free reagent water - obtained from the charcoal filter system in the VOA laboratory.
- 10.3 Methanol - Purge and trap grade (EM-Omnisolv EM-0482-6 or equivalent)
- 10.4 Methanol - suitable for use in gas chromatography (B&J Omnisolv MX0484- 1, or equivalent)
- 10.5 Sodium bisulfate, NaHSO_4 - ACS reagent grade, or equivalent. Available from Aldrich (Part No. 30,782-3).
- 10.6 Stock standards are purchased in mixtures from reputable vendors. The date they are received is noted on the label. The date they are opened is noted on the label and recorded in the LIMS system along with their lot number and vendor and given a sequential number. Each standard label is completed with the standard number, name, preparation date, expiration date, solvent and analyst initials. Stock standards, when opened, have an expiration date of 6 months, **except for gas standards for South Carolina samples which have a one week expiration date**. All stocks and standards are stored in the freezer at a temperature of $-15^\circ\text{C} \pm 5^\circ\text{C}$ or less from the date they are received/prepared. The freezer temperature is monitored daily with a calibrated thermometer (annual calibration for liquid in glass and quarterly calibration for digital) and recorded with calibration correction in the VOA refrigerator/freezer logbook. Makeup of common standards is detailed below. See standard ID in LIMS system for makeup of other standards.
 - 10.6.1 The Bromofluorobenzene (BFB) tuning standard is prepared as follows: Using a 50 μL syringe, 40 μL of standard (BFB @ 2500ng/ μL) is injected into a 2mL volumetric flask containing approximately 1.0mL P&T methanol (Vendor, Lot) and diluted to volume with same making a 50ng/ μL standard. After capping and inverting 3 times, the solution is transferred to a labeled 2ml, teflon-lined, screw-capped vial and stored in the freezer at $-15^\circ\text{C} \pm 5^\circ\text{C}$ or less for up to 6 months (**1 week for South Carolina samples**). A direct injection of 1 μL (or equivalent purge) is used to tune the instrument.
 - 10.6.2 The internal and surrogate standards are prepared as follows: Using the indicated syringe, the indicated amount of standard is injected into a 50 mL volumetric flask containing P&T methanol (Vendor, Lot) and diluted to volume with same making a 150ng/ μL standard. After capping and inverting 3 times, the solution is transferred to the Archon standard vial and stored under helium for 1 month or less. Each 8260/624 sample is automatically injected with 1 μL of this standard. (The internal standard/surrogate solution may be replaced if the -50%-200% criteria fails in the CCV when calculated against the previous CCV.)

Standard	Conc. (ng/μL)	Syringe (μL)	Amount (μL)
8260 ISTD Mix	2500	1000	3000
Surr. Mix	2500	1000	3000

10.6.3 Calibration standards are prepared from the vendor stock standards at appropriate concentrations as follows. Occasionally unusual compounds are added to the mix so it is best to check the LIMS for exact standard makeup. Note: for laboratory control spikes (LCS), alternate sources or lot numbers from the main calibration standard are used to make the LCS standard.

10.6.3.1 Primary Standard: Using the indicated syringe, the indicated amount of standard is injected into a 2mL volumetric flask containing approximately 1.0mL P&T methanol (Vendor, Lot) and diluted to volume with same to make a 100-500ng/μL standard. After capping and inverting 3 times, the solution is transferred into 2ml amber vial w/mini-inert valve and stored in the freezer at $-15^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for 1 week. A 100μg/L (5mL purge) standard is made using 50μL of this standard to 50mL of reagent water.

Stock Standard(CCV)	Conc (ng/μL)	Syringe(μL)	Amount(μL)	Final Conc (ng/μL)
2-CEVE (Cat#30265)	20000	25	20	200
Vinyl Acetate (#3766)	5000	100	80	200
Ketones (cat#30006)	5000	100	80	200
Liquid mix (C-349H-07)	2000	100	100	100
Custom mix (CCS-1037)	5000	50	40	100
Gases (cat#30042)	2000	100	100	100
Acrolein/Acrylonitrile (CC2098.10)	20,000	50	50	500

Additional compounds may be added such as Appendix IX. Refer to standard ID in LIMS system.

10.6.4 ICV/LCS/Matrix Spike Mix: A second source standard is used to check the validity of the gas and primary calibration standards used in analyzing the calibration curve. Using the indicated syringe, the indicated amount of standard is injected into a 2mL volumetric flask containing approximately 1.0mL P&T methanol (Vendor, Lot) and diluted to volume with same to make a 100-500ng/μL standard. After capping and inverting 3 times, the solution is transferred into 2ml amber vial w/mini-inert valve and stored in the freezer at $-15^{\circ}\text{C} \pm 5^{\circ}\text{C}$ for 1 week. A 50μg/L ICV/LCS/Matrix Spike is made using 25μL of this standard to 50mL of reagent water/Sample Matrix.

Stock Standard(ICV/LCS)	Conc (ng/ μ L)	Syringe(μ L)	Amount(μ L)	Final Conc (ng/ μ L)
2-CEVE	20,000	25	20	200
Vinyl Acetate	5000	100	80	200
Ketones	5000	100	80	200
Liquid mix	2000	100	100	100
Custom Mix	5000	50	40	100
Gases	2000	100	100	100
Acrolein/Acrylonitrile	50,000	50	50	500

11. Sample Collection, Preservation, Shipment, and Storage

- 11.1 Quality Systems SOP QS10 related to Sample Receipt, Handling, & Processing provides details for collection, preservation, shipment, and storage.
- 11.2 All water samples are stored in the “True” refrigerator in the VOA lab at a temperature of 4°C. All unpreserved soil samples in TerraCore or encores are stored in the freezer in the VOA lab. All soil samples in bulk jars or chemically preserved TerraCore are stored in the soil walk-in refrigerator at a temperature of 4°C. Non-preserved water volatile samples have a holding time of 7 days from date of sampling. Preserved water samples and soil volatile samples have a holding time of 14 days from date of sampling (unless otherwise specified for the project). The temperature is monitored daily with a calibrated thermometer (annual calibration for liquid in glass and quarterly calibration for digital) and recorded with calibration correction in the VOA refrigerator/freezer logbook. The weekend temperature is monitored with a Min/Max thermometer and recorded upon arrival next business day.

12. Quality Control

- 12.1 Quality Systems SOP QS08 “Technical / Operational Definitions, Minimum Essential Quality Control Elements, and Laboratory Calibration Procedures” outlines details related to laboratory wide protocols on quality control.
- 12.1 Internal Standards - All samples and QC are spiked with internals. See **Table 2** for acceptance criteria and corrective action.
- 12.2 Surrogates - All samples and QC are spiked with surrogates. See **Table 2** of this SOP for acceptance criteria and corrective action.
- 12.3 LCS Sample - An LCS is analyzed every 12 hour tune. To prepare the LCS, a blank is spiked with standards prepared from an alternate vendor or lot number from the calibration standards. Note: the concentration of the LCS will be 20 μ g/L when analyzing 624 samples (QC Check Sample). See **Table 2** of this SOP for acceptance criteria and corrective action. **When analyzing samples for South Carolina the limits are 70-130% except for poor purgers which are 60-140%.**
- 12.4 Method Blanks - A method blank is analyzed every 12 hour tune. See **Table 2** of this SOP for acceptance criteria and corrective action..
- 12.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Sample - 1 in 20 samples are spiked for an MS/MSD with the LCS standard. See **Table 2** of this SOP for acceptance

criteria and corrective action. MS data evaluation must include the consideration of the following factors.

12.5.1 Sample matrix - If the sample is a soil, grab sample or sequentially collected water sample it may affect the %R and RPD of the MS/MSD. A water sample which was taken from the same VOA vial for the original sample and the MS/MSD should have very good RPDs unless there has been a method problem. Corrective action must be taken in the form of reanalysis if a method problem is indicated.

12.5.2 Original sample concentration - If a spiked compound has a problem and the concentration of that compound in the original sample was four or more times the concentration of the spike, no further corrective action may be necessary other than the generation of a corrective action report to document the problem.

12.5.3 MS vs. MSD - If a spiked compound has a problem in both the MS and MSD, review the LCS and if acceptable no further action may be necessary since it is attributable to matrix effect.

12.5.4 Non-target Interference - The presence of significant non-target interference should be brought to the immediate attention of your supervisor who should discuss the problem with the client/project manager to determine the action to be taken.

13. Calibration and Standardization

13.1 Quality Systems **SOP QS08** "Technical / Operational Definitions, Minimum Essential Quality Control Elements, and Laboratory Calibration Procedures" related to Calibration Procedures provides laboratory wide protocols for calibration and standardization.

13.2 Chromatographic conditions – Refer to corresponding instrument maintenance log for current gas chromatograph, mass spectrometer, and concentrator conditions.

13.3 System Bakeout - Prior to analysis an instrument blank is analyzed.

NOTE: Further cleaning may be accomplished by backflushing the lines with methanol and then analyzing blanks overnight.

13.4 Tuning - Prior to any calibration or analysis, BFB tuning criteria must be met for a 1.0µL injection of the tuning standard. See **Table 5** of this SOP for acceptance criteria. Tune must be met every 12 hours sample analysis is to be performed (**every 24 hours for *Federal Register Method 624* except for South Carolina which only allows 12 hours**). The mass spectrum of BFB is acquired as follows: by using the BFB method in Target (which uses three scans with background subtraction) to process the BFB data file. If the BFB tune does not pass criteria corrective action should be taken

13.5 **Calibration:** Calibration standards are made up in water using the appropriate amount of the methanol standard. See the LIMS for preparation of standards. **Calibration for soils for South Carolina requires that 5mL of sodium bisulfate**

solution is added to each calibration standard made if the samples will be preserved with sodium bisulfate. All manual calibration integrations must be approved by the section manager or designated peer reviewer.

13.5.1 Initial Calibration - An initial calibration curve at no less than five (six if using a quadratic curve fit) concentration levels must be analyzed and shown to meet the initial calibration criteria before any sample analysis may be performed. **For Arizona samples the surrogates must also be calibrated at a minimum of five concentrations.** See **Table 2** of this SOP for acceptance criteria and corrective action. The lowest standard must be less than or equal to the reported quantitation limit and the highest standard must not exceed the linear range of the detector. Any manual integrations are documented by inclusion of the integrated signals (**before and after manual integration**) initialed, dated, and reason with the quantitation report and chromatograms. All manual calibration integrations must be approved by the section manager or designated peer reviewer Any response factors less than 0.050 must be supported by the mass spectrum of the lowest standard. **No quadratic curves for South Carolina.**

CCCs:	1,1-Dichloroethene	Toluene
	Chloroform	Ethylbenzene
	1,2-Dichloropropane	Vinyl chloride
SPCCs:	Chloromethane	0.10
	1,1-Dichloroethane	0.10
	Bromoform	0.10
	Chlorobenzene	0.30
	1,1,2,2-Tetrachloroethane	0.30

13.5.2 Initial Calibration Verification (ICV) - A second source standard is prepared at or near the CCV concentration and calculated against the initial calibration curve, then shown to meet the calibration check criteria before any sample analysis may be performed. See **Table 2** of this SOP for acceptance criteria and corrective action. Any manual integrations are documented by inclusion of the integrated signals (**before and after manual integration**) initialed, dated, and reason with the quantitation report and chromatograms. All manual ICV integrations must be approved by the section manager or designated peer reviewer.

13.5.3 Continuing Calibration Verification (CCV) - A CCV is analyzed every 12 hour tune and calculated against the initial calibration curve, then shown to meet the calibration check criteria before any sample analysis may be performed. See **Table 2** of this SOP for acceptance criteria and corrective action. Any manual integrations are documented by inclusion of the integrated signals (**before and after manual integration**) initialed, dated, and reason with the quantitation report and chromatograms. All manual CCV integrations must be approved by the section manager or designated peer reviewer. .

NOTE: Acceptance criteria for method 624 consists of meeting recovery limits found in table 5 of the method for a QC check sample. This QC check

sample is made from a separate source or lot number than the calibration standard at a concentration of 20 µg/L.

14. Procedure

- 14.1 LCS - An LCS is analyzed every 12 hour tune. Using standards prepared from an alternate vendor or lot number, blank water is spiked at the 50 µg/L (5mL/soil) or 10 µg/L (25mL) level. See **Table 2** of this SOP for acceptance criteria and corrective action. **Note: the concentration of the LCS will be 20 µg/L when analyzing 624 samples (QC Check Sample).**
- 14.2 Method Blank - Prior to sample analysis, the system must be shown to be free of contamination through analysis of a method blank. See **Table 2** of this SOP for acceptance criteria and corrective action.
- 14.3 Sample Analysis - Prior to analysis, the samples are prepared for chromatography using the appropriate sample preparation method (5mL water, 25mL water, low soil, high soil, etc.) See SOP 225 for preparation of a 5035 soil sample. For a 5mL/25mL water sample, use the following procedure:
 - 14.3.1 Load the vial into the Archon autosampler in the expected position.
 - 14.3.2 Program the Archon for the loaded vial range and necessary dilutions, making sure the programmed method is set for the same volume as the purge vessel on the front of the LSC 2000 or 3000/3100 and that the Chemstation sequence matches the Archon sequence. Note: TCLP samples are analyzed at a 10x dilution. One TCLP sample is spiked per batch at receipt of leachates.
 - 14.3.3 After analysis of the sample has been completed, check the pH of the sample using pH paper and verify it to be less than a pH of 2 (recorded on the sequence log). If it is not, record the pH on the sequence log and generate a non-conformance report. The sample report will have to be qualified for preservation if the analysis is being performed more than 7 days after sampling. [Note: TCLP samples do not require a pH check.]

14.4 Instrument sequence

An example of a typical instrument sequence log follows:

- 1-BFB Tune (12:00 am)
- 2-CCV
- 3-LCS
- 4-Method Blank
- 5-Sample
- 6-Sample
- 7-Sample
- 8-Sample
- 9-Sample
- 10-Sample
- 11-Sample
- 12-Sample
- 13-Sample
- 14-Sample

- 15-Sample
- 16-Sample
- 17-Sample MS
- 18-Sample MSD
- 19-BFB (12:00pm - 12 hours since last BFB/CCV)
- 20-CCV
- 21-LCS
- 22-Method Blank
- 23-Sample
- 24-Sample

14.5 Data Reduction/Evaluation - Each sample analysis sequence is documented using the computer run log generated on the chemstation. This run log is signed, dated and paginated then placed in a 3 ring binder for that instrument. After the sample has been analyzed, the data is processed through the TargetDB on Windows NT data system. Quantitative measurements are performed using the calculations found in section 15.2 of this SOP. The following must be checked to determine if the sample will need any reanalysis or dilution. See **Table 2** of this SOP for acceptance criteria and corrective action. Formal data evaluation is detailed in SOP QS05. **See SOP QS07 for guidance on manual integrations.**

14.5.1 Internal Standards - Areas counts and retention times.

14.5.2 Surrogates – Recoveries and retention times.

Federal Register Method 624 contains no criteria for surrogate recovery.

Surrogate	WATER	SOIL
Dibromofluoromethane	85-120	80-125
1,2-Dichloroethane-d4	85-135	75-140
Toluene-d8	85-115	80-120
Bromofluorobenzene	80-120	80-125

14.5.3 Analyte concentration.

14.5.4 Qualitative identification based on spectrum and retention time.

15. Data Analysis and Calculations

15.1 Quality Systems SOP QS09 “General and Commonly used Laboratory Calculations” provides details on general calculations used throughout the laboratory.

15.2 Calculations:

15.2.1 The RF is calculated as follows:

$$RF = \frac{A_s \times C_{is}}{A_{is} \times C_s}$$

where:

A_s = Peak area (or height) of the analyte or surrogate.

A_{is} = Peak area (or height) of the internal standard.

C_s = Concentration of the analyte or surrogate.

C_{is} = Concentration of the internal standard.

- 15.2.2 Calibration verification involves the calculation of the percent drift (linear) or the percent difference (average) of the instrument response between the initial calibration and each subsequent analysis of the verification standard. Use the equations below to calculate % Drift or % Difference, depending on the calibration procedure used.

$$\% \text{ Drift} = \frac{(\text{Calculated concentration} - \text{Theoretical concentration}) * 100}{\text{Theoretical Concentration}}$$

where the calculated concentration is determined from the initial calibration and the theoretical concentration is the concentration at which the standard was prepared.

$$\% \text{ Difference} = \frac{(\text{CCV RF} - \text{Average RF}) * 100}{\text{Average RF}}$$

where CCV RF is the response factor from the analysis of the verification standard and Average RF is the average response factor from the initial calibration. The % difference or % drift calculated for the calibration verification standard must be within $\pm 20\%$ for each CCC analyte, or for all target analytes if the CCCs are not target analytes, before any sample analyses may take place.

- 15.2.3 Concentration in water samples is calculated as follows: [Note: Using the units specified here for these terms will result in a concentration in units of ng/mL, which is equivalent to ug/L.]

$$\text{Concentration } (\mu\text{g/L}) = \frac{(A_s)(C_{is})(D)(V_i)}{(A_{is})(\overline{\text{RF}})(V_s)(1000)}$$

where:

A_s = Area (or height) of the peak for the analyte in the sample.

A_{is} = Area (or height) of the peak for the internal standard.

C_{is} = Concentration of the internal standard in the volume purged in ug/L.

D = Dilution factor, if the sample was diluted prior to analysis. If no dilution was made, $D = 1$. The dilution factor is always dimensionless.

V_i = For purge-and-trap analysis, V_i is not applicable and is set at 1.

$\overline{\text{RF}}$ = Mean response factor from the initial calibration.

V_s = Volume of the aqueous sample purged (mL). If units of liters are used for this term, multiply the results by 1000.

- 15.2.4 Concentration in non-aqueous samples is calculated as follows: [Note: Using the units specified here for these terms will result in a concentration in units of ng/g, which is equivalent to ug/kg.]

$$\text{Concentration } (\mu\text{g/kg}) = \frac{(A_s)(C_{is})(D)(V_i)}{(A_{is})(\overline{\text{RF}})(W_s)(1000)}$$

where: A_s , A_{is} , C_{is} , D , and \overline{RF} are the same as for aqueous samples.
 W_s = Weight of sample extracted (g). Either a dry weight or wet weight may be used, depending upon the specific application of the data. If units of kilograms are used for this term, multiply the results by 1000.

16. Method Performance

16.1 Demonstration of Capability (DOC): Each analyst must perform a DOC prior to reporting data. The analyst must prepare (for prep technicians) and analyze (analysts reviewing and reporting data) 4-LCS samples. The data is calculated for accuracy and precision requirements. The DOC form is completed by each analyst and then provided to the supervisor for further processing and approval. See **Table 2** for acceptance criteria.

17. Pollution Prevention

17.1 Quantity of chemicals purchased should be based on expected usage during its shelf-life and the disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

18. Data Assessment and Acceptance Criteria for Quality Control Measures

18.1 Quality Control SOP QS05, "Data Deviations / Interpretations / Exceptions: Laboratory Non-Conformance / Corrective Action Procedures, Decision Making Guidelines for Evaluating Laboratory Analytical Sample and Quality Control Results", provides details on data assessment and acceptance criteria for Quality Control Measures. **Table 2** of this SOP provides information on QC samples, frequency, and the associated criteria specific to the performance of this method.

19. Contingencies for Handling out-of-control or unacceptable data

19.1 Quality Control SOP QS05, "Data Deviations / Interpretations / Exceptions: Laboratory Non-Conformance / Corrective Action Procedures, Decision Making Guidelines for Evaluating Laboratory Analytical Sample and Quality Control Results", provides details on handling out of control data. Table 2 within this SOP also lists corrective actions associated with the failure of the various QC samples employed for the performance of this method.

20. Waste Management.

20.1 Laboratory SOP QS14 on Waste Handling discusses general guidelines for the appropriate handling of wastes and the laboratory program on waste management.

21. References

- 21.1 40 CFR, Part 136; Appendix A
- 21.2 Test Methods for Evaluating Solid Waste, SW-846, Third Edition and updates
- 21.3 National Environmental Laboratory Accreditation Conference; CH. 5, 2001
- 21.4 USACE, EM 200-1-3; Appendix 1; Shell, 2/2001
- 21.5 DOD Quality Systems Manual for Environmental Laboratories version 3, 3/2005

22. Tables, Diagrams, Flowcharts and Validation Data

- 22.1 Table 1, all applicable parameters with the applicable DL(MDL)/LOD/LOQ(MRL).
- 22.2 Table 2, QA/QC summary table
- 22.3 Table 3, Technical Completeness / Accuracy Checklist
- 22.4 Table 4, Data Reviewers Checklist(s)
- 22.5 Table 5, BFB Tuning Criteria
- 22.6 Table 6, Analyst Checklist
- 22.7 Table 7, INTERNAL STANDARD ASSOCIATION

Table 1 – DL/LOD/LOQ

Analyte	MDL/DL	LOD	MRL/LOQ	Units
1,1,1,2-Tetrachloroethane	1.25	2.50	5.00	ug/Kg
1,1,1-Trichloroethane (1,1,1-TCA)	1.25	2.50	5.00	ug/Kg
1,1,2,2-Tetrachloroethane	1.25	2.50	5.00	ug/Kg
1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)	2.50	5.00	10.0	ug/Kg
1,1,2-Trichloroethane	1.25	2.50	5.00	ug/Kg
1,1-Dichloroethane (1,1-DCA)	1.25	2.50	5.00	ug/Kg
1,1-Dichloroethene (1,1-DCE)	1.25	2.50	5.00	ug/Kg
1,1-Dichloropropene	1.25	2.50	5.00	ug/Kg
1,2,3-Trichlorobenzene	1.25	2.50	5.00	ug/Kg
1,2,3-Trichloropropane	1.25	2.50	5.00	ug/Kg
1,2,4-Trichlorobenzene	1.25	2.50	5.00	ug/Kg
1,2,4-Trimethylbenzene	1.25	2.50	5.00	ug/Kg
1,2-Dibromo-3-chloropropane (DBCP)	2.50	5.00	10.0	ug/Kg
1,2-Dibromoethane (EDB)	1.25	2.50	5.00	ug/Kg
1,2-Dichlorobenzene	1.25	2.50	5.00	ug/Kg
1,2-Dichloroethane (EDC)	1.25	2.50	5.00	ug/Kg
1,2-Dichloropropane	1.25	2.50	5.00	ug/Kg
1,3,5-Trimethylbenzene	1.25	2.50	5.00	ug/Kg
1,3-Dichlorobenzene	1.25	2.50	5.00	ug/Kg
1,3-Dichloropropane	1.25	2.50	5.00	ug/Kg
1,4-Dichlorobenzene	1.25	2.50	5.00	ug/Kg
2,2-Dichloropropane	1.25	2.50	5.00	ug/Kg
2-Butanone (Methyl ethyl ketone; MEK)	2.50	5.00	10.0	ug/Kg
2-Chlorotoluene	1.25	2.50	5.00	ug/Kg
2-Hexanone (Methyl butyl ketone; MBK)	1.25	2.50	5.00	ug/Kg
4-Chlorotoluene	1.25	2.50	5.00	ug/Kg
4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)	1.25	2.50	5.00	ug/Kg
Acetone	5.00	10.0	20.0	ug/Kg
Acrolein	5.00	10.0	20.0	ug/Kg
Acrylonitrile	5.00	10.0	20.0	ug/Kg
Benzene	1.25	2.50	5.00	ug/Kg
Bromobenzene	1.25	2.50	5.00	ug/Kg
Bromochloromethane	1.25	2.50	5.00	ug/Kg
Bromodichloromethane	1.25	2.50	5.00	ug/Kg
Bromoform	1.25	2.50	5.00	ug/Kg
Bromomethane	2.50	5.00	10.0	ug/Kg
Carbon Disulfide	1.25	2.50	5.00	ug/Kg
Carbon Tetrachloride	1.25	2.50	5.00	ug/Kg
Chlorobenzene	1.25	2.50	5.00	ug/Kg
Chloroethane	2.50	5.00	10.0	ug/Kg
Chloroform	1.25	2.50	5.00	ug/Kg
Chloromethane	2.50	5.00	10.0	ug/Kg
cis-1,2-Dichloroethene (cis-1,2-DCE)	1.25	2.50	5.00	ug/Kg
cis-1,3-Dichloropropene	1.25	2.50	5.00	ug/Kg
Cyclohexane	1.25	2.50	5.00	ug/Kg
Dibromochloromethane	1.25	2.50	5.00	ug/Kg

Analyte	MDL/DL	LOD	MRL/LOQ	Units
Dibromomethane	1.25	2.50	5.00	ug/Kg
Dichlorodifluoromethane (CFC-12)	2.50	5.00	10.0	ug/Kg
Ethyl methacrylate	1.25	2.50	5.00	ug/Kg
Ethylbenzene	1.25	2.50	5.00	ug/Kg
Hexachlorobutadiene	1.25	2.50	5.00	ug/Kg
Iodomethane	5.00	10.0	20.0	ug/Kg
Isopropylbenzene (Cumene)	1.25	2.50	5.00	ug/Kg
Methyl Acetate	2.50	5.00	10.0	ug/Kg
Methyl methacrylate	1.25	2.50	5.00	ug/Kg
Methyl Tertiary Butyl Ether (MTBE)	1.25	2.50	5.00	ug/Kg
Methylcyclohexane	1.25	2.50	5.00	ug/Kg
Methylene Chloride, or Dichloromethane	2.50	5.00	10.0	ug/Kg
Naphthalene	1.25	2.50	5.00	ug/Kg
n-Butylbenzene	1.25	2.50	5.00	ug/Kg
n-Propylbenzene	1.25	2.50	5.00	ug/Kg
p-Isopropyltoluene	1.25	2.50	5.00	ug/Kg
sec-Butylbenzene	1.25	2.50	5.00	ug/Kg
Styrene	1.25	2.50	5.00	ug/Kg
tert-Butylbenzene	1.25	2.50	5.00	ug/Kg
Tetrachloroethene (PCE; PERC)	1.25	2.50	5.00	ug/Kg
Toluene	1.25	2.50	5.00	ug/Kg
trans-1,2-Dichloroethene (trans-1,2-DCE)	1.25	2.50	5.00	ug/Kg
trans-1,3-Dichloropropene	1.25	2.50	5.00	ug/Kg
Trichloroethene (TCE)	1.25	2.50	5.00	ug/Kg
Trichlorofluoromethane (CFC-11)	2.50	5.00	10.0	ug/Kg
Vinyl acetate	2.50	5.00	10.0	ug/Kg
Vinyl Chloride (VC)	2.50	5.00	10.0	ug/Kg
m,p-Xylene	2.50	5.00	10.0	ug/Kg
o-Xylene	1.25	2.50	5.00	ug/Kg
1,1,1,2-Tetrachloroethane	0.25	0.50	1.00	ug/L
1,1,1-Trichloroethane (1,1,1-TCA)	0.25	0.50	1.00	ug/L
1,1,2,2-Tetrachloroethane	0.25	0.50	1.00	ug/L
1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)	0.50	1.00	2.00	ug/L
1,1,2-Trichloroethane	0.25	0.50	1.00	ug/L
1,1-Dichloroethane (1,1-DCA)	0.25	0.50	1.00	ug/L
1,1-Dichloroethene (1,1-DCE)	0.25	0.50	1.00	ug/L
1,1-Dichloropropene	0.25	0.50	1.00	ug/L
1,2,3-Trichlorobenzene	0.25	0.50	1.00	ug/L
1,2,3-Trichloropropane	0.50	1.00	2.00	ug/L
1,2,4-Trichlorobenzene	0.25	0.50	1.00	ug/L
1,2,4-Trimethylbenzene	0.25	0.50	1.00	ug/L
1,2-Dibromo-3-chloropropane (DBCP)	0.50	1.00	2.00	ug/L
1,2-Dibromoethane (EDB)	0.25	0.50	1.00	ug/L
1,2-Dichlorobenzene	0.25	0.50	1.00	ug/L
1,2-Dichloroethane (EDC)	0.25	0.50	1.00	ug/L
1,2-Dichloropropane	0.25	0.50	1.00	ug/L
1,3,5-Trimethylbenzene	0.25	0.50	1.00	ug/L
1,3-Dichlorobenzene	0.25	0.50	1.00	ug/L
1,3-Dichloropropane	0.25	0.50	1.00	ug/L

Analyte	MDL/DL	LOD	MRL/LOQ	Units
1,4-Dichlorobenzene	0.25	0.50	1.00	ug/L
1-Chlorohexane	0.50	1.00	2.00	ug/L
2,2-Dichloropropane	0.25	0.50	1.00	ug/L
2-Butanone (Methyl ethyl ketone; MEK)	2.50	5.00	10.0	ug/L
2-Chloroethyl vinyl ether	1.25	2.50	5.00	ug/L
2-Chlorotoluene	0.25	0.50	1.00	ug/L
2-Hexanone (Methyl butyl ketone; MBK)	1.25	2.50	5.00	ug/L
4-Chlorotoluene	0.25	0.50	1.00	ug/L
4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)	1.25	2.50	5.00	ug/L
Acetone	2.50	5.00	10.0	ug/L
Acrolein	1.25	2.50	5.00	ug/L
Acrylonitrile	2.50	5.00	10.0	ug/L
Benzene	0.25	0.50	1.00	ug/L
Bromobenzene	0.25	0.50	1.00	ug/L
Bromochloromethane	0.25	0.50	1.00	ug/L
Bromodichloromethane	0.25	0.50	1.00	ug/L
Bromoform	0.25	0.50	1.00	ug/L
Bromomethane	0.50	1.00	2.00	ug/L
Carbon Disulfide	0.25	0.50	1.00	ug/L
Carbon Tetrachloride	0.25	0.50	1.00	ug/L
Chlorobenzene	0.25	0.50	1.00	ug/L
Chloroethane	0.50	1.00	2.00	ug/L
Chloroform	0.25	0.50	1.00	ug/L
Chloromethane	0.25	0.50	1.00	ug/L
cis-1,2-Dichloroethene (cis-1,2-DCE)	0.25	0.50	1.00	ug/L
cis-1,3-Dichloropropene	0.25	0.50	1.00	ug/L
Cyclohexane	0.25	0.50	1.00	ug/L
Dibromochloromethane	0.25	0.50	1.00	ug/L
Dibromomethane	0.25	0.50	1.00	ug/L
Dichlorodifluoromethane (CFC-12)	0.50	1.00	2.00	ug/L
Di-isopropyl ether	0.25	0.50	1.00	ug/L
ETBE	0.25	0.50	1.00	ug/L
Ethyl methacrylate	0.25	0.50	1.00	ug/L
Ethylbenzene	0.25	0.50	1.00	ug/L
Hexachlorobutadiene	0.25	0.50	1.00	ug/L
Iodomethane	0.25	0.50	1.00	ug/L
Isopropylbenzene (Cumene)	0.25	0.50	1.00	ug/L
Methyl Acetate	0.50	1.00	2.00	ug/L
Methyl methacrylate	0.25	0.50	1.00	ug/L
Methyl Tertiary Butyl Ether (MTBE)	0.25	0.50	1.00	ug/L
Methylcyclohexane	0.25	0.50	1.00	ug/L
Methylene Chloride, or Dichloromethane	0.50	1.00	2.00	ug/L
Naphthalene	0.25	0.50	1.00	ug/L
n-Butylbenzene	0.25	0.50	1.00	ug/L
n-Propylbenzene	0.25	0.50	1.00	ug/L
p-Isopropyltoluene	0.25	0.50	1.00	ug/L
sec-Butylbenzene	0.25	0.50	1.00	ug/L
Styrene	0.25	0.50	1.00	ug/L
t-Butyl alcohol	1.25	2.50	5.00	ug/L

Analyte	MDL/DL	LOD	MRL/LOQ	Units
tert-Amyl methyl ether	2.50	5.00	10.0	ug/L
tert-Butylbenzene	0.25	0.50	1.00	ug/L
Tetrachloroethene (PCE; PERC)	0.25	0.50	1.00	ug/L
Tetrahydrofuran	1.25	2.50	5.00	ug/L
Toluene	0.25	0.50	1.00	ug/L
trans-1,2-Dichloroethene (trans-1,2-DCE)	0.25	0.50	1.00	ug/L
trans-1,3-Dichloropropene	0.25	0.50	1.00	ug/L
Trichloroethene (TCE)	0.25	0.50	1.00	ug/L
Trichlorofluoromethane (CFC-11)	0.50	1.00	2.00	ug/L
Vinyl acetate	1.25	2.50	5.00	ug/L
Vinyl Chloride (VC)	0.50	1.00	2.00	ug/L
m,p-Xylene	0.50	1.00	2.00	ug/L
o-Xylene	0.25	0.50	1.00	ug/L

Table 2. Organic Analysis by Gas Chromatography/Mass Spectrometry (Method 8260B)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise, method-specific criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria (see Section C.1.f of DoD QSM 4.1).	NA.	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
MDL determination	Initial method demonstration required for some states – not required for DoD	Refer to SOP QS09.			
LOD determination and verification	Prior to initial analysis then quarterly verification.	See Box D-13 of DoD QSM 4.1			
LOQ establishment and verification	Prior to initial analysis then quarterly verification.	See Box D-14 of DoD QSM 4.1			
Tuning	Prior to ICAL and at the beginning of each 12-hour period.	Refer to table 5 of this SOP.	Retune instrument and verify. Rerun affected samples.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be accepted without a valid tune.
Minimum five-point initial calibration (ICAL) for all analytes	ICAL prior to sample analysis.	1. Average response factor (RF) for SPCCs: VOCs ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane; ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. 2. RSD for RFs for CCCs: VOCs $\leq 30\%$ and one option below: Option 1: RSD for each analyte $\leq 15\%$; Option 2: linear least squares regression $r \geq 0.995$; Option 3: non-linear regression-coefficient of determination (COD) $r^2 \geq 0.99$ (6 points shall be used for second order, 7 points shall be used for third order).	Correct problem then repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until ICAL has passed. Calibration may not be forced through the origin for DoD projects.

Table 2. Organic Analysis by Gas Chromatography/Mass Spectrometry (Methods 8260B) (continued)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Second source calibration verification (ICV)	Once after each ICAL.	All project analytes within $\pm 20\%$ of true value. [$\pm 25\%$ for non-DoD 8260B;]	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL. NA.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.
Retention time window position establishment for each analyte and surrogate	Once per ICAL.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the sequence CCV is used.	NA.	NA.	
Evaluation of relative retention times (RRT)	With each sample.	RRT of each target analyte within ± 0.06 RRT units. Note - retention times may be updated based on the CCV to account for minor performance fluctuations or after routine system maintenance (such as column clipping).	Correct problem, then rerun ICAL.	Flagging criteria are not appropriate.	With each sample, the RRT shall be compared with the most recently updated RRT. If the RRT has changed by more than ± 0.06 RRT units since the last update, this indicates a significant change in system performance and the laboratory must take appropriate corrective actions as required by the method and rerun the ICAL to reestablish the retention times.
Continuing calibration verification (CCV)	Daily before sample analysis and every 12 hours of analysis time.	1. Average RF for SPCCs: VOCs ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane; ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. 2. %Difference/Drift for all target compounds and surrogates: VOCs $\leq 20\%D$ (Note: D = difference when using RFs or drift when using least squares regression or non-linear calibration). [$\pm 20\%$ for CCCs only non-DoD 8260B]	DoD project level approval must be obtained for each of the failed analytes or corrective action must be taken. Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply qualifier to all results for the specific analyte(s) in all samples since last acceptable CCV. [For non-DoD 8260B, if CCCs exceed, evaluate all analytes for 20%D and qualify as above]	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed, holding time has been exceeded or client has approved reporting.

Table 2. Organic Analysis by Gas Chromatography/Mass Spectrometry (Methods 8260B) (continued)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Internal standards verification	Every field sample, standard, and QC sample.	Retention time \pm 30 seconds from retention time of the midpoint standard in the ICAL or daily CCV; EICP area within -50% to +100% of ICAL midpoint standard or daily CCV.	Inspect mass spectrometer and GC for malfunctions. Reanalysis of samples analyzed while system was malfunctioning is mandatory.	If corrective action fails in field samples, apply qualifier to analytes associated with the non-compliant IS. Flagging criteria are not appropriate for failed standards.	Sample results are not acceptable without a valid IS verification.
Method blank	One per preparatory batch.	No analytes detected > 1/2 RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected >RL/LOQ	Correct problem. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
LCS containing all analytes to be reported, including surrogates	One per preparatory batch.	QC acceptance criteria specified by client or DoD (appendix G), if available. Otherwise, use in-house control limits. In-house control limits may not be greater than \pm 3 times the standard deviation of the mean LCS recovery.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike (MS)	One per preparatory batch per matrix (see Box D-7).	Use LCS criteria, above.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply qualifier if acceptance criteria are not met.	For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.
Matrix spike duplicate (MSD) or sample duplicate	One per preparatory batch per matrix (see Box D-7).	MSD: For matrix evaluation, use LCS acceptance criteria above. MSD or sample duplicate: RPD \leq 30% or client specified limit (between MS and MSD or sample and sample duplicate).	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply qualifier if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.

Table 2. Organic Analysis by Gas Chromatography/Mass Spectrometry (Methods 8260B) (continued)

QC Check	Minimum Frequency	Acceptance Criteria			Corrective Action	Flagging Criteria	Comments
		Surrogate	WATER	SOIL			
Surrogate spike	All field and QC samples.	Dibromofluoromethane	85-120	80-125	For QC and field samples, correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	Apply qualifier to all associated analytes if acceptance criteria are not met.	Alternative surrogates are recommended when there is obvious chromatographic interference.
		1,2-Dichloroethane-d4	85-135	75-140			
		Toluene-d8	85-115	80-120			
		Bromofluorobenzene	80-120	80-125			
		QC acceptance criteria specified by DoD (above) or Client. Otherwise, in-house control limits may be used. No limits specified for Method 624.					
Results reported between DL and LOQ	NA.	NA.			NA.	Apply J-flag to all results between DL and LOQ.	

Table 3, Technical Completeness / Accuracy Checklist

1. Were all the QC check elements analyzed – refer to Table 2 of the SOP
2. Were the QC criteria met
3. In cases of failures, was there an NCR written
4. Were all manual integrations signed
5. Were dilution factors applied correctly
6. Was there supervisory approval for manual integrations on standards and QC samples
7. Was the data uploaded into LIMS via direct upload – if yes, then was a cross check subset of the uploaded values performed
8. If the data was entered into LIMS manually, was a check of all entered values performed
9. Was the red marked data in LIMS checked for accuracy and the corresponding hard copy data documented appropriately
10. Were proper data qualifiers applied to the data in LIMS
11. Was the hard copy package checked for completeness to include all data for the sequence such that the data reviewer could reconstruct sample analyses and validate / approve the data

Table 4, Data Reviewers Checklist (Prior to approving data)

1. Does the hard copy raw data (or electronic raw data) package look complete and include all data points
2. Were QA objectives met and for failures were the appropriate actions taken
3. For direct uploads to LIMS, did a subset cross check match the raw data
4. Did all the manual entries into LIMS match the raw data
5. Were there appropriate signatures and documentation on the raw data
6. Were appropriate LIMS flags used
7. Were manual integrations signed
8. Were manual integrations for calibration and QC samples approved by supervisor
9. Were manual calculations verified

Table 5, Tuning Criteria

m/z	Required Intensity (relative abundance)
50	15 to 40% of m/z 95
75	30 to 60% of m/z 95
95	Base peak, 100% relative abundance
96	5 to 9% of m/z 95
173	Less than 2% of m/z 174
174	Greater than 50% of m/z 95
175	5 to 9% of m/z 174
176	Greater than 95% but less than 101% of m/z 174
177	5 to 9% of m/z 176

Table 6, ANALYST DATA REVIEW CHECKLIST

Sample Number(s):
Batch Number(s):
Method: 8260B/624/8270C/8270D/625 (Circle One)

QA/QC Item	Yes	No	NA	Second Review	Level
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1. Is the BFB/DFTPP tune performed every 12 hours and is the tuning criteria met?

Are the RRFs and % RSDs within QC limits for appropriate analytes for the initial calibration? Check the retention times for compounds with the same spectra. Check compounds with different conc. (e.g. m/p-xylene, ketones, etc.).

3. Was the initial calibration curve verified by a second source calibration standard (ICV) and have criteria been met?

4. Does the Continuing Calibration Standard (CCV) meet the criteria for the CCCs, SPCCs and/or 20%D for all analytes.

5. Is the Method Blank run at the desired frequency and is its concentration for target analytes less than the MDLs?

6. Are the LCS, MS, MSD within control limits and run at the desired frequency?

7. Are all sample holding times met, analytes within calibration range, IS areas and surrogate recoveries within QC limits?

8. Were the Method Blank, LCS, MS, MSD and samples uploaded to the LIMS and verified (at least one calculation per batch uploaded)?

Comments on any "No" response:

Primary-Level Review: _____ Date: _____

Second-Level Review: _____ Date: _____

Table 7, Internal Standard Association

Analyte	Internal Standard	Analyte	Internal Standard
1,1,1-Trichloroethane	Fluorobenzene	1,1,1,2-Tetrachloroethane	d5-Chlorobenzene
1,1,2-Trichloro-1,2,2-trifluoroethane	Fluorobenzene	1,1,2-Trichloroethane	d5-Chlorobenzene
1,1-Dichloroethane	Fluorobenzene	1,2,3-Trichloropropane	d5-Chlorobenzene
1,1-Dichloroethane	Fluorobenzene	1,2-Dibromochloroethane (EDB)	d5-Chlorobenzene
1,1-Dichloropropane	Fluorobenzene	1,3-Dichloropropane	d5-Chlorobenzene
1,2-Dichloroethane	Fluorobenzene	1-Chlorohexane	d5-Chlorobenzene
1,2-Dichloroethane-d4	Fluorobenzene	2-Hexanone	d5-Chlorobenzene
1,2-Dichloroethane (total)	Fluorobenzene	Bromofluorobenzene	d5-Chlorobenzene
1,2-Dichloropropane	Fluorobenzene	Bromoforn	d5-Chlorobenzene
1,4-Dioxane	Fluorobenzene	Chlorobenzene	d5-Chlorobenzene
2,2-Dichloropropane	Fluorobenzene	Chlorobenzene-d5	d5-Chlorobenzene
2-Butanone	Fluorobenzene	Dibromochloromethane	d5-Chlorobenzene
2-Chloroethyl vinyl ether	Fluorobenzene	Ethyl Methacrylate	d5-Chlorobenzene
4-Methyl-2-pentanone	Fluorobenzene	Ethylbenzene	d5-Chlorobenzene
Acetaldehyde	Fluorobenzene	m,p-Xylene	d5-Chlorobenzene
Acetone	Fluorobenzene	Methacrylonitrile	d5-Chlorobenzene
Acetonitrile	Fluorobenzene	o-Xylene	d5-Chlorobenzene
Acrolein	Fluorobenzene	Styrene	d5-Chlorobenzene
Acrylonitrile	Fluorobenzene	Tetrachloroethene	d5-Chlorobenzene
Allyl chloride	Fluorobenzene	Toluene	d5-Chlorobenzene
Benzene	Fluorobenzene	Toluene-d8	d5-Chlorobenzene
Bromochloromethane	Fluorobenzene	trans-1,3-Dichloropropane	d5-Chlorobenzene
Bromodichloromethane	Fluorobenzene	Xylenes (total)	d5-Chlorobenzene
Bromomethane	Fluorobenzene	1,1,2,2-Tetrachloroethane	1,4-dichlorobenzene-d4
Carbon disulfide	Fluorobenzene	1,2,2-Trichlorobenzene	1,4-dichlorobenzene-d4
Carbon tetrachloride	Fluorobenzene	1,2,4-Trichlorobenzene	1,4-dichlorobenzene-d4
Chloroethane	Fluorobenzene	1,2,4-Trimethylbenzene	1,4-dichlorobenzene-d4
Chloroform	Fluorobenzene	1,2-Dibromo-3-chloropropane	1,4-dichlorobenzene-d4
Chloromethane	Fluorobenzene	1,2-Dichlorobenzene	1,4-dichlorobenzene-d4
Chloroprene	Fluorobenzene	1,3,5-Trimethylbenzene	1,4-dichlorobenzene-d4
cis-1,2-Dichloroethane	Fluorobenzene	1,3-Dichlorobenzene	1,4-dichlorobenzene-d4
cis-1,3-Dichloropropene	Fluorobenzene	1,4-Dichlorobenzene	1,4-dichlorobenzene-d4
Cyclohexane	Fluorobenzene	1,4-Dichlorobenzene-d4	1,4-dichlorobenzene-d4
Dibromofluoromethane	Fluorobenzene	2-Chlorotoluene	1,4-dichlorobenzene-d4
Dibromomethane	Fluorobenzene	4-Chlorotoluene	1,4-dichlorobenzene-d4
Dichlorodifluoromethane	Fluorobenzene	Bromobenzene	1,4-dichlorobenzene-d4
Diisopropyl Ether	Fluorobenzene	cis-1,4-Dichloro-2-butene	1,4-dichlorobenzene-d4
Ethyl tert-Butyl Ether	Fluorobenzene	Hexachlorobutadiene	1,4-dichlorobenzene-d4
Fluorobenzene	Fluorobenzene	Naphthalene	1,4-dichlorobenzene-d4
Hexane	Fluorobenzene	n-Butylbenzene	1,4-dichlorobenzene-d4
Iodomethane	Fluorobenzene	n-Propylbenzene	1,4-dichlorobenzene-d4
Isobutyl alcohol	Fluorobenzene	p-Isopropyltoluene	1,4-dichlorobenzene-d4
Isopropylbenzene	Fluorobenzene	sec-Butylbenzene	1,4-dichlorobenzene-d4
Methyl Acetate	Fluorobenzene	tert-Butylbenzene	1,4-dichlorobenzene-d4
Methyl Methacrylate	Fluorobenzene	trans-1,4-Dichloro-2-butene	1,4-dichlorobenzene-d4
Methyl t-Butyl Ether	Fluorobenzene		
Methylcyclohexane	Fluorobenzene		
Methylene chloride	Fluorobenzene		
Propionitrile	Fluorobenzene		
t-Butyl alcohol	Fluorobenzene		
Tert-Amyl Methyl Ether	Fluorobenzene		
Tetrahydrofuran	Fluorobenzene		
trans-1,2-Dichloroethane	Fluorobenzene		
Trichloroethene	Fluorobenzene		
Trichlorofluoromethane	Fluorobenzene		
Vinyl acetate	Fluorobenzene		
Vinyl chloride	Fluorobenzene		

EMPIRICAL LABORATORIES, LLC
STANDARD OPERATING PROCEDURE

METALS: SOP 105

REVISION #: 16

EFFECTIVE DATE: 041110

METALS
BY INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION
SPECTROMETRY (ICP-AES) TECHNIQUE

References: SW-846, Method 6010B, December 1996; SW-846, Method 6010C, Revision 3 February 2007; USEPA, Method 200.7, June 1991; Standard Methods 19th Edition 2340B; 1995 USEPA CLP, ILM 04.1. See Addendum for USEPA CLPILM 05.2

APPROVALS:

Lab Director:  Date: 4/12/10

Data Quality Manager:  Date: 4/11/10

Section Supervisor:  Date: 4/13/10

Changes Summary

Revision 16, 04/11/10

- The SOP is an update from Revision 15 dated 05/08/09
- The SOP is formatted to include all 22-elements required per the NELAC standards
- The laboratory's revision of all technical SOPs now includes a Table of Contents that provides the map of the technical information contained within the SOP.
- Additional requirements, based upon the DoD QSM 4.1, have been integrated into the routine sample flow; however, if the requirement is different from routine sample flow, then the requirement is outlined and documented as such to be followed only when DoD samples are analyzed.

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1. Identification of the Test Method

This SOP is compliant with methods – SW846 6010B, SW846 6010C, EPA 200.7, (SM 19th Edition 2340B) Hardness Calculation, (USEPA CLP) ILMO 4.1 (NJDEP does not accept CLPILM 04.1 after June, 2003) and Addendum for USEPA CLPILM 05.2.

2. Applicable Matrix or Matrices

This SOP is applicable to all matrices, including ground water, aqueous samples, TCLP, SPLP and EP extracts, industrial and organic wastes, soils, sludge samples, sediments, and other solid wastes, require digestion prior to analysis.

3. Detection Limit: Detection limits, sensitivity, and optimum ranges of the metals may be found in the ICP method file.

4. Scope of Application, Including components to be Analyzed

Each parameter that is analyzed and reported under the scope of this SOP is listed in **Table 1** of this SOP. This table also lists the associated Method Detection Limit and the Reporting Limit (also defined as the Limit of Quantitation).

5. Summary of the Test Method

5.1 Prior to analysis, samples must be solubilized or digested using appropriate Sample Preparation Methods (e.g., Methods 3005-3050 and SOW ILM 04.1/05.2). When analyzing for dissolved constituents, acid digestion is not always necessary if the samples are filtered and acid preserved prior to analysis. If particulates form after filtration and preservation the sample must be digested prior to analysis.

NOTE: When selenium is required soluble samples must always be digested.

5.2 This method describes the simultaneous multi-elemental determination of elements by ICP. The method measures element-emitted light by optical spectrometry. Samples are nebulized and the large droplets are removed by a spray chamber and the small droplets then pass through to the plasma. The solvent is evaporated. The residual sample decomposed to atoms and ions that become excited and emit characteristic light which is measured, giving a measurement of the concentration of each element type in the original sample. Background correction is required for trace element determination. Background must be measured adjacent to analyte lines on samples during analysis. The position selected for the background-intensity measurement, on either or both sides of the analytical line, will be determined by the complexity of the spectrum adjacent to the analyte line. The position used must be free of spectral interference and reflect the same change in background intensity as occurs at the analytic wavelength measured. Background correction is not required in cases of line broadening where a background correction measurement would actually degrade the analytical result. Control of the spectrometer is provided by PC based *ITEVA* software.

5.3 Inductively Coupled Argon Plasma (ICAP) primary advantage is that it allows simultaneous determination of any elements in a short time. The primary disadvantage of ICP is background radiation from other elements and the plasma gases. Although all ICP instruments

utilize high-resolution optics and background correction to minimize these interferences, analysis for traces of metals in the presence of a large excess of a single metal is difficult. Examples would be traces of metals in an alloy or traces of metals in a limed (high calcium) waste. ICP and Flame AA have comparable detection limits (within a factor of 4) except that ICP exhibits greater sensitivity for refractories (Al, Ba, etc.). Furnace AA, in general, will exhibit lower detection limits than either ICP or FAA.

5.4 It is standard procedure to use an internal standard (scandium) with samples to increase the stability of the instrument as recommended by the manufacturer (Thermo Fisher). (When samples are suspected of containing scandium, internal standard cannot be used.)

6. Definitions

Laboratory Quality System SOP QS08 "Technical / Operational Definitions, Minimum Essential Quality Control Elements, and Laboratory Calibration Procedures" provides information on the commonly used definitions.

Additional definitions specific to this SOP are listed below:

- 6.1 **ICP or ICAP**- Inductively Coupled Plasma or Inductively Coupled Argon Plasma.
- 6.2 **Inter-element correction (IEC)**- Defined as a correction factor applied by the instrument when there is an overlap of the spectrum from the plasma gases or from another metal into the spectrum of another metal causing that metals concentration to either be inflated or deflated.

7. Interferences

7.1 Spectral interferences are caused by background contribution from continuum or recombination phenomena, stray light from the line emission of high-concentration elements, overlap of a spectral line from another element, or unresolved overlap of molecular band spectra.

- 7.1.1. Background emission and stray light can usually be compensated for by subtracting the background emission determined by measurements adjacent to the analyte wavelength peak. Spectral scans of samples or single element solutions in the analyte regions may indicate when alternate wavelengths are desirable because of severe spectral interference. These scans will also show whether the most appropriate estimate of the background emission is provided by an interpolation from measurements on both sides of the wavelength peak or by measured emission on only one side. The locations selected for the measurement of background intensity will be determined by the complexity of the spectrum adjacent to the wavelength peak. The locations used for routine measurement must be free of off-line spectral interference (inter-element or molecular) or adequately corrected to reflect the same change in background intensity as occurs at the wavelength peak. For multivariate methods

using whole spectral regions, background scans should be included in the correction algorithm. Off-line interferences are handled by including spectra on interfering species in the algorithm.

7.1.2. To determine the appropriate location for off-line background correction, the user must scan the area on either side adjacent to the wavelength and record the apparent emission intensity from all other method analytes. This spectral information must be documented and kept on file. The location selected for background correction must be either free of off-line inter-element spectral interference or a computer routine must be used for automatic correction on all determinations. If a wavelength other than the recommended wavelength is used, the analyst must determine and document both the overlapping and nearby spectral interference effects from all method analytes and common elements and provide for their automatic correction on all analyses. Tests to determine spectral interference must be done using analyte concentrations that will adequately describe the interference. Normally, 100 mg/L single element solutions are sufficient; however, for analytes such as iron that may be found at high concentration, a more appropriate test would be to use a 200 mg/L or 500 mg/L concentration near the upper analytical range limit.

7.1.3. Spectral overlaps may be avoided by using an alternate wavelength or can be compensated by equations that correct for inter-element contributions. Instruments that use equations for inter-element correction require the interfering elements be analyzed at the same time as the element of interest. When operative and uncorrected, interferences will produce false positive determinations and be reported as analyte concentrations. More extensive information on interferant effects at various wavelengths and resolutions is available in reference wavelength tables and books. Users may apply inter-element correction equations determined on their instruments with tested concentration ranges to compensate (off line or on line) for the effects of interfering elements. Some potential spectral interferences observed for the recommended wavelength are listed in the method in table 2. For multivariate methods using whole spectral regions, spectral interferences are handled by including spectra of the interfering elements in the algorithm. The interferences listed are only those that occur between method analytes. Only interferences of a direct overlap nature are listed. These overlaps were observed with a single instrument having a working resolution of 0.035 nm.

7.1.4. When using inter-element correction equations, the interference may be expressed as analyte concentration equivalents (i.e. false analyte concentrations) arising from 100 mg/L of the interference element. For example, assume that Arsenic is to be determined (at 193.696 nm) in a sample containing approximately 10 mg/L of Aluminum. According to Table 2 from the method, 100 mg/L of Aluminum would yield a false signal for Arsenic equivalent to approximately 1.3 mg/L. Therefore, the presence of 10 mg/L of Aluminum would result in a false signal for Arsenic equivalent to approximately 0.13 mg/L. The user is cautioned that other instruments may exhibit somewhat different levels of interferences than that shown in Table 2 from the method. The

interference effects must be evaluated for each individual instrument since the intensities will vary.

7.1.5. Inter-element corrections will vary for the same emission line among instruments because of differences in resolution, as determined by the grating, the entrance and exit slit widths, and by the order of dispersion. Inter-element corrections will also vary depending upon the choice of background correction points. Selecting a background correction point where an interfering emission line may appear should be avoided when practical. Inter-element corrections that constitute a major portion of an emission signal may not yield accurate data. Users should not forget that some samples may contain uncommon elements that could contribute spectral interferences.

7.1.6. The interference effects must be evaluated for each individual instrument. For each instrument, intensities will vary not only with optical resolution but also with operating conditions (such as power, viewing height and argon flow rate). When using the recommended wavelengths, the analyst is required to determine and document for each wavelength the effect from referenced interferences as well as any other suspected interferences that may be specific to the instrument or matrix. The instrument utilizes a computer routine for automatic correction on all analyses.

7.1.7. If the correction routine is operating properly, the determined, apparent analyte(s) concentration from analysis of each interference solution should fall within a specific concentration range around the calibration blank. The concentration range is calculated by multiplying the concentration of the interfering element by the value of the correction factor being tested and divided by 10. If after the subtraction of the calibration blank the apparent analyte concentration falls outside of this range in either a positive or negative direction, a change in the correction factor of more than 10% should be suspected. The cause of the change should be determined and corrected and the correction factor updated. The interference check solutions should be analyzed more than once to confirm a change has occurred. Adequate rinse time between solutions and before analysis of the calibration blank will assist in the confirmation.

7.1.8 When inter-element corrections are applied, their accuracy should be verified, daily, by analyzing spectral interference check solutions (IFA/IFB). If the correction factors or multivariate correction matrices tested on a daily basis are found to be within 20% criteria for 5 consecutive days, the required verification frequency of those factors in compliance may be extended to a weekly basis. Also, if the nature of the samples analyzed is such they do not contain concentrations of the interfering elements at \pm one reporting limit from zero, daily verification is not required. All inter-element spectral correction factors or multivariate correction matrices must be verified and updated every six months or when an instrumentation-change, such as in the torch, nebulizer, injector, or plasma conditions occurs.

Standard solution should be inspected to ensure that there is no contamination that may be perceived as a spectral interference.

7.2. Physical interferences are effects associated with the sample nebulization and transport processes. Changes in viscosity and surface tension can cause significant inaccuracies, especially in samples containing high dissolved solids or high acid concentrations. If physical interferences are present, they must be reduced by diluting the sample or by using a peristaltic pump, by using an internal standard or by using a high solids nebulizer. Another problem that can occur with high dissolved solids is salt buildup at the tip of the nebulizer, affecting aerosol flow rate and causing instrumental drift. The problem can be controlled by wetting the argon prior to nebulization, using a tip washer, using a high solids nebulizer or diluting the sample. Also it has been reported that better control of the argon flow rate, especially to the nebulizer, improves instrument performance: this may be accomplished with the use of mass flow controllers.

7.3. Memory interferences result when analytes in a previous sample contribute to the signals measured in a new sample. Memory effects can result from sample deposition on the uptake tubing to the nebulizer and from the build-up of sample material in the plasma torch and spray chamber. The site where these effects occur is dependent on the elements and can be minimized by flushing the system with a rinse blank between samples. The possibility of memory interferences should be recognized

7.4 Users are advised that high salt concentrations can cause analyte signal suppressions and confuse interference tests. When the instrument displays negative values, dilution of the samples may be necessary.

8. Safety

Laboratory SOP QS13 "Safety Program & Chemical Hygiene Plan" discusses the safety program that is to be followed lab-wide.

8.1 Normal accepted laboratory safety practices should be followed while performing this analysis.

8.1.1 Care should be used in handling all samples. Safety glasses must be worn in the lab at all times. The use of appropriate safety gloves and lab coats is highly recommended.

8.1.2 Research into expected sample content and concentration should be done in order to be prepared for additional safety considerations. Generally, any samples that need special consideration have applicable notes on the sample logs.

8.1.3 MSDS sheets are available for all reagents and standards that have been purchased. These are located in the bookshelves in the Quality Assurance Officers office.

9. Equipment & Supplies

- 9.1. Inductively coupled argon plasma emission spectrometer: Thermo Scientific 6500 DUO.
- 9.2. Computer-controlled emission spectrometer with background correction: Thermo Scientific 6500 DUO or equivalent.
- 9.3. Radio frequency generator compliant with FCC regulations: Thermo Fisher or equivalent.
- 9.4. Auto-sampler: Thermo Fisher or equivalent.
- 9.5. Printer capable of printing results every 4 minutes.
- 9.6. Cooling Water recycler.
- 9.7. Iteva software.
- 9.8. Argon gas supply – Liquid Argon
- 9.9. Class A volumetric flasks
- 9.10. Analytical balance - capable of accurate measurement to a minimum of three significant figures (0.001gm).
- 9.11. Variable Eppendorf Pipettes 1000 μ L; 5000 μ L
- 9.12. Disposable beakers 10, 20 and 50 mL size.
- 9.13. Hood system capable of venting the heat from the system off of the instrument during analysis.

10. Reagents and Standards

The laboratory's LIMS system allows for complete documentation and for the traceability of reagents and standards used within the laboratory. The following information relates to the specific reagents and standards used for the performance of the method:

- 10.1. Reagent Water. All references to water in the method refer to reagent grade water unless otherwise specified. Reagent water will be interference free.
- 10.2. Reagent grade chemicals shall be used in all tests. Unless otherwise indicated, it is intended that all reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination. If the purity of a reagent is in question analyze for contamination. If the concentration is less than the MDL then the reagent is acceptable.

10.3. Hydrochloric acid (concentrated), HCl. A method blank is digested and analyzed before a new lot number of HCl is put into use, to ascertain purity. The lot # is logged into Element and the data kept on file.

10.4. Nitric acid (concentrated), HNO₃. A method blank is digested and analyzed before a new lot number of HNO₃ is put into use, to ascertain purity. The lot # is logged into Element and the data kept on file.

10.5. Calibration standards

10.5.1. All standards have an acid matrix of 2% HNO₃ and 5% HCl and should be prepared using class A volumetric flasks and calibrated Eppendorfs).

10.5.2. CAL1 is the calibration blank: Reagent grade water **matrix matched as in 10.5.1. Note: when this standard is analyzed the intensities should be compared to a previous run to make sure that no contamination has occurred. Prepare this solution fresh daily.**

10.5.3. Stock QC21 solution: (100 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element and includes the following metals - Sb, As, Be, Cd, Ca, Cr, Co, Cu, Fe, Pb, Li, Mg, Mn, Mo, Ni, Se, Sr, Tl, Ti, V, and Zn.

10.5.4. Stock QC7 solution: Order from the manufacturer already prepared. This solution is given a unique identifier within Element and includes the following metals- (50 ug/mL)- silver; (100 ug/mL)- aluminum, boron, barium and sodium; (1000 ug/mL)- potassium; (500 ug/mL or 100 ug/mL note we use two sources of this standard and each have different concentrations for Si) –Silica.

10.5.5. Boron solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.

10.5.6. Stock Tin solution: (10000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element. Note: Two sources are needed.

10.5.7. Stock Silver solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.

10.5.8. Stock Aluminum solution: (10000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element. Note: Two sources are needed.

- 10.5.9. Stock Calcium solution: (10000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier. Note: Two sources are needed.
- 10.5.10. Stock Magnesium solution: (10000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element. Note: Two sources are needed.
- 10.5.11. Stock Iron solution: (10000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element. Note: Two sources are needed.
- 10.5.12. Stock Potassium solution: (10000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element. Note: Two sources are needed.
- 10.5.13. Stock Barium solution: (10000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.
- 10.5.14. Stock Sodium solution: (10000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element. Note: Two sources are needed.
- 10.5.15. Stock Arsenic solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.
- 10.5.16. Stock Cobalt solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.
- 10.5.17. Stock Chromium solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.
- 10.5.18. Stock Copper solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.
- 10.5.19. Stock Manganese solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.
- 10.5.20. Stock Nickel solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.
- 10.5.21. Stock Lead solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.
- 10.5.22. Stock Selenium solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.

10.5.23. Stock Thallium solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.

10.5.24. Stock Beryllium solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.

10.5.25. Stock Cadmium solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.

10.5.26. Stock Antimony solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.

10.5.27. Stock Molybdenum solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.

10.5.28. Stock Strontium solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.

10.5.29. Stock Titanium solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.

10.5.30. Stock Vanadium solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.

10.5.31. Stock Zinc solution: (1000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.

10.5.32. Stock Scandium solution (10000 ug/mL). Order from the manufacturer already prepared. This solution is given a unique identifier within Element.

10.6. Calibration and Calibration Verification standards

10.6.1. The calibration standards and calibration verification standards preparations are recorded in Element. Please find method of preparation in Appendix I.

10.6.2. The CRL solution is analyzed to check the accuracy of the instrument at the reporting limit. The stock standard solutions A and B are prepared from single element standards listed in 10.5 above. Please find method of preparation in Appendix I. This solution is stable for 6 months. The working solutions are made up as needed or every 3 months as follows: Prepared by adding 1.0 ml of RL Stock solution A and 1.0 ml of RL Stock Solution B to de-ionized water with 2% HNO₃ and 5% HCL matrix and diluting to 100 mLs , mix well. This solution is stable for 3 months.

10.6.3. The interference check standard solutions (IFA and IFB) are prepared to provide an adequate test of the IECs. A purchased solution containing 500

ug/mL Al, Ca, Mg and 200 ug/mL Fe is diluted 10x to prepare the IFA. The IFB is prepared by diluting 100x a purchased solution containing 10 ug/mL of As and Tl; 20 ug/mL Ag; 50 ug/mL Ba, Be, Cr, Co, Cu, Mn, and V; 100 ug/mL Cd, Ni and Zn; 5 ug/mL Pb and Se; and 60 ug/L Sb. Add to this a purchased solution containing 500 ug/mL Al, Ca, Mg and 200 ug/mL Fe diluted 10x. These solutions are prepared as needed or monthly and assigned an Element # for traceability.

10.7 Digestion standards

10.7.1 The Blank Spike (BS) is prepared from High Purity solutions CLP-CAL-1 solution A and B; CLP-CAL-2 and CLP-CAL-3. 0.50 mL of CLP-CAL-1 A and B; and 0.50 mLs of the 1000 ug/mL single element standards for Molybdenum, Boron, Titanium and Strontium is diluted to 500 mL with 0.125 mL of CLP-CAL-2 and CLP-CAL-3 and 0.050 mLs of 10000 ug/mL Tin. 25 mL of HCl and 10 mL of HNO₃ are added for preservation. This solution is stored in a Teflon bottle. A portion is reserved in case of a problem with digestion. When there is a problem with the analysis of the BS the solution is checked first before action is taken to make sure that it was made properly and has not deteriorated since it was made up. This solution is given a unique identifier within Element. The BS is prepared from a source independent from that used in the calibration standards. This solution is prepared daily or as needed. 50 mLs of this solution is used for digestion for normal level water samples and the sample is brought back to 50 mLs after digestion. Low level water samples start with two 50 mLs vials with only 1.0 mL of the stock blank spike solution in each taken to 50 mLs. The samples are cooked down to below 25 mLs and combined and then cooked down to below 25 mLs again and then brought back to 25 mLs. This low level BS is given a unique identifier in Element.

10.7.2. The solid BS used with soil samples is prepared by weighing up 1.0 gram of Teflon chips for regular level and 2.0 grams of Teflon chips for low level and spiking using the same spiking solutions used to spike the sample matrix. This standard is given a unique identifier i.e. Batch #-BS1. Note: Amount of spiking solution used varies according to whether the samples are being digested for normal level or low level soils. See spiking solutions in 10.7.3.1 for how to prepare the BS for a solid sample, it is prepared the same way that a soil spike is prepared only the known amounts of metals are added to laboratory water.

10.7.3. The spiking solutions are prepared as follows:

10.7.3.1. Stock Multi-element Spiking Solutions: High Purity CLP-CAL-1 solution A: 2000 ug/mL Al and Ba; 50 ug/mL Be; 200 ug/mL Cr; 500 ug/mL Co, Mn, Ni, V and Zn; 250 ug/mL Cu; 1000 ug/mL Fe; 5000 ug/mL Ca, Mg, K and Na; solution B: 250 ug/mL Ag; CLP-CAL-2: 1000 ug/L Sb; CLP-CAL-3: 1000 ug/mL As, Pb, Se, Tl; 500 ug/mL Cd. Order from the manufacturer already prepared. These solutions are given a unique identifier within Element. Add 0.050 mL for water samples and 0.20 mL for normal level soil samples and 0.10 for low

level soil samples of CLP-CAL-1 solutions A and B, and 0.0125 mL for water samples and 0.05 mLs for normal level soil samples and 0.025 mLs for low level soil samples of CLP-CAL-2 and 3 to 50 mL of sample for water samples and 1 gram of sample for normal level soils and 2 grams of sample for low level soils for the following spike values: 2000 ug/L Al and Ba; 50 ug/L Be; 200 ug/L Cr; 500 ug/L Co, Mn, Ni, V and Zn; 250 ug/L Cu; 1000 ug/L Fe; 5.0 mg/L Ca, Mg, K and Na, 250 ug/L Ag, Sb, As, Pb, Se and Tl; 125 ug/L Cd. A blank spike should be prepared at the time the samples are spiked to check the actual spike value and accuracy.

10.7.3.2. TCLP Spiking Solution: Use 0.50 mL diluted to 50 mL for digestion:

2.5 mL 10000 mg/L Ba stock standard diluted to 100 mL; 2.5 mL Cr, Pb and As 1000 mg/L stock standard diluted to 100 mL; 0.50 mL Cd and Se diluted to 100 mL. Store in a Teflon bottle. A blank spike should always be prepared at the same time a sample is being spiked. This solution should produce a spike value of 2500 ug/L Ba; 250 ug/L Cr, Pb and As; and 50 ug/L of Cd and Se. Note: Since the samples are diluted 10x when digested the spike value will appear to be 10x greater when analyzed.

10.7.3.3. TCLP Silver Spiking Solution: Use 5.0 mL diluted to 50 mL for digestion:

0.40 mL of 1000 mg/L stock Ag solution diluted to 200 mL. Store this solution in a Teflon bottle. A blank spike should always be prepared at the same time a sample is being spiked. This solution should produce a spike value of 200 ug/L. Note: Since the samples are diluted 10x when digested the spike value will appear to be 10x greater when analyzed. Also this solution is not very stable and may require fresh preparation at least weekly.

11. Sample Collection, Preservation, Shipment, and Storage

Quality Systems SOP QS10 related to Sample Receipt, Handling, & Processing provides details for collection, preservation, shipment, and storage.

11.1. Preliminary treatment of most matrices is necessary because of the complexity and variability of sample matrices. Water samples which have been pre-filtered and acidified will not need acid digestion as long as the samples and standards are matrix matched and particulates do not form after the filtration and preservation take place. Solubilization and digestion procedures are presented in Sample Preparation Methods (Methods 3005A-3050A).

11.2. Sample digestates are stored at room temperature for at least 2 months unless a longer time is requested by the client. The samples contain an acid matrix of 3:1. All metal samples are neutralized before disposal in the receiving section of the laboratory.

11.3. **The appropriate SOPs should be consulted regarding sample preparation.** The following is a brief summary of the methods we use for metals preparation.

11.3.1. Method 3005A prepares groundwater and surface water samples for total recoverable and dissolved metals determination by ICP. The unfiltered or filtered sample is heated with dilute HCl and HNO₃ prior to metal determination.

11.3.2. Method 3010A prepares waste samples for total metal determination by ICP. The samples are vigorously digested with a mixture of nitric acid and hydrochloric acid followed by dilution with laboratory water. The method is applicable to aqueous samples, TCLP and mobility-procedure extracts.

11.3.3. Standard Methods 19th Edition Method 3030C prepares ground-waters and surface water samples for acid extractable metals: (lead and chromium.) This preparation has a holding time of 72 hours. The samples are preserved at collection with 5mL/L of HNO₃, in the laboratory 5 mL/100mL of 1+1 HCl is added and the sample is heated for 15 minutes in a block digester. The sample is filtered through a membrane filter and the filtrate is carefully transferred to a volumetric flask and brought back to 100 mLs.

11.3.4. Method 3050B prepares wastes samples for total metals determination by ICP. The samples are vigorously digested in nitric acid and hydrogen peroxide followed by dilution with either laboratory water or hydrochloric acid and laboratory water. The method is applicable to soils, sludges, and solid waste samples.

12. Quality Control

Quality Systems SOP QS08 “Technical / Operational Definitions, Minimum Essential Quality Control Elements, and Laboratory Calibration Procedures” outlines details related to laboratory wide protocols on quality control.

12.1. Daily run and batch QC

12.1.1. Calibration is required daily. Either a blank and a high standard or a client specific three standard concentration points and a blank calibration is required daily.

12.1.2. IEC correction standards for aluminum and iron are required daily.

12.1.3. ICV within $\pm 5\%$ for 200.7 and within $\pm 10\%$ for all other methods.

12.1.4. ICB/CCB less than two times \pm MDL or less than \pm LOD for DOD. The ICB/CCB must immediately follow the ICV/CCV.

12.1.5. RL standard run against the curve within $\pm 20\%$ initially and client specific requirement of $\pm 30\%$ at the end of the analysis.

12.1.6. IFA/IFB analyzed daily. IFA must be less than two times \pm MDL or less than \pm LOD unless verified standard contamination for DOD. The IFB must recover within \pm 20% for all analytes in the IFB standard solution. If the IFA/IFB solution is not within the required limits- if possible reanalyze all associated samples, if not possible to reanalyze all associated samples must be flagged with an "Q" on the final report for DOD.

12.1.7. CCV must be analyzed every ten samples or at the end of the analysis within \pm 10% or the samples are reanalyzed if possible. If samples cannot be reanalyzed, all samples are flagged with a "Q" for DOD.

12.1.8. CCB must be analyzed every ten samples immediately following the CCV or at the end of the analysis less than two times \pm MDL or $<\pm$ LOD for DOD. If the CCB is out of the allowable range the samples are flagged with "B".

12.1.9. *The following should be analyzed with each preparation batch containing a matrix spike.*

- Serial dilution: If the analyte concentration is sufficiently high (minimally, a factor of 50 above the instrumental detection limit after dilution), an analysis of a 1:4 dilution (volumetric glassware must be used) should agree within \pm 10% of the original determination. If not, a chemical or physical interference effect should be suspected. The analyst and or section manager must note this situation on the final analytical report.
- Post digestion spike addition: An analyte spike added to a portion of a prepared sample, or its dilution, should be recovered to within 75% to 125% of the known value for SW6010B and 80 to 120% for SW6010C and is required especially if the pre-digestion matrix spike is outside of control limits. The spike addition should produce a minimum level of 10 times and a maximum of 100 times the instrumental detection limit. If the spike is not recovered within the specified limits, a matrix effect should be suspected. Run all associated samples in the preparatory batch by method of standard additions (MSA) or apply "J" flag. The analyst and or section manager must note this situation on the final analytical report. Apply "J" flag if the post spike is outside the range of 75 to 125% for 6010B or 80 to 120% for 6010C.

12.2 Quarterly and/or every six months

12.2.1. Linear range standards must be analyzed at a frequency no less than once every six months. The linear range standard is required for verification that samples are actually linear to the degree claimed. The analyst is responsible for completing this task in a timely manner. The linear range standard must be within \pm 10% of true value. This standard can be analyzed as the linear dynamic range.

12.2.2. The inter-element correction factors (IEC) should be verified at the time the linear range standards are analyzed or whenever there is any question about whether an IEC is correcting correctly.

12.2.3. IDL's, linear range and IEC checks must be performed quarterly if straight CLP work is required.

12.3. Digested Batch QC

12.3.1. All quality control data should be maintained and available for easy reference or inspection.

12.3.2. Employ a minimum of one method blank per sample batch to determine if contamination or any memory effects are occurring. A method blank (BLK), sometimes referred to as the preparation blank is a volume of reagent water acidified with the same amounts of acids as were the standards and samples. These blanks are taken through the same digestion/preparation steps as the sample being tested. The result for the method blank should not indicate contamination greater than $\pm \frac{1}{2}$ RL for DOD or \pm RL/CRDL for other or CLP. If exceeded, the impact upon the data should be evaluated and the associated sample(s) should be either re-digested or the data should be qualified. The extracted blank associated with TCLP batches must be less than 100 X the regulatory limit for barium.

12.3.3. Employ a minimum of one blank spike (BS) for aqueous samples or one Teflon chip spiked sample per sample batch to verify the digestion procedure. These blank spikes are taken through the same digestion/preparation steps as the sample being tested. The control limits are $\pm 15\%$ method 200.7 - aqueous and soil samples or $\pm 20\%$ for all other methods aqueous and soil samples. If the BS is not in control, the impact upon the client data should be evaluated and the associated sample(s) should be re-digested. Consult your supervisor for further action. Qualifying the associated data may not be permissible for some clients.

12.4. Sample

12.4.1. Analyze one replicate sample for every twenty samples or per analytical batch, whichever is more frequent. A replicate sample is a sample brought through the whole sample preparation and analytical process in duplicate. It is acceptable to substitute a matrix spike duplicate for the sample replicate. Project specific requirements will take precedence in these situations. NJDEP demands that this requirement be met with a client specific duplicate rather than a spike duplicate. The control limits are less than or equal to 20% RPD (if both are $>5x$ RL) or \pm the RL (if either are $<5X$ RL). Supervisor must be notified if the control limit is not met. Supervisor will dictate corrective action if required. The final analytical report must document this situation. Apply "J" flag for DOD if acceptance criteria are not met. Apply "*" flag for CLP and other work if acceptance criteria are not met.

12.4.2. Analyze a minimum of one spiked sample and/or spiked sample duplicate for every twenty samples or per analytical batch, whichever is more frequent. Project

specific requirements will take precedence in determining whether a matrix spike duplicate is employed in these situations. If the analyte level in the sample is not greater than 4X the spiking level, the spike recoveries should be within $\pm 20\%$ of the true value. If not, and sufficient sample volume exist, a post digestion spike should be analyzed. Apply "J" flag for DOD if acceptance criteria are not met. Apply "N" flag or CLP and other work if acceptance criteria are not met.

13. Calibration and Standardization

Quality Systems **SOP QS08** "Technical / Operational Definitions, Minimum Essential Quality Control Elements, and Laboratory Calibration Procedures" related to Calibration Procedures provides laboratory wide protocols for calibration and standardization.

- 13.1. Set up the instrument with proper operating parameters. The instrument must be allowed to become thermally stable before beginning (usually requiring at least 30 minutes of operation prior to calibration).
- 13.2. Operating conditions - **The instrument settings can be found in method file within the iTEVA software.** For operation with organic solvents, use of the auxiliary argon inlet is recommended, as are solvent-resistant tubing, increased plasma (coolant) argon flow, decreased nebulizer flow, and increased RF power to obtain stable operation and precise measurements. Sensitivity, instrumental detection limit, precision, linear dynamic range, and interference effects must be established for each individual analyte line on that particular instrument. The analyst must (1) verify that the instrument configuration and operating conditions satisfy the analytical requirements and (2) maintain quality control data confirming instrument performance and analytical results.
- 13.3. Auto-peak when some change has been made to the introductory system and calibrate the instrument according to the instrument manufacturers recommended procedures, using the specified calibration standard solutions. Flush the system with 2% HNO₃ / 5% HCl between each standard or as the manufacturer recommends. (Use the average intensity of multiple exposures for both standardization and sample analysis to reduce random error.) The calibration curve consists of a blank and three standards ($r \geq 0.998$). If a three point calibration curve is not required for the client samples being analyzed by Empirical Laboratories may use a blank and one standard as referenced in USEPA - CLP protocols.
- 13.4. Before beginning the sample run, analyze single element Iron and Aluminum standards at their linear range to check for IEC drifts. Analyze these standards first as QC samples with an IEC check table and action taken should be to calculate IECs using the iTEVA software. Make sure to rinse thoroughly after running these linear range standards, they can cause carry over into the initial QC samples which are analyzed next. The analysis order follows as: ICV ($\pm 10\%$) for 200.7 ($\pm 5\%$) and ICB ($< \pm 2 \times \text{MDL}$, $< \pm \text{LOD-DOD}$ or $\pm \text{RL/CRDL}$ for others or CLP, first, then analyze a reporting limit standard (a standard at the concentration of the reporting limit). This standard should be within $\pm 20\%$ for DOD projects and $\pm 30\%$ for samples analyzed for 6010C. Then reanalyze the

highest mixed calibration standard(s) as if it were a sample. Concentration values obtained should not deviate from the actual values by more than 5%. If they do, follow the recommendations of the instrument manufacturer to correct for this condition. Note: Supervisor must be notified if the control limit is not met. Supervisor will dictate corrective action if required. The final analytical report must document this situation.

13.5. For **CLP projects**, verify the validity of the curve in the region of 2x the contract required detection limit (CRDL) before and after each batch of 20 samples in the specific order of CRI, ICSA, ICSAB, CCV and CCB (CCB criteria: $< \pm\text{MDL}$ or $\pm\text{RL}/\text{CRDL}$ for others or CLP, or twice during every 8-hour work shift, whichever is more frequent. Results should be within $\pm 20\%$. Supervisor must be notified if the control limit is not met. Supervisor will dictate corrective action if required. The final analytical report must document this situation. (For Internal QC)

13.6. Verify the inter-element and background correction factors at the beginning of the sequence in the specific order of IFA, IFB, CCV and CCB (IFA criteria: non-spiked analytes $< \pm 2x\text{MDL}$ or $< \pm\text{LOD}$ for DOD beginning of sequence. Do this by analyzing the interference check solution IFA and IFB. Absolute value of concentration for all non-spiked analytes in the IFA must be $< \text{LOD}$ (unless they are verified trace impurity from one of the spiked analytes) for DOD. Results must be within $\pm 20\%$ of the true value for IFB. If corrective action fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the ICS. (CRI, ICSA and ICSAB required at the end for CLP projects only).

Note: Supervisor must be notified if the control limit is not met. Supervisor will dictate corrective action if required. The final analytical report must document this situation.

13.7. The instrument must be calibrated once every 24 hours.

13.8. Instrument Autosampler Report example:

Calibration Rack (used by instrument software to insert QC)

- 1) Cal Std 1 (blank)
- 2) Cal Std 2 (Low Cal)
- 3) Cal Std 3 (Mid Cal)
- 4) Cal Std 4 (Ba @ 5000 ppb)
- 5) Cal Std 5 (QC5)
- 6) Cal Std 6 (QC 21)
- 7) Cal Std 7 (NAK 100)
- 8) Cal Std 8 (QC3)
- 9) Cal Std 9 (Ag)
- 10) Al IEC-(correction using ITEVA software)
- 11) Fe IEC-(correction using ITEVA software)

Sample Sequence RACK 1

- 1) SEQ-ICV
- 2) SEQ-ICB
- 3) SEQ-CRL1-reporting limit standard 1
- 4) SEQ-CRL2-reporting limit standard 2
- 5) Ba@ 5000 ppb (readback)
- 6) QC5
- 7) NAK High-(readback)
- 8) QC 21 High-(readback)
- 9) Salt Cal at 500 ppm (readback)
- 10) Rinse
- 11) SEQ-IFA1
- 12) SEQ-IFB1
- 13) Rinse
- 14) SEQ-CCV
- 15) SEQ-CCB
- 16) Method Blank (*Batch # -BLK1*)
- 17) Blank Spike (*Batch # -BS1*)
- 18) Sample 1
- 19) Sample 2
- 20) Sample 3
- 21) Sample 4
- 22) Sample 5
- 23) Sample 6
- 24) Sample 7
- 25) Sample 8
- 26) Sample 9
- 27) Sample 10
- 28) SEQ-CCV
- 29) SEQ-CCB
- 30) Sample 11
- 31) Sample 12
- 32) Sample 13
- 33) Sample 14
- 34) Sample 15
- 35) Sample 16
- 36) Sample 17
- 37) Sample 18
- 38) Sample 19
- 39) Sample 20
- 40) Sample matrix spike (*batch#- MS1*)
- 41) Sample matrix spike duplicate (*batch# -MSD1*)
- 42) Sample post digestion spike (*batch# -PS1*)
- 43) Sample serial dilution (*batch# -DUP1*)
- 44) SEQ-CCV

- 45) SEQ-CCB
- 46) Preparation Blank (*batch# -BLK1*)
- 47) Blank Spike (*batch# -BS1*)
- 48) Sample 1
- 49) Sample 2
- 50) Sample 3
- 51) Sample 4
- 52) Sample 5
- 53) Sample 6
- 54) Sample 7
- 55) Sample 8
- 56) Sample 9
- 57) Sample10
- 58) SEQ-CCV
- 59) SEQ-CCB
- 60) Sample 11

RACK 2

- 1) Sample 12
- 2) Sample 13
- Etcetera...

Each rack holds 60 samples and there are 4 racks that are used for samples, CCVs and CCBs and run QC.

14. Procedure

- 14.1. Once the instrument has been calibrated, begin the analysis of samples.
- 14.2. If particulates are visible in the digestate, the sample must be filtered prior to analysis. If filtration is required, a filter blank must be prepared by filtering reagent grade water which has been properly acidified. **In the event USACE samples are filtered, all USACE samples and the QC samples in that QC batch must be filtered. All USACE solid samples and their associated batch QC samples must be filtered prior to analysis.**
- 14.3. Flush the system with 2% HNO₃ / 5% HCl for at least 1 minute before the analysis of each sample.
- 14.4. Dilute and reanalyze samples that are more concentrated than the linear calibration limit or, for 200.7, $\pm 10\%$ of the linear range standard. **In the case of USACE samples, the criterion changes and requires dilution and reanalysis of all samples which produce a concentration that exceeds the highest calibration standard. Sample results detected between the MDL and LOQ are flagged as estimated with a "J" flag.**

14.5. Verify calibration every 10 samples or every 2 hours, whichever is more frequent and at the end of the analytical run, using a continuing calibration verification (CCV) sample and a continuing calibration blank (CCB) sample.

14.5.1. The results of the CCV are to agree within $\pm 10\%$ for 6010 (5% for 200.7) on initial verification of the expected value, with relative standard deviation (RSD) $< 5\%$ from 3 replicates (minimum of three integrations). If not, terminate the analysis, correct the problem, and reanalyze the previous ten samples. The analyst may continue the analytical run, and after conferring with the section manager it may be necessary to reanalyze a group of samples. The analyst must notify the section manager within 24 hours.

14.5.2. The results of the calibration blank (this is not the method/preparation blank) are to be $< 2x \pm MDL$, for CLP $< RL$, for **DOD no analytes detected** $> \pm LOD$. If the calibration blank is not in control, evaluate the impact upon the previous 10 samples. Reanalysis may be required after an evaluation of the data. If the blank $< 1/10$ the concentration of the action level of interest and no sample is within 10% of the action limit, samples need not be reanalyzed. One must also evaluate the reporting limit (RL) as it relates to 3X the IDL/MDL. If the RL is significantly above 3X IDL or MDL then reanalysis may not be required (Na, K, Mg and Ca are good examples of this situation).

14.6. Demonstration of Capability (DOC) – Each analyst must perform a DOC to demonstrate proficiency with this method. Refer to SOP-413 for guidance.

15. Data Analysis and Calculations

Quality Systems SOP QS09 “General and commonly used Laboratory Calculations” provides details on general calculations used throughout the laboratory.

15.1. Total hardness is reported from HNO_3 preserved sample. The final concentration is calculated from the calcium and magnesium results as follows: $Ca \text{ mg/L} \times 2.5 + Mg \text{ mg/L} \times 4.1 = \text{total Hardness in mg/L as } CaCO_3$.

15.2. The instrument will generate data results in mg/L or $\mu\text{g/L}$ (labeled appropriately). Each result represents an average of three individual readings per metal channel.

15.3. For aqueous samples, if a post/pre-digestion dilution is performed, the result must be multiplied by this factor or the dilution factor must be entered into the instrument data table in which case the instrument will generate data corrected for the dilution.

15.4. For solid samples, if a post-digestion dilution is performed, the result must be multiplied by this factor or the dilution factor must be entered into the instrument data table in which case the instrument will generate data corrected for the dilution. Also, the result must be converted to reporting units which are usually mg/kg.

$$SR \text{ (ug/g or mg/kg)} = IR * DF * FED / SM$$

SR	=	Sample result
IR	=	Instrument result ($\mu\text{g/L}$)
DF	=	Dilution factor (post digestion)
FED	=	Final volume of digestate (L)
SM	=	Sample mass digested (g)

16. Method Performance

Demonstration of Capability (DOC): Each analyst must perform a DOC prior to reporting data. The analyst must prepare (for prep technicians) and analyze (analysts reviewing and reporting data) 4-LCS samples. The data is calculated for accuracy and precision requirements. The DOC form, as listed within section 2.5 of the Quality Manual is completed by each analyst and then provided to the supervisor for further processing and approval.

DOC LCS Preparation: See BS preparation under 10.7.1 through 10.7.3 above.

DOC Accuracy and Precision Criteria: The LOD is analyzed at 2 times the MDL and must result in an concentration 3 times the noise. The LOQ is analyzed at the RL or 2 times the RL and must be recovered within $\pm 50\%$.

17. Pollution Prevention:

Quantity of chemicals purchased should be based on expected usage during its shelf-life and the disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

18. Data Assessment and Acceptance Criteria for Quality Control Measures

Quality Control SOP QS05, "Data Deviations / Interpretations / Exceptions: Laboratory Non-Conformance / Corrective Action Procedures, Decision Making Guidelines for Evaluating Laboratory Analytical Sample and Quality Control Results", provides details on data assessment and acceptance criteria for Quality Control Measures. Table 2 of this SOP provides information on QC samples, frequency, and the associated criteria specific to the performance of this method.

19. Contingencies for Handling out-of-control or unacceptable data

Quality Control SOP QS05, "Data Deviations / Interpretations / Exceptions: Laboratory Non-Conformance / Corrective Action Procedures, Decision Making Guidelines for Evaluating Laboratory Analytical Sample and Quality Control Results", provides details on handling out of control data. Table 2 within this SOP also lists corrective actions associated with the failure of the various QC samples employed for the performance of this method.

CORRECTIVE ACTIONS

19.1. INSTRUMENT RELATED

- 19.1.1. ICV not within $\pm 10\%$ or $\pm 5\%$ for 200.7
 - a. Is the problem with the solution?
 - i. Re-prepare or obtain new stock.

- b. Is the problem with the calibration?
 - i. Recalibrate through analysis of appropriate standards and recheck ICV.
- 19.1.2. ICB not \pm MDL or within \pm 3X IDL or CRDL for CLP, **DOD no analytes detected >LOD**
- a. Is the problem with the solution?
 - i. Re-prepare
 - b. Is the problem with the calibration?
 - i. Recalibrate with the blank solution or the low level standard. Restart analysis with the ICV.
- 19.1.3. Check standards not within \pm 5%
- a. Is the problem with the solution?
 - i. Re-pour, re-prepare or obtain new stock.
 - b. Is the problem with the calibration?
 - i. Recalibrate thru analysis of appropriate standards. Restart analysis with the ICV.
- 19.1.4. CLP only-CRI not within \pm 20% (Internal QC, only required for CLP work).
- a. Is the problem with the solution?
 - i. Re-prepare or obtain new stock.
 - b. Is the problem with the calibration?
 - i. Recalibrate thru analysis of appropriate standards. Restart analysis with the ICV.
- 19.1.5. IFA metals not present are not less than the detection limit for that metal, **for IFA DOD, absolute value of concentration for all non-spiked analytes $<\pm$ LOD.**
- a. Is the problem with the solution?
 - i. Re-prepare or obtain new stock.
 - b. Is the problem with the calibration?
 - i. Recalibrate thru analysis of appropriate standards. Restart analysis with the ICV.
- 19.1.6. IFB not within \pm 20%
- a. Is the problem with the solution?
 - i. Re-prepare or obtain new stock.
 - b. Is the problem with the calibration?
 - i. Recalibrate thru analysis of appropriate standards. Restart analysis with the ICV.
- 19.1.7. CCV not within \pm 10%
- a. Is the problem with the solution?
 - i. Re-prepare or obtain new stock.
 - b. Is the problem with the calibration?
 - i. If appropriate, continue the analysis. Discuss effect of the out of control situation with your supervisor. The samples will be reanalyzed or the data will be qualified.

- 19.1.8.. CCB not $\pm 2 \times \text{MDL}$ or CRDL for CLP, DOD no analytes detected $> \pm \text{LOD}$.
- a. Is the problem with the solution?
 - i. Re-prepare
 - b. Is the problem with the calibration?
 - i. Re-calibrate and reanalyze.

19.2. DIGESTION RELATED

- 19.2.1. Preparation blank (BLK) not within $\pm \frac{1}{2}$ RL and \pm RL for common contaminants DOD or RL/CRDL for other or CLP
- a. Is the problem with the instrument?
 - i. Evaluate with respect to instrumental bias or reanalyze when instrument is in control.
 - b. Is the problem with the digestion?
 - i. If associated samples are less than 10X the level of the preparation blank but above the RL, the sample must be re-digested or the data must be qualified on the final report.
- 19.2.2. BS not within control limits
- a. Is the problem with the instrument?
 - i. Evaluate with respect to instrumental bias or reanalyze when instrument is in control.
 - b. Is the problem with the digestion?
 - i. If biased low, associated samples must be re-digested.
 - ii. If biased high, the impact upon the data user must be evaluated. The samples will be re-digested or the data will be qualified on the final report.

19.3. SAMPLE MATRIX RELATED

- 19.3.1. Replicate analysis RPD not within $\pm 20\%$ (if both are $> 5 \times \text{CRDL}$) or \pm the CRDL (if either are $< 5 \times \text{CRDL}$).
- a. The associated sample data must be qualified on the final report.
- 19.3.2. Spike analysis recovery not within $\pm 20\%$.
- a. Is the analyte level in the sample greater than 4X the spiking level?
 - i. If yes, the spike recovery is not evaluated.
 - ii. If no, a post digestion spike must be analyzed and the associated sample data must be qualified on the final report.
- 19.3.3. When required, post digestion spike analysis recovery not within $\pm 25\%$ for SW6010B, DOD or $\pm 20\%$ SW6010C.
- a. The associated sample data must be qualified on the final report.
 - b. For USACE analysis by MSA is required.
- 19.3.4. Serial dilution analysis percent difference not within $\pm 10\%$
- a. Is the analyte concentration a factor of 50 above the instrumental detection limit after dilution?

- i. If no, the serial dilution data can not be evaluated.
- iii. If yes, a chemical or physical interference effect should be suspected. The analyst and or section manager must note this situation on the final analytical report.

20. Waste Management

Laboratory SOP QS14 on Waste Handling discusses general guidelines for the appropriate handling of wastes and the laboratory program on waste management.

21. References

21.1. *Test Methods for Evaluating Solid Waste Physical/Chemical Methods, SW-846; Third Edition (Update III); Method 6010B and Method 6010C.*

21.2. *USEPA Code of Federal Regulations, 40, CH 1,PT 136; Method 200.7; APX-B.*

21.3. *USEPA Contract Laboratory Program (CLP) for Inorganics ILM04.1; ILM05.2*

21.4. DOD Quality Systems Manual for Environmental Laboratories Version 4.1. (Based on NELAC Voted Revision June 5, 2003. 4/22/09)

22. Tables, Diagrams, Flowcharts and Validation Data

Table 1 contains all applicable parameters with the applicable RL/LOQ, LOD and Detection Limit.

Table 1A, contains a list of the wavelengths used for each analyte.

Table 2, for all technical methods, contains the QA/QC summary table.

Table 3, Technical Completeness / Accuracy Checklist

Table 4, Data Reviewers Checklist

Table 1 Water				
Analyte	MDL	LOD	MRL	Units
Aluminum	50.0	100	200	ug/L
Antimony	5.00	8.00	15.0	ug/L
Arsenic	3.00	6.00	10.0	ug/L
Barium	5.00	10.0	40.0	ug/L
Beryllium	1.00	2.00	5.00	ug/L
Boron	10.0	20.0	30.0	ug/L
Cadmium	1.00	2.00	5.00	ug/L
Calcium	1000	2000	5000	ug/L
Chromium	2.00	4.00	10.0	ug/L
Cobalt	5.00	10.0	12.5	ug/L
Copper	4.00	8.00	10.0	ug/L
Iron	30.0	60.0	100	ug/L
Lead	1.50	3.00	3.00	ug/L
Magnesium	1000	3000	5000	ug/L
Manganese	3.00	6.00	15.0	ug/L
Molybdenum	5.00	10.0	15.0	ug/L
Nickel	3.00	6.00	10.0	ug/L
Potassium	1000	3000	5000	ug/L
Selenium	3.00	5.00	6.00	ug/L
Silver	1.00	2.00	10.0	ug/L
Sodium	1000	3000	5000	ug/L
Thallium	3.00	4.00	8.00	ug/L
Tin	10.0	20.0	30.0	ug/L
Titanium	5.00	10.0	15.0	ug/L
Vanadium	5.00	10.0	12.5	ug/L
Zinc	5.00	10.0	20.0	ug/L
Table 1 TCLP				
Analyte	MDL	LOD	MRL	Units
Antimony	0.00500	0.00800	0.0150	mg/L
Arsenic	0.00300	0.00600	0.0100	mg/L
Barium	0.00500	0.0100	0.0400	mg/L
Cadmium	0.00100	0.00200	0.00500	mg/L
Chromium	0.00200	0.00400	0.0100	mg/L
Copper	0.00400	0.00800	0.0100	mg/L
Lead	0.00150	0.00300	0.00300	mg/L
Selenium	0.00300	0.00500	0.00600	mg/L
Silver	0.00100	0.00200	0.0100	mg/L

Table 1 Soil				
Analyte	MDL	LOD	MRL	Units
Aluminum	10.0	20.0	40.0	mg/Kg
Antimony	1.00	1.60	3.00	mg/Kg
Arsenic	0.600	1.20	2.00	mg/Kg
Barium	1.00	2.00	8.00	mg/Kg
Beryllium	0.200	0.400	1.00	mg/Kg
Boron	2.00	4.00	6.00	mg/Kg
Cadmium	0.200	0.400	1.00	mg/Kg
Calcium	200	400	1000	mg/Kg
Chromium	0.400	0.800	2.00	mg/Kg
Cobalt	1.00	2.00	2.50	mg/Kg
Copper	0.800	1.60	2.00	mg/Kg
Iron	6.00	12.0	20.0	mg/Kg
Lead	0.300	0.600	0.600	mg/Kg
Magnesium	200	600	1000	mg/Kg
Manganese	0.600	1.20	3.00	mg/Kg
Molybdenum	1.00	2.00	3.00	mg/Kg
Nickel	0.600	1.20	2.00	mg/Kg
Potassium	200	600	1000	mg/Kg
Selenium	0.600	1.00	1.20	mg/Kg
Silver	0.200	0.400	2.00	mg/Kg
Sodium	200	600	1000	mg/Kg
Thallium	0.600	0.800	1.60	mg/Kg
Tin	2.00	4.00	6.00	mg/Kg
Titanium	1.00	2.00	3.00	mg/Kg
Vanadium	1.00	2.00	2.50	mg/Kg
Zinc	1.00	2.00	4.00	mg/Kg

TABLE 1A

METAL	WAVELENGTH
Aluminum	396.1
Antimony	206.8
Arsenic	189.0
Barium	233.5
Beryllium	313.0
Boron	249.7
Cadmium	228.8
Calcium	317.9
Chromium	267.7
Cobalt	228.6
Copper	324.7
Iron	261.1
Lead	220.3
Magnesium	279.0
Manganese	257.6
Molybdenum	202.0
Nickel	231.6
Potassium	766.4
Selenium	196.0
Silver	328.0
Sodium	589.5
Strontium	421.5
Thallium	190.8
Tin	189.9
Titanium	334.9
Vanadium	292.4
Zinc	206.2

Table 2 - Method Quality Control Requirements Summary

QC Check	Minimum Frequency / Requirements	Acceptance Criteria	Corrective Action for Failures / Data Useability
Interference Check	<ul style="list-style-type: none"> once per calibration 	<ul style="list-style-type: none"> IFA less than LOD if not verified contamination of standard. IFB must be within $\pm 20\%$. 	<ul style="list-style-type: none"> Check IEC corrections for metals in the IFA.
Calibration Curve	<ul style="list-style-type: none"> Prior to analyzing any samples A minimum of a blank and 3-points for linear fit client specific requirement or a blank and high standard. Low standard at the RL level run against the curve within 20% initially and within 30% for subsequent analysis (6010C). 	<ul style="list-style-type: none"> Linear calibration Corr. of 0.998 Must follow curve processing requirements from SOP QS08 	<ul style="list-style-type: none"> Re-evaluate curve mix and makeup Re-run curve Check instrument for maintenance needs Re-prepare the curve standards <p>Samples cannot be analyzed until there is a passing calibration</p>
ICB	At the beginning of every sequence	Must meet the $\leq \pm \text{LOD}$ for DOD or $< 2 \times \text{MDL}$	Re-run
ICV	Alternate source standard to be analyzed after every calibration curve	<ul style="list-style-type: none"> Must be in the range 90 to 110% for 6010B&C, or 95 to 115% for 200.7. 	<ul style="list-style-type: none"> Re-analyze an ICV from a different source Re-prepare and re-analyze the ICV Re-calibrate and verify standard preps and sources
CCV	<ul style="list-style-type: none"> At the beginning of every sequence For every 10-client samples 	<ul style="list-style-type: none"> Must be in the range 90 to 110% 	<ul style="list-style-type: none"> Samples must be reanalyzed if possible, if not samples are flagged with a "Q".
Closing CCV	<ul style="list-style-type: none"> At the end of every sequence 	<ul style="list-style-type: none"> Must be in the range 90 to 110% 	<ul style="list-style-type: none"> Samples must be reanalyzed if possible, if not samples are flagged with a "Q".
BLK	One per prep batch	<ul style="list-style-type: none"> Must be less than $\frac{1}{2} \pm \text{RL}$. 	<ul style="list-style-type: none"> Re-analysis to confirm the positive value Ascertain if there are any samples within the batch that meet the MB criteria and provide the information for the decision makers If results are between the LOD or RL/LOQ, then assess the data and notify the PM for further action Re-prepare of samples associated with the MB NCR will be required for data reported Final Report data flagging will be required

Table 2 - Method Quality Control Requirements Summary

QC Check	Minimum Frequency / Requirements	Acceptance Criteria	Corrective Action for Failures / Data Useability
BS	One per prep batch	Must be in the range of 80 to 120% for 6010B, DOD; or 85 to 115% for 200.7.	<ul style="list-style-type: none"> • Rerun to confirm problem. • All samples associated with the LCS must be re-digested, reanalyzed if possible. • NCR will be required for data reported • If samples cannot be re-digested or re-analyzed Final Report data flagging will be required
MS	One per prep batch	Must be in the range of 80 to 120%	Final Report data flagging will be required
MSD	One per prep batch	Must be in the range of 80 to 120%	Final Report data flagging will be required

Table 3, Technical Completeness / Accuracy Checklist

1. Were all the QC check elements analyzed – refer to Table 2 of the SOP
2. Were the QC criteria met
3. In cases of failures, was there an NCR written
4. Were dilution factors applied correctly
5. Was the data uploaded into LIMS via direct upload – if yes, then was a cross check subset of the uploaded values performed
6. Was the red marked data in LIMS checked for accuracy and the corresponding hard copy data documented appropriately
7. Were proper data qualifiers applied to the data in LIMS
8. Was the hard copy package checked for completeness to include all data for the sequence such that the data reviewer could reconstruct sample analyses and validate / approve the data

Table 4, Data Reviewers Checklist (Prior to approving data)

1. Does the hard copy raw data (or electronic raw data) package look complete and include all data points
2. Were QA objectives met and for failures were the appropriate actions taken
3. For direct uploads to LIMS, did a subset cross check match the raw data
4. Did all the manual entries into LIMS match the raw data
5. Were there appropriate signatures and documentation on the raw data
6. Were appropriate LIMS flags used
7. Were manual calculations verified

ANALYST DATA REVIEW CHECKLIST Sample Number(s):				
Batch Number(s):				
Method: 6010B or 6010C (ICP)				

QA/QC Item	Yes	No	NA	Second Level Review
1. Were samples analyzed within USACE holding times?	_____	_____	_____	_____
2. Was initial calibration curve QC criteria met?	_____	_____	_____	_____
3. Was all continuing calibration criteria in control?	_____	_____	_____	_____
4. Did any sample exceed the highest calibration standard? (If yes, were appropriate dilutions made to generate samples concentration within calibration range?)	_____	_____	_____	_____
5. Did BS or blank spike meet control limits?	_____	_____	_____	_____
6. Did MS/MSD meet control limits?	_____	_____	_____	_____
7. Was the preparation (Method) Blank (BLK) below the project required detection limits?	_____	_____	_____	_____
8. Did you return samples back to cold storage immediately after use?	_____	_____	_____	_____
9. Was hot plate temperature monitored/documented and did you apply the thermometer correction factor?	_____	_____	_____	_____
10. Sample preparation information is correct and complete.	_____	_____	_____	_____
11. Analytical results are correct and complete.	_____	_____	_____	_____
12. The appropriate SOP's have been used and followed.	_____	_____	_____	_____
14. "Raw data" including all manual integration's have been correctly interpreted.	_____	_____	_____	_____
15. "Special" sample preparation and analytical requirements have been met.	_____	_____	_____	_____
16. Documentation complete (e.g., all anomalies in the analytical sequence have been documented, corrective action forms are complete.	_____	_____	_____	_____

Comments on any "No" response:

Analyst: _____ Date: _____

EMPIRICAL LABORATORIES, LLC
STANDARD OPERATING PROCEDURE

INORGANICS: SOP100 REVISION #: 21 EFFECTIVE DATE: 20100901

METALS DIGESTION/PREPARATION

References:

Methods 3005A/USEPA CLPILM0 4.1 Aqueous, 3010A, 3030C, 3050B
USEPA CLPILM0 4.1 (Soil/Sediment), 200.7, Standard Methods 3030C 21st
See Addendum for USEPA CLPILM 05.2 (Aqueous & Soil/Sediment)

APPROVALS:

Lab Director:  Date: 9/8/10

Data Quality Manager:  Date: 9/8/10

Section Supervisor:  Date: 9/9/10

Changes Summary

Revision 21, 9/1/10

- The SOP is an update from Revision 20 dated 04/27/10
- The SOP has been found to be up-to-date with Standard Methods 21st edition.
- Reference to adjusting filtrate volume for method 3030C has been removed.
- References to bound logbooks have been replaced with LIMS references.

Revision 20, 4/27/10

- The SOP is an update from Revision 19 dated 04/20/09.
- References to oil sample preparation have been removed.
- Extraction volumes for TCLP have been updated.

METALS DIGESTION/PREPARATION

References:

Methods 3005A/USEPA CLPILM0 4.1 Aqueous, 3010A, 3030C, 3050B
USEPA CLPILM0 4.1 (Soil/Sediment), 200.7, Standard Methods 3030C
See Addendum for USEPA CLPILM 05.2 (Aqueous & Soil/Sediment)

I. SCOPE AND APPLICATION

A. AQUEOUS

1. Method 3005A and USEPA CLP ILM0 4.1, "Acid Digestion of Waters for Total Recoverable or Dissolved Metals for Analysis by ICP Spectroscopy".
 - a. This method is used to prepare surface water, ground water, drinking water and wastewater samples for analysis by inductively coupled argon plasma spectroscopy (ICP).
2. Method 200.7, "Determination of Metals and Trace Metals in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry"
 - a. This method is used to prepare surface water, ground water, drinking water and wastewater samples for analysis by inductively coupled argon plasma spectroscopy (ICP).
3. Method 3010A, "Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by ICP Spectroscopy".
 - a. This method is used to prepare aqueous samples, EP and mobility-procedure extracts, and wastes that contain suspended solids for analysis by ICP. The procedure is used to determine total metals.
4. Method 3030C (Standard methods), "Preliminary Treatment for Acid-Extractable Metals".
 - a. This method is used to prepare ground water samples from North Carolina for analysis by ICP.

B. SOLIDS

1. Method 3050B, "Acid Digestion of Sediments, Sludges and Soils".
 - a. This method is used to prepare sediments, sludges and soil samples for analysis by ICP. Since certain matrices may result in poor recovery, the method of standard additions may be used when analyzed.
 - b. It should be noted that some metals could be biased high with the soil digestion when dilution is necessary. Take necessary measures to ensure that dilutions are made as accurately as possible.
2. USEPA CLP ILM0 4.1, "Acid Digestion of Soil/Sediment"
 - a. This method is used to prepare sediments and soil samples for analysis by ICP. Since certain matrices may result in poor recovery, the method of standard additions may be used when analyzed.

D. NOTES:

1. "Total Metals" includes all metals, inorganically and organically bound and both dissolved and particulate.
2. "Dissolved metals" includes all metals present in a sample after filtration through a 0.45 micron filter followed by digestion.

II. SUMMARY OF METHODS

- A. A representative sample of water or soil is put into an acid medium and exposed to heat for a certain amount of time. This allows for reduction of interferences by organic matter and converts metals bound to particulates to form the free metal that can be determined by ICP-Atomic Emission Spectrometry.

NOTE: When a reporting limit is required for a project lower than is customary, a four times concentration or alternate soil digestion ratio must be used in order to reach that lower level. Care must be taken to matrix match this concentrated aliquot. A blank and laboratory control sample (at a reduced concentration) are required with this concentration. A matrix spike (not at reduced concentration) and duplicate or matrix spike and matrix spike duplicate is needed per 20 samples or per batch.

III. SAMPLE HANDLING AND PRESERVATION

A. AQUEOUS

1. Samples are taken in high density polyethylene, one liter bottles. Samples should be preserved with concentrated HNO₃ to a pH <2 immediately upon sampling. If dissolved metals are to be analyzed the sample should be filtered before the HNO₃ is added. The samples should be maintained at 4°C until analysis. The holding time for metals samples is 180 days or approximately 6 months.

B. SOLIDS

1. Samples are taken in high density polyethylene (CLP only) or glass bottles. The samples should be maintained at 4°C until analysis. The holding time for metals samples is 180 days or approximately 6 months.

IV. INTERFERENCES

A. AQUEOUS

1. Solvents, reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing method blanks.

B. SOLIDS

1. Sludge samples can contain diverse matrix types, each of which may present its own analytical challenge. Spiked samples and any relevant standard reference material should be processed to aid in determining whether this method is applicable to a given waste.

V. SAFETY

- A. Normal accepted laboratory safety practices should be followed while performing this analysis.
- B. Be certain the exhaust hood is functioning before you begin the digestion procedure.
- C. Hot acids can be extremely corrosive. Avoid inhalation or contact with skin.

VI. EQUIPMENT/APPARATUS

- A. Fume hood, Labconco or equivalent.
- B. Hot plate, Thermolyne cimarec-3 or equivalent source for use at 95°C. The temperature of the hot plate must be monitored via the use of a temperature blank.
- C. Thermometer capable of reading 80 to 120 degrees C – ERTCO cat# 611-3-SC or equivalent.
- D. Vacuum pump for filtering dissolved metals- Gast or equivalent.
- E. Analytical balance capable of weighing to 0.01 gram. Mettler model BB300 or equivalent.

- F. Beckman CS-6R centrifuge.
 - G. Various class A volumetric glassware and ribbed watchglasses, Pyrex or equivalent.
 - H. Whatman No. 41 filter paper or equivalent.
 - I. Whatman No. 42 filter paper or equivalent.
 - J. Whatman 0.45 micron filter paper or equivalent.
 - K. 250 mL beaker or other appropriate vessel such as polypropylene block digester tubes, watch glasses and caps.
 - L. Stirring device, e.g. magnetic stirrer, glass rod or equivalent.
 - M. Manual Sample Mill
 - N. Wiley Sample Mill
 - O. Clippers for cutting vegetation
- NOTE: All glassware should be acid washed.

VII. REAGENTS AND STANDARD PREPARATION

A. REAGENTS

1. Metals grade Nitric acid (HNO₃). Reagent should be analyzed to determine level of impurities. If method blank is <MDL, then the reagent can be used.
2. Metals grade Hydrochloric acid (HCl). Reagent should be analyzed to determine level of impurities. If method blank is <MDL, then the reagent can be used.
3. 30% hydrogen peroxide reagent, ACS Grade. Reagent should be analyzed to determine level of impurities. If method blank is <MDL, then the reagent can be used.
4. Metals grade Sulfuric acid (H₂SO₄). Reagent should be analyzed to determine level of impurities. If method blank is <MDL, then the reagent can be used.
5. Reagent water (Deionized water).
6. Potassium Permanganate - Ultra pure grade. Reagent should be analyzed to determine level of impurities. If method blank is <MDL, then the reagent can be used.
7. Ammonium hydroxide, concentrated, reagent grade. Reagent should be analyzed to determine level of impurities. If method blank is <MDL, then the reagent can be used.
8. Ammonium phosphate, reagent grade- Reagent should be analyzed to determine level of impurities. If method blank is <MDL, then the reagent can be used.

B. STANDARDS

1. Traceability

- a. A LIMS record shall be maintained on all reference materials. The record shall include date of receipt, source, purity, all compositional information, storage conditions and expiration date. These materials/solutions are to be identified by a unique number in the LIMS as well as on the container's label.
- b. All working standards made from reference materials shall be labeled with a unique ID number with complete information on preparation date, concentration of each compound, solvent, preparer's name, expiration date and the information is recorded in LIMS. Reagents shall be labeled with date received and expiration date, if applicable. All of the information described above shall also be recorded in LIMS. Measurements made during standards preparation (e.g., from weighing operations, volume diluted to, etc.) shall also be recorded. There should be no container with sample, sample extract, standard solution, etc. that is not correctly labeled and properly stored.
- c. The analyst must initial and date each entry made in LIMS.

2. PREPARATION

A. Laboratory control sample

1. Aqueous

- a. This solution is prepared as follows: 50 mL concentrated HCl, 20 mL concentrated HNO₃, 1 mL of CLP-CAL-1, Solution A, 1 mL of CLP-CAL-1 Solution B, 0.25 mL of CLP-CAL-2, and 0.25 mL of CLP-CAL-3 diluted to 1 L in a volumetric flask. Use 50 mL (100 mL for strict CLPIIM0 4.1) for digestion. This solution is given a unique identifier and recorded in sample LIMS.
- b. For four times concentrated samples: The solution is prepared as follows: 50 mL concentrated HCl, 20 mL concentrated HNO₃, 1mL CLPP-SPK-4 (Inorganic Ventures) (This solution contains 10 mg/L Selenium, 100 mg/L Antimony, 50 mg/L Cadmium and Thallium, 40 mg/L Arsenic and 20 mg/L Lead) to 1 L in a volumetric flask. This solution is given a unique identifier. Use 12.5 mLs to 50 mLs and prepare two aliquots. Heat at 90 to 95°C to reduce the volume in each vessel to ten mLs and then combine each 10 mL aliquot into one vessel and take to a final volume of 25 mLs. Take care to matrix match acids so that the final 25 mL portion will contain 2% HNO₃ and 5% HCl. Use 0.125 mLs HNO₃ and 0.3125 mLs HCl to each 50 mL vessel.

2. Solids:

- a. 1.0 ±0.02 (or 2.0 ±0.02) gram aliquot of teflon chips is weighed and spiked using the same spiking solution used for matrix spikes. This sample is given a unique identifier according to the Lot# for the teflon chips used and when digested is given the descriptor. i.e. BS1 and then BS2 etc. plus the unique identifier number assigned. Alternatively a solid matrix standard reference material is obtained from the manufacturer. This sample is given a unique identifier and the weight is recorded in a bound logbook and transferred to LIMS.

B. Spiking solution

1. Sample is spiked using 0.1 mL of CLP-CAL-1, Solution A, 0.1 mL of CLP-CAL-1 Solution B, 0.025 mL of CLP-CAL-2 and 0.025 mL of CLP-CAL-3 for a final volume of 100 mL. If only 50 mL is used, decrease amount used appropriately. These solutions are given unique identifiers. Record the amount spiked and the unique identifier of the standard.
2. CLP sample is spiked using 0.1 mL CLPP-SPK-1 and 0.1 mL CLPP-SPK-4 for a final volume of 100 mL. If only 50 mL is used, decrease amount used appropriately. These solutions are given unique identifiers.
3. For samples that require four times concentration, the sample is spiked using 0.0125 mLs of CLPP-SPK-4 to each of two vessels with 50 mLs of sample in each. The volume of each of the vessels is lowered to less than 10 mLs and combined and the final volume of this concentrated sample is 25mLs.

VIII. CALIBRATION

- A. The temperature of the samples must be maintained at 95°C and monitored via a temperature blank. Record in temperature logbook for later transfer into LIMS.

IX. PROCEDURE

- A. Glassware preparation for digestion or when the hot-block can not be used:
1. Wash glassware with hot soapy water and rinse thoroughly. (Beakers must be washed as soon as possible after being used, dirty beakers must not be allowed to sit overnight.)
 2. Rinse glassware with reagent water that contains 5% HNO₃ and 5% HCl followed by a rinse with reagent water.
 3. Prior to use, all glassware must be confirmed clean via a glassware check. Otherwise, repeat step "2" until the glassware check passes.
- B. Aqueous sample filtration (for dissolved metals):
1. Thoroughly clean a flask and funnel with hot soapy water. Next, rinse the flask and funnel with 1:5 HNO₃ followed by a thorough D.I. water rinsing. This step is very important because the filters contain some metals (namely Zn) which could contaminate the samples.
 2. Rinse a 0.45 micron filter with 1:5 HNO₃ thoroughly, followed by D.I. water.
 3. Filter the unpreserved sample. If dissolved Hg analysis is requested for the sample, filter at least 200 mL.
 4. Discard the first 50 to 100 mL.
 5. A preparation blank must be taken through the filtration step and analyzed with the sample.
 6. Preserve the sample with HNO₃ to pH<2.
 7. Soluble samples that are clean and clear do not have to be digested. Use 100 mL sample, add 5 mL of concentrated HCl and 2 mL of concentrated HNO₃. **Samples must be digested unless approval for analysis without digestion is received from the project manager.**
- C. Aqueous sample preparation
1. Method 3005A and USEPA CLP ILM0 4.1, "**Acid digestion procedure for total recoverable or dissolved metals for analysis by ICP**".
 - a. Shake sample thoroughly and pour 50 mL of the well-mixed sample into a digestion vessel. For samples which require concentration pour 50 mLs of the well-mixed sample into two digestion vessels.
 - b. Add 0.50 mL (1 mL of (1+1) when strict CLP ILM0 4.1 is required) concentrated HNO₃ to the sample. For samples which require concentration, add 0.125 mL (0.25 mL of (1+1) when strict CLP ILM0 4.1 is required) concentrated HNO₃ to the sample.
 - c. Add 2.5 mL (5 mL of 1+1) when strict CLP ILM0 4.1 is required) concentrated HCl to the sample. For samples which require concentration, add 0.3125 mL (0.625 mL of (1+1) when strict CLP ILM0 4.1 is required) concentrated HCl to the sample.
 - d. Cover the sample with a ribbed watch glass or equivalent source.
 - e. Transfer the digestion vessel to a pre-heated hot plate or hot block at 90 to 95°C. A temperature blank will assure correct temperature. The temperature must be recorded in the temperature logbook. Take the volume down to between 5 to 10 mL, (12 to 25 mLs when strict CLP ILM0 4.1 is required) **making certain that the sample does not boil. This is extremely important. Boiling may lead to vaporization of certain analytes.** Remove the sample from the hot plate and cool
 - f. When necessary, filter or centrifuge the sample to remove insoluble material that could clog the nebulizer. The filtering apparatus must be thoroughly cleaned with dilute nitric acid prior to filtration.

- g. Bring sample to its predigestion volume (or when samples require concentration, to a volume four times lower then what was started with) with DI water in the digestion vessel. The final volume must be recorded in the LIMS.
 - h. The sample is now ready for analysis.
 - i. The LIMS must contain the date, analyst, sample number, client, sample mass/volume, final volume of digestate, lot # of acids used and the preparation and ID of standards plus identification #'s for standards used for spiking and the volume spiked into the sample.
2. Method 200.7, "**Acid digestion procedure for total recoverable metals**".
- a. Shake sample thoroughly and pour 50 mL of the well-mixed sample into the digestion vessel. If sample contains undissolved solids >1% refer to Section 11.3 of Method 200.7 for subsequent procedures.
 - b. Add 1.0 mL concentrated HNO₃ to the sample.
 - c. Add 2.50 mL concentrated HCl to the sample.
 - d. Cover the sample with a ribbed watch glass or equivalent source.
 - e. Transfer the digestion vessel to a pre-heated hot plate or equivalent source at 85°C. Take the volume down to between 10 to 15 mL, **making certain that the sample does not boil. This is extremely important. Boiling may lead to vaporization of certain analytes.**
 - f. Leave sample on hot plate and gently reflux for 30 minutes. Remove from hot plate and cool.
 - g. Bring sample to its predigestion volume with DI water in the digestion vessel.
 - h. When necessary, filter or centrifuge the sample to remove insoluble material that could clog the nebulizer. The filtering apparatus must be thoroughly cleaned with dilute nitric acid prior to filtration.
 - i. The sample is now ready for analysis.
 - j. The LIMS must contain the date, analyst, sample number, client, sample mass/volume, final volume of digestate, lot # of acids used and the preparation and ID of standards.
3. Method 3010A, "**Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by ICP Spectroscopy**".
- a. Shake sample thoroughly and pour 50 mL (5ml diluted to 50mL for TCLP, full 50ml volume for SPLP) of the well-mixed sample into the digestion vessel.
 - b. Add 1.5 mL concentrated HNO₃ to the sample.
 - c. Cover the sample with a ribbed watch glass.
 - d. Transfer the digestion vessel to a pre-heated hot plate or hot block at 90 to 95°C. A temperature blank must be used, with the temperature being recorded in the temperature logbook. Take the volume down to a low volume (~5 mL), **making certain that the sample does not boil. This is extremely important. Boiling may lead to vaporization of certain analytes. Also make certain that no portion of the bottom of the digestion vessel is allowed to go dry. This may lead to low recoveries.** Remove the sample from the hot plate and cool.
 - e. Add another 1.5 mL portion of concentrated HNO₃ to the sample.
 - f. Cover the sample with a ribbed watch glass.
 - g. Transfer the vessel to the hotblock or equivalent source. Increase the temperature so a gentle reflux occurs. Continue heating, adding additional acid as necessary, until the digestion is complete (generally indicated when the digestate is light in color or does not change in appearance with continued refluxing).

- h. Uncover the vessel and evaporate to a low volume (~3 mL) **making certain that no portion of the bottom of the digestion vessel is allowed to go dry.** Remove and cool.
- i. Add 2.5 ml of 1:1 HCl (10 mL/100 mL of final solution).
- j. Cover the digestion vessel and reflux for an additional 15 minutes.
- k. Bring sample to its predigestion volume in digestion vessel.
- l. When necessary, filter or centrifuge the sample to remove insoluble material that could clog the nebulizer. The filtering apparatus must be thoroughly cleaned with dilute nitric acid prior to filtration.
Note: When preparing DoD project samples, if any sample in a digestion batch requires filtration, all samples (including QC samples) must be treated in the same manner.
- m. The sample is now ready for analysis.
- n. The LIMS must contain the date, analyst, sample number, client, sample mass/volume, final volume of digestate, lot # of acids used and the preparation and ID of standards.

4 Method 3030C (Standard Methods), "**Preliminary treatment for Acid-Extractable Metals**"

- a. Shake sample thoroughly and pour 50 mL of the well-mixed sample into a 50 mL digestion vessel.
- b. Add 2.5 mL 1:1 HCl to the sample.
- c. Heat 15 minutes in a hot bath.
- d. Filter through a membrane filter.
- e. Transfer to ICP analyst.

D. Solid sample preparation

It is extremely important that waste (when appropriate), soil and sediment samples be mixed thoroughly to ensure that the sample is as representative as possible of the sample media. The most common method of mixing is referred to as quartering. The quartering procedure should be performed as follows:

- *The material in the sample pan (inorganic-plastic/organic-aluminum) should be divided into quarters and each quarter should be mixed individually.*
- *Two quarters should then be mixed to form halves.*
- *The two halves should be mixed to form a homogenous matrix.*

This procedure should be repeated several times until the sample is adequately mixed.

NOTE: Samples that are clay type materials should be handled in a different manner. Due to these type sample matrices having an affinity to stick to most anything that touches it, another approach must be followed. Obtain a representative sub-sample aliquot from the center or middle section of the sample container.

Grinding of Vegetation Samples

Remove sample from shipping container and brush off dirt particles. Chop sample into about half inch pieces with clippers or other cutting tool. Place the sample in an aluminum pan and air-dry in an exhaust hood to the appropriate dryness for grinding. It should be dry

enough where it won't stick to the inside of the mill. Grind the dried sample to fineness in either the manual sample mill or the Wiley mill or both if needed. Place the ground sample in a container and label immediately.

1. USEPA CLP ILM0 4.1, "**Acid digestion of Soil/Sediment**"

- a. Mix the sample thoroughly to achieve homogeneity. For each digestion procedure, weigh (to the nearest 0.01 g) a 1.0 to 1.5 g portion of sample and transfer to a digestion vessel.
- b. Add 10 mL of 1:1 nitric acid (HNO_3), mix the slurry, and cover with a watch glass or equivalent source. Heat the sample to 92 to 95°C and reflux for 10 minutes without boiling. Allow the sample to cool, add 5.0 mL of concentrated HNO_3 , replace with watch glass or equivalent source, as appropriate, and reflux for 30 minutes. Do not allow the volume to be reduced to less than 5 mL while maintaining a covering of solution over the bottom of the heating vessel.
- c. After the second reflux step has been completed and the sample has cooled, add 2 mL of Type II water and 3.0 mL of 30% hydrogen peroxide (H_2O_2). Return the heating vessel to the hot plate or equivalent heating source for warming to start the peroxide reaction. Care must be taken to ensure that losses do not occur due to excessively vigorous effervescence. Heat until effervescence subsides, and cool the heating vessel.
- d. Continue to add 30% H_2O_2 in 1 mL aliquots with warming until the effervescence is minimal or until the general sample appearance is unchanged. (NOTE: Do not add more than a total of 10 mL 30% H_2O_2 .)
- e. If the sample is being prepared for ICP analysis of Al, As, Sb, Ba, Be, Ca, Cd, Cr, Co, Cu, Fe, Pb, Mg, Mn, Ni, K, Se, Ag, Na, Tl, V, and Zn, add 5 mL of 1:1 HCl and 10 mL of Type II water, return the covered heating vessel to the hot plate or equivalent heating source, and heat for an additional 10 minutes. After cooling, filter through Whatman No. 42 filter paper (or equivalent) and dilute to 50 mL with Type II water. NOTE: In place of filtering, the sample (after dilution and mixing) may be centrifuged or allowed to settle by gravity overnight to remove insoluble material. Dilute the digestate to 144 mL with DI water, add 5 mLs concentrated HCl and 1 mL of concentrated HNO_3 , mix well and place into the appropriate container. The diluted sample has an approximate acid concentration of 2.5% (v/v) HCl and 5% (v/v) HNO_3 . The sample is now ready for analysis.
- f. The LIMS must contain the date, analyst, sample number, client, sample mass/volume, final volume of digestate, lot # of acids used and the preparation and ID of standards and ID of matrix spikes and the amounts used for spiking.

2. Method 3050B, "**Acid digestion of Sediments, Sludges and Soils**"

- a. Mix the sample thoroughly for 5 minutes using a plastic spatula or Teflon coated spatula in a glass or plastic weigh boat to achieve homogeneity.
- b. Weigh approximately (to the nearest 0.01 g) a 1 to 1.5 g portion of the sample directly into a digestion vessel. For samples with low percent solids a larger sample size may be used as long as digestion is completed. Record the exact mass in the LIMS.

NOTE: To achieve the lowest reporting limit possible, use a 2.0 g portion of sample with an ending volume of 100 mLs.

- c. Add 5 mL D.I. water and 5 mL concentrated HNO_3 (1:1), mix the slurry and cover with a watch glass. Place the sample in a preheated hot block and reflux at 95°C for

10 to 15 minutes being certain that the sample does not boil. Record temperature in temperature logbook

- d. Allow the sample to cool. Add 5 mL concentrated HNO_3 , replace the watch glass and heat/reflux again for 30 minutes. If brown fumes are generated, indicating oxidation of the sample by HNO_3 , repeat this step (addition of 5 mL of concentrated HNO_3) over and over until no brown fumes are given off by the sample indicating the complete reaction with HNO_3 . Using a watch glass or equivalent allow the solution to evaporate to approximately 5 mL without boiling at $95^\circ\text{C} \pm 5^\circ\text{C}$ for approximately two hours. Maintain a covering of solution over the bottom of the vessel at all times. Do not allow the volume to be reduced to less than 5 mL while maintaining a covering of solution over the bottom of the beaker. If the volume does get low, add 2.5 mL of D.I. water to bring volume back up.
- e. Take the sample off the hot block and allow it to cool. Next, add 2 mL of D.I. water and 3 mL of 30% Hydrogen Peroxide. (The sample will bubble upon the addition of H_2O_2 if it is still warm.) Cover the vessel with a watch glass and return the sample to the hot block or equivalent source and heat until the bubbling subsides. Care must be taken to ensure that losses do not occur due to excessively vigorous effervescence. Heat until effervescence subsides and cool the beaker. Add two more 3 mL portions of H_2O_2 to the sample in the same manner as before. (NOTE: Do not add more than a total of 10 mL 30% H_2O_2 .)
- f. Cover the sample with a ribbed watch glass and continue heating the acid-peroxide digestate at $95^\circ\text{C} \pm 5^\circ\text{C}$ without boiling for approximately two hours until the volume has been reduced to approximately 2.5 mL. Maintain covering of solution over the bottom of the vessel at all times.
- g. Add 2.5 mL of DI water and 2.5 mL of concentrated HCl and 10 mL of DI water, cover the sample with a ribbed watch glass and continue refluxing for an additional 10 minutes without boiling
- h. When necessary, filter or centrifuge the sample to remove insoluble material that could clog the nebulizer. The filtering apparatus must be thoroughly cleaned with dilute nitric acid prior to filtration.
- i. Bring sample up to 50 mL with D.I. water in the vessel. Add 150 ml of DI water to a 250 ml sample bottle. Invert the 50 ml sample digestion vessel several times to mix the sample and pour sample into the 150 ml of the sample bottle. Pour some sample back into the 50 ml sample digestion vessel to rinse and pour back into the 250 ml sample bottle and cap and mix.
NOTE1: When preparing DoD project samples, if any sample in a digestion batch requires filtration, all samples (including QC samples) must be treated in the same manner.
NOTE2: To achieve the lowest reporting limit possible use 2.0 grams of sample with an ending volume of 100 mLs.
- j. The sample is now ready for analysis.
- k. The LIMS must contain the date, analyst, sample number, client, sample mass/volume, final volume of digestate, lot # of acids used and the preparation and ID of standards.

X. CALCULATIONS

- A. The analyst must be supplied with both beginning sample masses/volumes and final digestate volumes. This information must be recorded in the digestion log.

XI. QUALITY CONTROL

A. Digestion

1. Temperature blank
 - a. The temperature of the hot plate/hot block must be monitored for temperature during the digestion process.
 - b. The thermometer must be tagged with annual calibration information. Record the thermometer reading, correction factor and the corrected temperature in the digestion log.
2. Blanks
 - a. Digest a blank with every batch of samples digested (20 sample maximum). The blank is prepared by adding all the same reagents added to the samples to a clean dry beaker and taking it through the same process as the samples.
 - b. Also, there must be a blank for every different method of digestion that is set up that day, every 20 samples.
 - c. There must also be a blank for every different matrix of samples that is to be digested, every 20 samples.
 - d. Sample is given a unique identifier in the digestion log.
3. Laboratory Control Samples
 - a. For water samples, one LCS is digested with every batch of samples digested (20 sample maximum).
 - b. For water samples, a LCS is digested every day for each type of digestion, every 20 samples.
 - c. For soil/sediment samples, a soil matrix standard reference material (SRM) must be digested per batch (20 samples maximum) or alternatively a spiked teflon chip sample.
 - d. Sample is given a unique identifier in the digestion log.
4. Duplicates
 - a. A duplicate is prepared every 20 samples. This usually takes the form of a matrix spike duplicate.

NOTE: Certain projects require a sample duplicate and a matrix spike duplicate with each set of twenty samples.
5. Blank Spike
 - a. This is required for certain projects.

B. Sample Matrix

NOTE: Field blanks/duplicates, trip blanks, or equipment blanks are not to be used for sample matrix QC samples.

1. Matrix spike
 - a. Digest a spike and spike duplicate every 20 samples where sample volume is adequate to do so. Choose a sample (if possible) that has a lot of metals requested to be analyzed.

NOTE: For some projects, a sample duplicate and sample spike may be required instead of a spike and spike duplicate. Your supervisor should make you aware of these projects.
 - b. The following metals do not get digested spikes when using CLP spike.
Calcium
Magnesium
Sodium

Potassium

- c. For TCLP samples, a spike must be digested for every matrix. You should inspect the sample (original sample prior to extraction) or check the log book to determine matrix type. (Also the matrix spike aliquot must be added to the extract after filtration but before preservation.)
- d. **The CLH project requires that a high and a low spike be prepared and analyzed. Spikes should be prepared at 40 mg/Kg and 400 mg/Kg for soil samples and 200 ug/L and 2000 ug/L for aqueous samples.**

XII. CORRECTIVE ACTIONS

- A. Sample boils during digestion.
 1. Redigest another sample aliquot.
- B. Sample goes dry or portion of beaker bottom is exposed due to excess evaporation during digestion.
 1. Redigest another sample aliquot.
 2. Glass beaker dry for an extended period of time? Discard beaker.

XIII. SPECIAL NOTES

- A. **Never** take for granted how a sample should be digested. If the sample looks strange or unusual, or if you are not sure what metals the sample gets, what detection limits are required, whether the sample is total or dissolved, or even what method of digestion should be used, always ask your supervisor or the person who is to analyze the sample. How metals need to be digested changes too often to take it for granted.
- B. **Antimony (Sb) soils** should be analyzed within 48 hours of digestion whenever possible. When a soil requesting Antimony analysis is received, you must coordinate with the person who will be analyzing it to be sure that they can analyze it on the same day that it is digested.
- C. Labels for the digested sample must be written in a neat and legible manner. The labels must include such information as sample number, client name, the date digested, and the volume or mass digested.
- D. There are several precautions that must be taken to minimize the possibility of contamination.
 1. All metals glassware must be kept separate from all other laboratory glassware.
 2. Metals glassware must be washed as soon as possible after being used. **Dirty metals beakers must not be left overnight.**
 3. Acid to be used for metals digestions must be kept separate from all other laboratory acid.
- E. Samples must be digested in a timely manner to ensure ICP analysis remains on schedule for data generation. Samples received on or before Wednesday of week X must be prepared for ICP digestion by the end of week X. Your supervisor must be consulted if this schedule can not be met at a particular time.
- F. Please consult Waste Disposal SOP-QS14, for information concerning disposal of waste generated from this area. Quantity of chemicals purchased should be based on expected usage during its shelf-life and the disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

Addendum for USEPA CLPILM 05.2 AQUEOUS & SOIL/SEDIMENT

The following is a list of changes for sample preparation when the 5.2 statement of work is required:

1. Soluble samples are required to be digested unless the chain of custody specifically states that digestion is not required. An MDL study must be done on the unprepared MDL solution in order to provide MDL levels for samples that are not digested. When digestion is not required an LCSW and post digestion spike are not required.
2. Digestates must be stored until 365 days after delivery of a complete, reconciled data package.
3. Preparation codes are used on form 13's. They are found in the 5.2 statement of work page B-39 3.4.12.2.4.

DEFINITIONS – Refer to SOP-QS08 for common environmental laboratory definitions.



**LABORATORY
ACCREDITATION
BUREAU**

Certificate of Accreditation

ISO/IEC 17025:2005

Certificate Number L2226

Empirical Laboratories, LLC

621 Mainstream Drive, Suite 270
Nashville, TN 37228

has met the requirements set forth in L-A-B's policies and procedures, all requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the U.S. Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP).*

The accredited lab has demonstrated technical competence to a defined "Scope of Accreditation" and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Accreditation Granted through: November 30, 2012

**R. Douglas Leonard, Jr., Managing Director
Laboratory Accreditation Bureau
Presented the 30th of November 2009**

*See the laboratory's Scope of Accreditation for details of the DoD ELAP requirements
Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).

Scope of Accreditation For Empirical Laboratories, LLC

621 Mainstream Drive, Suite 270
Nashville, TN 37228
Marcia K. McGinnity
877-345-1113

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.1) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to Empirical Laboratories, LLC to perform the following tests:

Accreditation granted through: **November 30, 2012**

Testing - Environmental

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8260B	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,1-Trichloroethane (1,1,1-TCA)
GC/MS	EPA 8260B	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)
GC/MS	EPA 8260B	1,1,2-Trichloroethane
GC/MS	EPA 8260B	1,1-Dichloroethane (1,1-DCA)
GC/MS	EPA 8260B	1,1-Dichloroethene (1,1-DCE)
GC/MS	EPA 8260B	1,1-Dichloropropene
GC/MS	EPA 8260B	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B	1,2,3-Trichloropropane
GC/MS	EPA 8260B	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 8260B	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260B	1,2-Dichlorobenzene
GC/MS	EPA 8260B	1,2-Dichloroethane (EDC)
GC/MS	EPA 8260B	1,2-Dichloropropane
GC/MS	EPA 8260B	1,3,5-Trimethylbenzene

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8260B	1,3-Dichlorobenzene
GC/MS	EPA 8260B	1,3-Dichloropropane
GC/MS	EPA 8260B	1,4-Dichlorobenzene
GC/MS	EPA 8260B	1,4-Dioxane
GC/MS	EPA 8260B	1-Chlorohexane
GC/MS	EPA 8260B	2,2-Dichloropropane
GC/MS	EPA 8260B	2-Butanone (Methyl ethyl ketone; MEK)
GC/MS	EPA 8260B	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B	2-Chlorotoluene
GC/MS	EPA 8260B	2-Hexanone (Methyl butyl ketone; MBK)
GC/MS	EPA 8260B	4-Chlorotoluene
GC/MS	EPA 8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)
GC/MS	EPA 8260B	Acetone
GC/MS	EPA 8260B	Acetonirile
GC/MS	EPA 8260B	Acrolein
GC/MS	EPA 8260B	Acrylonitrile
GC/MS	EPA 8260B	Allyl chloride
GC/MS	EPA 8260B	Benzene
GC/MS	EPA 8260B	Bromobenzene
GC/MS	EPA 8260B	Bromochloromethane
GC/MS	EPA 8260B	Bromodichloromethane
GC/MS	EPA 8260B	Bromoform
GC/MS	EPA 8260B	Bromomethane
GC/MS	EPA 8260B	Carbon Disulfide
GC/MS	EPA 8260B	Carbon Tetrachloride
GC/MS	EPA 8260B	Chlorobenzene
GC/MS	EPA 8260B	Chloroethane
GC/MS	EPA 8260B	Chloroform
GC/MS	EPA 8260B	Chloromethane
GC/MS	EPA 8260B	Chloroprene
GC/MS	EPA 8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)
GC/MS	EPA 8260B	cis-1,3-Dichloropropene
GC/MS	EPA 8260B	cis-1,4-Dichloro-2-butene

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8260B	Cyclohexane
GC/MS	EPA 8260B	Dibromochloromethane
GC/MS	EPA 8260B	Dibromomethane
GC/MS	EPA 8260B	Dichlorodifluoromethane (CFC-12)
GC/MS	EPA 8260B	Di-isopropyl ether
GC/MS	EPA 8260B	ETBE
GC/MS	EPA 8260B	Ethyl methacrylate
GC/MS	EPA 8260B	Ethylbenzene
GC/MS	EPA 8260B	Hexachlorobutadiene
GC/MS	EPA 8260B	Hexane
GC/MS	EPA 8260B	Iodomethane
GC/MS	EPA 8260B	Isobutyl alcohol
GC/MS	EPA 8260B	Isopropylbenzene (Cumene)
GC/MS	EPA 8260B	Methacrylonitrile
GC/MS	EPA 8260B	Methyl Acetate
GC/MS	EPA 8260B	Methyl methacrylate
GC/MS	EPA 8260B	Methyl Tertiary Butyl Ether (MTBE)
GC/MS	EPA 8260B	Methylcyclohexane
GC/MS	EPA 8260B	Methylene Chloride, or Dichloromethane
GC/MS	EPA 8260B	Naphthalene
GC/MS	EPA 8260B	n-Butylbenzene
GC/MS	EPA 8260B	n-Propylbenzene
GC/MS	EPA 8260B	p-Isopropyltoluene
GC/MS	EPA 8260B	Propionitrile
GC/MS	EPA 8260B	sec-Butylbenzene
GC/MS	EPA 8260B	Styrene
GC/MS	EPA 8260B	t-Butyl alcohol
GC/MS	EPA 8260B	tert-Amyl methyl ether
GC/MS	EPA 8260B	tert-Butylbenzene
GC/MS	EPA 8260B	Tetrachloroethene (PCE; PERC)
GC/MS	EPA 8260B	Tetrahydrofuran
GC/MS	EPA 8260B	Toluene
GC/MS	EPA 8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8260B	trans-1,3-Dichloropropene
GC/MS	EPA 8260B	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260B	Trichloroethene (TCE)
GC/MS	EPA 8260B	Trichlorofluoromethane (CFC-11)
GC/MS	EPA 8260B	Vinyl acetate
GC/MS	EPA 8260B	Vinyl Chloride (VC)
GC/MS	EPA 8260B	Xylenes (Total)
GC/MS	EPA 8270C/D	1,1'-Biphenyl
GC/MS	EPA 8270C/D	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D	1,2,4-Trichlorobenzene
GC/MS	EPA 8270C/D	1,2-Dichlorobenzene
GC/MS	EPA 8270C/D	1,2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1,3-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dioxane
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D	2,4,6-Trichlorophenol (TCP)
GC/MS	EPA 8270C/D	2,4-Dichlorophenol (DCP)
GC/MS	EPA 8270C/D	2,4-Dimethylphenol
GC/MS	EPA 8270C/D	2,4-Dinitrophenol
GC/MS	EPA 8270C/D	2,4-Dinitrotoluene (DNT)
GC/MS	EPA 8270C/D	2,6-Dichlorophenol
GC/MS	EPA 8270C/D	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol (o-Cresol)
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 8270C/D	2-Nitrophenol (ONP)
GC/MS	EPA 8270C/D	3,3'-Dichlorobenzidine (DCB)
GC/MS	EPA 8270C/D	3-Methylphenol

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4,6-Dinitro-2-methylphenol (DNOC)
GC/MS	EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 8270C/D	4-Chlorophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Methylphenol (p-Cresol)
GC/MS	EPA 8270C/D	4-Nitroaniline (PNA)
GC/MS	EPA 8270C/D	4-Nitrophenol (PNP)
GC/MS	EPA 8270C/D	7,12-Dimethylbenz(a)anthracene
GC/MS	EPA 8270C/D	Acenaphthene
GC/MS	EPA 8270C/D	Acenaphthylene
GC/MS	EPA 8270C/D	Acetaphenone
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 8270C/D	Benzdine
GC/MS	EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D	Benzoic Acid
GC/MS	EPA 8270C/D	Benzyl alcohol
GC/MS	EPA 8270C/D	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270C/D	bis(2-Chloroethyl)ether (BCEE)
GC/MS	EPA 8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)
GC/MS	EPA 8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)
GC/MS	EPA 8270C/D	Butyl benzyl phthalate (BBP)
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Dibenz(a,h)anthracene
GC/MS	EPA 8270C/D	Dibenzofuran (DBF)
GC/MS	EPA 8270C/D	Diethyl phthalate (DEP)
GC/MS	EPA 8270C/D	Dimethyl phthalate (DMP)
GC/MS	EPA 8270C/D	Di-n-butyl phthalate (DBP)
GC/MS	EPA 8270C/D	Di-n-octyl phthalate (DNOP)
GC/MS	EPA 8270C/D	Fluoranthene
GC/MS	EPA 8270C/D	Fluorene
GC/MS	EPA 8270C/D	Hexachlorobenzene (HCB)
GC/MS	EPA 8270C/D	Hexachlorobutadiene (HCBD)
GC/MS	EPA 8270C/D	Hexachlorocyclopentadiene (HCCPD)
GC/MS	EPA 8270C/D	Hexachloroethane (HCE)
GC/MS	EPA 8270C/D	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Naphthalene
GC/MS	EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	N-Nitrosodimethylamine
GC/MS	EPA 8270C/D	N-Nitroso-di-n-propylamine (NDPA)
GC/MS	EPA 8270C/D	N-nitrosodiphenylamine (NDPHA)
GC/MS	EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 8270C/D	Phenanthrene
GC/MS	EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/ECD	EPA 8081A/B	4,4'-DDD
GC/ECD	EPA 8081A/B	4,4'-DDE
GC/ECD	EPA 8081A/B	4,4'-DDT
GC/ECD	EPA 8081A/B	Aldrin
GC/ECD	EPA 8081A/B	alpha-BHC (alpha-HCH)
GC/ECD	EPA 8081A/B	alpha-Chlordane
GC/ECD	EPA 8081A/B	beta-BHC (beta-HCH)
GC/ECD	EPA 8081A/B	delta-BHC (delta-HCH)

Non-Potable Water		
Technology	Method	Analyte
GC/ECD	EPA 8081A/B	Dieldrin
GC/ECD	EPA 8081A/B	Endosulfan I
GC/ECD	EPA 8081A/B	Endosulfan II
GC/ECD	EPA 8081A/B	Endosulfan sulfate
GC/ECD	EPA 8081A/B	Endrin
GC/ECD	EPA 8081A/B	Endrin aldehyde
GC/ECD	EPA 8081A/B	Endrin ketone
GC/ECD	EPA 8081A/B	gamma-BHC (Lindane; gamma-HCH)
GC/ECD	EPA 8081A/B	gamma-Chlordane
GC/ECD	EPA 8081A/B	Heptachlor
GC/ECD	EPA 8081A/B	Heptachlor epoxide
GC/ECD	EPA 8081A/B	Methoxychlor
GC/ECD	EPA 8081A/B	Chlordane
GC/ECD	EPA 8081A/B	Toxaphene
GC/ECD	EPA 8082 /A	Aroclor-1016
GC/ECD	EPA 8082 /A	Aroclor-1221
GC/ECD	EPA 8082 /A	Aroclor-1232
GC/ECD	EPA 8082 /A	Aroclor-1242
GC/ECD	EPA 8082 /A	Aroclor-1248
GC/ECD	EPA 8082 /A	Aroclor-1254
GC/ECD	EPA 8082 /A	Aroclor-1260
GC/ECD	EPA 8082 /A	Aroclor-1262
GC/ECD	EPA 8082 /A	Aroclor-1268
GC/ECD	EPA 8151A	2,4,5-T
GC/ECD	EPA 8151A	2,4,5-TP (Silvex)
GC/ECD	EPA 8151A	2,4-D
GC/ECD	EPA 8151A	2,4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichlorprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP (Mecoprop)

Non-Potable Water		
Technology	Method	Analyte
HPLC/UV	EPA 8330A/B	1,3,5-Trinitrobenzene
HPLC/UV	EPA 8330A/B	1,3-Dinitrobenzene
HPLC/UV	EPA 8330A/B	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	EPA 8330A/B	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	EPA 8330A/B	2,4-Dinitrotoluene (DNT)
HPLC/UV	EPA 8330A/B	2,6-Dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Amino-4,6-dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Nitrotoluene (ONT)
HPLC/UV	EPA 8330A/B	3,5-Dinitroaniline
HPLC/UV	EPA 8330A/B	3-Nitrotoluene
HPLC/UV	EPA 8330A/B	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330A/B	4-Nitrotoluene (PNT)
HPLC/UV	EPA 8330A/B	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	EPA 8330A/B	Nitrobenzene
HPLC/UV	EPA 8330A/B	Nitroglycerin
HPLC/UV	EPA 8330A/B	Nitroguanidine
HPLC/UV	EPA 8330A/B	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	EPA 8330A/B	3,5-Dinitroaniline
HPLC/UV	EPA 8330A/B	PETN
GC/FID	FLPRO	Petroleum Range Organics
GC/FID	EPA 8015B	TPH DRO
GC/FID	EPA 8015B	TPH GRO
GC/FID	RSK-175	Methane
GC/FID	RSK-175	Ethane
GC/FID	RSK-175	Ethene
GC/ECD	EPA 8011	1,2-Dibromoethane (EDB)
GC/ECD	EPA 8011	1,2-Dibromo-3-chloropropane (DBCP)
HPLC/MS	EPA 6850	Perchlorate
ICP	EPA 6010B/C	Aluminum
ICP	EPA 6010B/C	Antimony
ICP	EPA 6010B/C	Arsenic
ICP	EPA 6010B/C	Barium
ICP	EPA 6010B/C	Beryllium

Non-Potable Water		
Technology	Method	Analyte
ICP	EPA 6010B/C	Boron
ICP	EPA 6010B/C	Cadmium
ICP	EPA 6010B/C	Calcium
ICP	EPA 6010B/C	Chromium, total
ICP	EPA 6010B/C	Cobalt
ICP	EPA 6010B/C	Copper
ICP	EPA 6010B/C	Iron
ICP	EPA 6010B/C	Lead
ICP	EPA 6010B/C	Magnesium
ICP	EPA 6010B/C	Manganese
CVAA	EPA 7470A	Mercury
ICP	EPA 6010B/C	Molybdenum
ICP	EPA 6010B/C	Nickel
ICP	EPA 6010B/C	Potassium
ICP	EPA 6010B/C	Selenium
ICP	EPA 6010B/C	Silver
ICP	EPA 6010B/C	Sodium
ICP	EPA 6010B/C	Strontium
ICP	EPA 6010B/C	Thallium
ICP	EPA 6010B/C	Tin
ICP	EPA 6010B/C	Titanium
ICP	EPA 6010B/C	Vanadium
ICP	EPA 6010B/C	Zinc
IC	EPA 300.0	Chloride
IC	EPA 300.0	Fluoride
IC	EPA 300.0	Nitrate
IC	EPA 300.0	Nitrite
IC	EPA 300.0	Sulfate
IC	EPA 9056A	Chloride
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Nitrate
IC	EPA 9056A	Nitrite
IC	EPA 9056A	Sulfate

Non-Potable Water		
Technology	Method	Analyte
Titration	SM 2320B 20 th /21 st edition	Alkalinity
Colorimetric	SM 4500 B, G, 20 th /21 st edition	Ammonia
Colorimetric	EPA 410.4	COD
UV/Vis	EPA 7196A	Hexavalent Chromium
Colorimetric	EPA 353.2	Nitrocellulose
Colorimetric	EPA 353.2	Nitrate/Nitrite
Gravimetric	EPA 1664A	O&G
Titration	Chap.7, Sect. 7.3.4 Mod.	Reactive Sulfide
Titration	SM 4500 S-2CF, 20 th /21 st edition	Sulfide
UV/Vis	SM 4500 P B5, E, 20 th /21 st edition	Total Phosphorus (as P)
UV/Vis	SM 4500 PE, 20 th /21 st edition	Ortho-Phosphate (as P)
TOC	9060A/SM5310C, 20 th /21 st edition	Total Organic Carbon
Gravimetric	SM 2540C, 20 th /21 st edition	TDS
Gravimetric	SM 2540D, 20 th /21 st edition	TSS
Colorimetric	EPA 9012A/B	Cyanide
Physical	EPA 1010A	Ignitability
Physical	EPA 9095B	Paint Filter
Probe	EPA 9040B/C	pH
Preparation	Method	Type
Preparation	EPA 1311	TCLP
Preparation	EPA 3005A	Metals digestion
Preparation	EPA 3010A	Metals digestion
Preparation	EPA 3510C	Organics Liquid Extraction
Preparation	EPA 5030A/B	Purge and Trap Water

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8260B	1,1,1-Trichloroethane (1,1,1-TCA)

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8260B	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)
GC/MS	EPA 8260B	1,1,2-Trichloroethane
GC/MS	EPA 8260B	1,1-Dichloroethane (1,1-DCA)
GC/MS	EPA 8260B	1,1-Dichloroethene (1,1-DCE)
GC/MS	EPA 8260B	1,1-Dichloropropene
GC/MS	EPA 8260B	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B	1,2,3-Trichloropropane
GC/MS	EPA 8260B	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 8260B	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260B	1,2-Dichlorobenzene
GC/MS	EPA 8260B	1,2-Dichloroethane (EDC)
GC/MS	EPA 8260B	1,2-Dichloropropane
GC/MS	EPA 8260B	1,3,5-Trimethylbenzene
GC/MS	EPA 8260B	1,3-Dichlorobenzene
GC/MS	EPA 8260B	1,3-Dichloropropane
GC/MS	EPA 8260B	1,4-Dichlorobenzene
GC/MS	EPA 8260B	1,4-Dioxane
GC/MS	EPA 8260B	2,2-Dichloropropane
GC/MS	EPA 8260B	2-Butanone (Methyl ethyl ketone; MEK)
GC/MS	EPA 8260B	2-Chlorotoluene
GC/MS	EPA 8260B	2-Hexanone (Methyl butyl ketone; MBK)
GC/MS	EPA 8260B	4-Chlorotoluene
GC/MS	EPA 8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)
GC/MS	EPA 8260B	Acetone
GC/MS	EPA 8260B	Acetonitrile
GC/MS	EPA 8260B	Acrolein
GC/MS	EPA 8260B	Acrylonitrile
GC/MS	EPA 8260B	Allyl chloride

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8260B	Benzene
GC/MS	EPA 8260B	Bromobenzene
GC/MS	EPA 8260B	Bromochloromethane
GC/MS	EPA 8260B	Bromodichloromethane
GC/MS	EPA 8260B	Bromoform
GC/MS	EPA 8260B	Bromomethane
GC/MS	EPA 8260B	Carbon Disulfide
GC/MS	EPA 8260B	Carbon Tetrachloride
GC/MS	EPA 8260B	Chlorobenzene
GC/MS	EPA 8260B	Chloroethane
GC/MS	EPA 8260B	Chloroform
GC/MS	EPA 8260B	Chloromethane
GC/MS	EPA 8260B	Chloroprene
GC/MS	EPA 8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)
GC/MS	EPA 8260B	cis-1,3-Dichloropropene
GC/MS	EPA 8260B	cis-1,4-Dichloro-2-butene
GC/MS	EPA 8260B	Cyclohexane
GC/MS	EPA 8260B	Dibromochloromethane
GC/MS	EPA 8260B	Dibromomethane
GC/MS	EPA 8260B	Dichlorodifluoromethane (CFC-12)
GC/MS	EPA 8260B	Ethyl methacrylate
GC/MS	EPA 8260B	Ethylbenzene
GC/MS	EPA 8260B	Hexachlorobutadiene
GC/MS	EPA 8260B	Hexane
GC/MS	EPA 8260B	Iodomethane
GC/MS	EPA 8260B	Isobutyl alcohol
GC/MS	EPA 8260B	Isopropylbenzene (Cumene)
GC/MS	EPA 8260B	Methacrylonitrile
GC/MS	EPA 8260B	Methyl Acetate
GC/MS	EPA 8260B	Methyl methacrylate
GC/MS	EPA 8260B	Methyl Tertiary Butyl Ether (MTBE)
GC/MS	EPA 8260B	Methylcyclohexane

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8260B	Methylene Chloride, or Dichloromethane
GC/MS	EPA 8260B	Naphthalene
GC/MS	EPA 8260B	n-Butylbenzene
GC/MS	EPA 8260B	n-Propylbenzene
GC/MS	EPA 8260B	p-Isopropyltoluene
GC/MS	EPA 8260B	Propionitrile
GC/MS	EPA 8260B	sec-Butylbenzene
GC/MS	EPA 8260B	Styrene
GC/MS	EPA 8260B	tert-Butylbenzene
GC/MS	EPA 8260B	Tetrachloroethene (PCE; PERC)
GC/MS	EPA 8260B	Toluene
GC/MS	EPA 8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)
GC/MS	EPA 8260B	trans-1,3-Dichloropropene
GC/MS	EPA 8260B	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260B	Trichloroethene (TCE)
GC/MS	EPA 8260B	Trichlorofluoromethane (CFC-11)
GC/MS	EPA 8260B	Vinyl acetate
GC/MS	EPA 8260B	Vinyl Chloride (VC)
GC/MS	EPA 8260B	Xylenes (Total)
GC/MS	EPA 8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)
GC/MS	EPA 8270C/D	1,1'-Biphenyl
GC/MS	EPA 8270C/D	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D	1,2,4-Trichlorobenzene
GC/MS	EPA 8270C/D	1,2-Dichlorobenzene
GC/MS	EPA 8270C/D	1,2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1,3-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dioxane
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D	2,4,6-Trichlorophenol (TCP)

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8270C/D	2,4-Dichlorophenol (DCP)
GC/MS	EPA 8270C/D	2,4-Dimethylphenol
GC/MS	EPA 8270C/D	2,4-Dinitrophenol
GC/MS	EPA 8270C/D	2,4-Dinitrotoluene (DNT)
GC/MS	EPA 8270C/D	2,6-Dichlorophenol
GC/MS	EPA 8270C/D	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol (o-Cresol)
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 8270C/D	2-Nitrophenol (ONP)
GC/MS	EPA 8270C/D	3,3'-Dichlorobenzidine (DCB)
GC/MS	EPA 8270C/D	3-Methylphenol
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4,6-Dinitro-2-methylphenol (DNOC)
GC/MS	EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 8270C/D	4-Chlorophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Methylphenol (p-Cresol)
GC/MS	EPA 8270C/D	4-Nitroaniline (PNA)
GC/MS	EPA 8270C/D	4-Nitrophenol (PNP)
GC/MS	EPA 8270C/D	Acenaphthene
GC/MS	EPA 8270C/D	Acenaphthylene
GC/MS	EPA 8270C/D	Acetaphenone
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 8270C/D	Benzidine
GC/MS	EPA 8270C/D	Benzo(a)anthracene

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D	Benzoic Acid
GC/MS	EPA 8270C/D	Benzyl alcohol
GC/MS	EPA 8270C/D	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270C/D	bis(2-Chloroethyl)ether (BCEE)
GC/MS	EPA 8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)
GC/MS	EPA 8270C/D	Butyl benzyl phthalate (BBP)
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole
GC/MS	EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Dibenz(a,h)anthracene
GC/MS	EPA 8270C/D	Dibenzofuran (DBF)
GC/MS	EPA 8270C/D	Diethyl phthalate (DEP)
GC/MS	EPA 8270C/D	Dimethyl phthalate (DMP)
GC/MS	EPA 8270C/D	Di-n-butyl phthalate (DBP)
GC/MS	EPA 8270C/D	Di-n-octyl phthalate (DNOP)
GC/MS	EPA 8270C/D	Fluoranthene
GC/MS	EPA 8270C/D	Fluorene
GC/MS	EPA 8270C/D	Hexachlorobenzene (HCB)
GC/MS	EPA 8270C/D	Hexachlorobutadiene (HCBD)
GC/MS	EPA 8270C/D	Hexachlorocyclopentadiene (HCCPD)
GC/MS	EPA 8270C/D	Hexachloroethane (HCE)
GC/MS	EPA 8270C/D	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Naphthalene
GC/MS	EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	N-Nitrosodimethylamine
GC/MS	EPA 8270C/D	N-Nitroso-di-n-propylamine (NDPA)

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8270C/D	N-nitrosodiphenylamine (NDPHA)
GC/MS	EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 8270C/D	Phenanthrene
GC/MS	EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/ECD	EPA 8081A/B	4,4'-DDD
GC/ECD	EPA 8081A/B	4,4'-DDE
GC/ECD	EPA 8081A/B	4,4'-DDT
GC/ECD	EPA 8081A/B	Aldrin
GC/ECD	EPA 8081A/B	alpha-BHC (alpha-HCH)
GC/ECD	EPA 8081A/B	alpha-Chlordane
GC/ECD	EPA 8081A/B	beta-BHC (beta-HCH)
GC/ECD	EPA 8081A/B	delta-BHC (delta-HCH)
GC/ECD	EPA 8081A/B	Chlordane
GC/ECD	EPA 8081A/B	Dieldrin
GC/ECD	EPA 8081A/B	Endosulfan I
GC/ECD	EPA 8081A/B	Endosulfan II
GC/ECD	EPA 8081A/B	Endosulfan sulfate
GC/ECD	EPA 8081A/B	Endrin
GC/ECD	EPA 8081A/B	Endrin aldehyde
GC/ECD	EPA 8081A/B	Endrin ketone
GC/ECD	EPA 8081A/B	gamma-BHC (Lindane; gamma-HCH)
GC/ECD	EPA 8081A/B	gamma-Chlordane
GC/ECD	EPA 8081A/B	Heptachlor
GC/ECD	EPA 8081A/B	Heptachlor epoxide
GC/ECD	EPA 8081A/B	Methoxychlor
GC/ECD	EPA 8081A/B	Toxaphene
GC/ECD	EPA 8082 /A	Aroclor-1016
GC/ECD	EPA 8082 /A	Aroclor-1221
GC/ECD	EPA 8082 /A	Aroclor-1232
GC/ECD	EPA 8082 /A	Aroclor-1242

Solid and Chemical Materials		
Technology	Method	Analyte
GC/ECD	EPA 8082 /A	Aroclor-1248
GC/ECD	EPA 8082 /A	Aroclor-1254
GC/ECD	EPA 8082 /A	Aroclor-1260
GC/ECD	EPA 8082 /A	Aroclor-1262
GC/ECD	EPA 8082 /A	Aroclor-1268
GC/ECD	EPA 8151A	2,4,5-T
GC/ECD	EPA 8151A	2,4,5-TP (Silvex)
GC/ECD	EPA 8151A	2,4-D
GC/ECD	EPA 8151A	2,4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichlorprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP (Mecoprop)
HPLC/UV	EPA 8330A	1,3,5-Trinitrobenzene
HPLC/UV	EPA 8330A	1,3-Dinitrobenzene
HPLC/UV	EPA 8330A	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	EPA 8330A	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	EPA 8330A	2,4-Dinitrotoluene (DNT)
HPLC/UV	EPA 8330A	2,6-Dinitrotoluene
HPLC/UV	EPA 8330A	2-Amino-4,6-dinitrotoluene
HPLC/UV	EPA 8330A	2-Nitrotoluene (ONT)
HPLC/UV	EPA 8330A	3-Nitrotoluene
HPLC/UV	EPA 8330A	3,5-Dinitroaniline
HPLC/UV	EPA 8330A	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330A	4-Nitrotoluene (PNT)
HPLC/UV	EPA 8330A	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	EPA 8330A	Nitroglycerin
HPLC/UV	EPA 8330A	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	EPA 8330A	Nitrobenzene
HPLC/UV	EPA 8330A	Nitroguanidine

Solid and Chemical Materials		
Technology	Method	Analyte
HPLC/UV	EPA 8330A	PETN
HPLC/UV	EPA 8330B	1,3,5-Trinitrobenzene
HPLC/UV	EPA 8330B	1,3-Dinitrobenzene
HPLC/UV	EPA 8330B	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	EPA 8330B	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	EPA 8330B	2,4-Dinitrotoluene (DNT)
HPLC/UV	EPA 8330B	2,6-Dinitrotoluene
HPLC/UV	EPA 8330B	2-Amino-4,6-dinitrotoluene
HPLC/UV	EPA 8330B	2-Nitrotoluene (ONT)
HPLC/UV	EPA 8330B	3-Nitrotoluene
HPLC/UV	EPA 8330B	3,5-Dinitroaniline
HPLC/UV	EPA 8330B	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330B	4-Nitrotoluene (PNT)
HPLC/UV	EPA 8330B	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	EPA 8330B	Nitroglycerin
HPLC/UV	EPA 8330B	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	EPA 8330B	Nitrobenzene
HPLC/UV	EPA 8330B	Nitroguanidine
HPLC/UV	EPA 8330B	PETN
GC/FID	FLPRO	Petroleum Range Organics
GC/FID	EPA 8015B	TPH DRO
GC/FID	EPA 8015B	TPH GRO
HPLC/MS	EPA 6850	Perchlorate
ICP	EPA 6010B/C	Aluminum
ICP	EPA 6010B/C	Antimony
ICP	EPA 6010B/C	Arsenic
ICP	EPA 6010B/C	Barium
ICP	EPA 6010B/C	Beryllium
ICP	EPA 6010B/C	Boron
ICP	EPA 6010B/C	Cadmium
ICP	EPA 6010B/C	Calcium
ICP	EPA 6010B/C	Chromium, total

Solid and Chemical Materials		
Technology	Method	Analyte
ICP	EPA 6010B/C	Cobalt
ICP	EPA 6010B/C	Copper
ICP	EPA 6010B/C	Iron
ICP	EPA 6010B/C	Lead
ICP	EPA 6010B/C	Magnesium
ICP	EPA 6010B/C	Manganese
CVAA	EPA 7471A/B	Mercury
ICP	EPA 6010B/C	Molybdenum
ICP	EPA 6010B/C	Nickel
ICP	EPA 6010B/C	Potassium
ICP	EPA 6010B/C	Selenium
ICP	EPA 6010B/C	Silver
ICP	EPA 6010B/C	Sodium
ICP	EPA 6010B/C	Strontium
ICP	EPA 6010B/C	Tin
ICP	EPA 6010B/C	Titanium
ICP	EPA 6010B/C	Thallium
ICP	EPA 6010B/C	Vanadium
ICP	EPA 6010B/C	Zinc
UV/Vis	EPA 7196A	Hexavalent Chromium
TOC	Lloyd Kahn	Total Organic Carbon
Colorimetric	EPA 353.2	Nitrocellulose
Colorimetric	EPA 9012A/B	Cyanide
Titration	Chap.7, Sect. 7.3.4 Mod.	Reactive Sulfide
Titration	EPA 9034	Sulfide
Probe	EPA 9045C/D	pH
Preparation	Method	Type
Preparation	EPA 1311	TCLP
Preparation	EPA 1312	SPLP
Preparation	NJ Modified 3060A	Hexavalent Chromium
Preparation	EPA 3050B	Metals Digestion
Preparation	EPA 3546	Organics Microwave Extraction



Solid and Chemical Materials		
Technology	Method	Analyte
Preparation	EPA 3550B/C	Organics Sonication
Preparation	SM 2540B 20 th /21 st edition	Percent Solids (Percent Moisture)
Preparation	EPA 5035 /A	Purge and Trap Solid

Notes:

- 1) This laboratory offers commercial testing service.



Approved By: _____

R. Douglas Leonard
Chief Technical Officer

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