BW-2785H
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Quality Assurance Project Plan
Former Fort Ord, California
Volume I, Appendix A

Draft Final Revision 7
Groundwater Remedies and Monitoring at Operable Unit 2, Sites 2 and 12, and Operable Unit Carbon Tetrachloride Plume

Prepared for:
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On behalf of:
U.S. Department of the Army
Fort Ord BRAC
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USACE Contract No. W91238-14-C-0048
Task No. 14

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Report Date: **June 19, 2019**
Report Version: **Draft Final**

Report Use and Limitations

Report Title:	**Quality Assurance Project Plan, Former Fort Ord, California, Volume I, Appendix A Draft Final Revision 7, Groundwater Remedies and Monitoring at Operable Unit 2, Sites 2 and 12, and Operable Unit Carbon Tetrachloride Plume**
Prime Contractor:	Ahtna Environmental, Inc.
USACE Contract No.	W91238-14-C-0048
Task No.	14

Ahtna Environmental, Inc. (Ahtna) prepared this report at the direction of the U.S. Army Corps of Engineers (USACE) for the sole use of the U.S. Department of the Army (Army), the intended beneficiary. No other party should rely on the information contained herein without the prior written consent of the Army. This report and its interpretations, conclusions, and recommendations use the information presented in other documents, as cited in the text and listed in the references. Therefore, this report is subject to the limitations and qualifications presented in the referenced documents.

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Acronyms and Abbreviations

%	percent
%D	percent difference/percent drift
°C	degrees Celsius
µg/L	micrograms per liter
1,1-DCA	1,1-dichloroethane
1,1-DCE	1,1-dichloroethene
1,2-DCA	1,2-dichloroethane
1,2-DCE (total)	total 1,2-dichloroethene
1,2-DCPA	1,2-dichloropropane
1,3-DCPE (total)	total 1,3-dichloropropene
2/12	Sites 2 and 12
ACL	Aquifer Cleanup Level
ADR	Automated Data Review
AES	Ahtna Engineering Services
Ahtna	Ahtna Environmental, Inc.
Army	U.S. Department of the Army
BCT	BRAC Cleanup Team
BEC	BRAC Environmental Coordinator
BFB	4-bromofluorobenzene
BRAC	Base Realignment and Closure
CCB	continuing calibration blanks
CCRWQCB	California Regional Water Quality Control Board, Central Coast Region
CCV	continuing calibration verification
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cis-1,2-DCE	cis-1,2-dichloroethene
COC	chemical of concern
COD	coefficient of determination
CQCR	Contractor Quality Control Report
CRF	Cooler Receipt Form
CT	carbon tetrachloride
DL	detection limit
DO	dissolved oxygen
DoD	Department of Defense
DQI	data quality indicator
DQO	data quality objective
DTSC	California Department of Toxic Substances Control
DTW	depth to water
EDD	electronic data deliverable
EISB	enhanced *in situ* bioremediation

Acronyms and Abbreviations (continued)

ELAP	Environmental Laboratory Accreditation Program
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
EW	Extraction Well
FADL	Field Activity Daily Logbook
FODIS	Fort Ord Data Integration System
FO-SVA	Fort Ord-Salinas Valley Aquitard
GAC	granular activated carbon
GC/MS	gas chromatography-mass spectrometry
GIS	geographic information system
GWMP	groundwater monitoring program
GWTP	groundwater treatment plant
GWTS	groundwater treatment system
HCl	hydrochloric acid
HLA	Harding Lawson Associates
HNO_3	nitric acid
IC	ion chromatography
ICAL	initial calibration
ICP	inductively coupled plasma
ICS	interference check sample
ICV	initial calibration verification
ID	identification
IDQTF	Intergovernmental Data Quality Task Force
LCS	laboratory control samples
LCSD	LCS duplicate
LOD	limit of detection
LOQ	limit of quantitation
MACTEC	MACTEC Engineering and Consulting, Inc.
MC	methylene chloride
MCL	maximum contaminant level
MCWD	Marina Coast Water District
mg/L	milligrams per liter
mL	milliliter
MNA	monitored natural attenuation
MPC	measurement performance criteria
MS/MSD	matrix spike/matrix spike duplicate
MSL	mean sea level
N/A	not applicable
ND	non-detect
NPL	National Priorities List

Acronyms and Abbreviations (continued)

O&M	operations and maintenance
ORP	oxidation-reduction potential
OU	operable unit
OU2	Operable Unit 2
OUCTP	Operable Unit Carbon Tetrachloride Plume
PARCCS	precision, accuracy, representativeness, comparability, completeness, sensitivity
PCE	tetrachloroethene
PDB	passive diffusion bag
PDS	post-digestion spike
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RI	Remedial Investigation
RF	response factor
ROD	Record of Decision
RPD	relative percent difference
RSD	relative standard deviation
SIM	selected ion monitoring
Sites 2/12	Sites 2 and 12
SM	Standard Methods
SOP	standard operating procedure
SRF	Sample Receipt Forms
SSHO	Site Safety and Health Officer
TAT	turnaround time
TCE	trichloroethene
trans-1,2-DCE	trans-1,2-dichloroethene
TS	treatment system
UCL	upper confidence limit
USACE	U.S. Army Corps of Engineers
VC	vinyl chloride
VOA	volatile organic analysis
VOC	volatile organic compound
Wood	Wood Environment & Infrastructure Solutions, Inc. (formerly Amec Foster Wheeler)

1.0 Introduction

On behalf of the U.S. Army Corps of Engineers (USACE), Sacramento District, Ahtna Environmental, Inc. (Ahtna) updated this Quality Assurance Project Plan (QAPP)[1] under Contract Number W91238-14-C-0048 for response actions to be performed at the former Fort Ord (Figure 1) in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or "Superfund") to address historical releases of chemicals of concern (COCs) at the former Fort Ord. The QAPP was updated and revised to:

- Update the number of wells monitored on an annual basis (Table 1), the list of wells sampled (Worksheet #17c) and the sampling location maps (Figures 2, 5A, 8A, 8B, 8C, and 9 through 13) based on newly installed wells,[2] recently decommissioned wells,[3] and recent progress in remedial actions for groundwater.[4]
- Update laboratory company name from SGS North America, Inc. to SGS.
- Update subcontractor company name from Amec Foster Wheeler to Wood Environment & Infrastructure Solutions, Inc. (Wood).
- Reference Department of Defense (DoD) Quality Systems Manual (QSM) Version 5.1.
- Update metals analysis from 6010C to 6010D.
- Reflect recent changes in project personnel.
- Update Operable Unit 2 (OU2) groundwater treatment system (GWTS) changes based on the new groundwater treatment plant (GWTP) and new extraction wells (Figure 7 and Worksheets #17b1 and #17b2).
- Include a description of how COC concentration contours and groundwater elevation contours are drawn in the quarterly reports.

This QAPP is the governing guidance document for groundwater and treatment system sampling associated with Sites 2/12, OU2, and Operable Unit Carbon Tetrachloride Plume (OUCTP) at the former Fort Ord. This QAPP details quality assurance (QA) and quality control (QC) procedures for sampling and analytical activities performed for the GWTS and the groundwater monitoring program (GWMP). The QAPP ensures the data generated are accurate, precise, complete, and representative of field conditions, and of sufficient quality to support project decisions.

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[1] This document is Appendix A to the *Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I*. Volume I is also the governing document for sampling and analysis of soil (Appendix B), soil gas (Appendix C), and landfill gas (Appendix D). Volume II of the QAPP pertains to the former Fort Ord military munitions response program.

[2] Based on the *Monitoring Well Installation Completion Report, Former Fort Ord, California* (Well Install Completion Report; Ahtna, 2019f).

[3] Based on the *2019 Monitoring Well and Soil Gas Probe Decommissioning Completion Report, Former Fort Ord, California* (Ahtna, 2019g).

[4] The United States Environmental Protection Agency (EPA), California Department of Toxic Substances Control (DTSC) and California Regional Water Quality Control Board, Central Coast Region (CCRWQCB) agreed to these changes.

2.0 Project Management

2.1 Worksheets #1 and #2: Title and Approval Page

Site Name/Project Name:	Former Fort Ord/Superfund Response Actions
Site Location:	Former Fort Ord, California
Document Title:	Quality Assurance Project Plan, Former Fort Ord, California, Volume I, Appendix A Draft Final Revision 7, Groundwater Remedies and Monitoring at Operable Unit 2, Sites 2 and 12, and Operable Unit Carbon Tetrachloride Plume
Lead Organization:	U.S. Army Corps of Engineers
Preparer's Name, Organization, and Contact Info:	Holly Dillon, Ahtna 296 12th St, Marina, CA 93933 (831) 384-3735 hdillon@ahtna.net
Preparation Date:	June 19, 2019

Project Role	Name Organization	Signature	Date
Investigative Organization's Project Manager	Derek Lieberman Ahtna		
Investigative Organization's Program Chemist	Christopher Ohland Ahtna		
Lead Organization's Technical Lead	Alex Kan USACE		
Lead Organization's Project Chemist	Jonathan Whipple USACE		

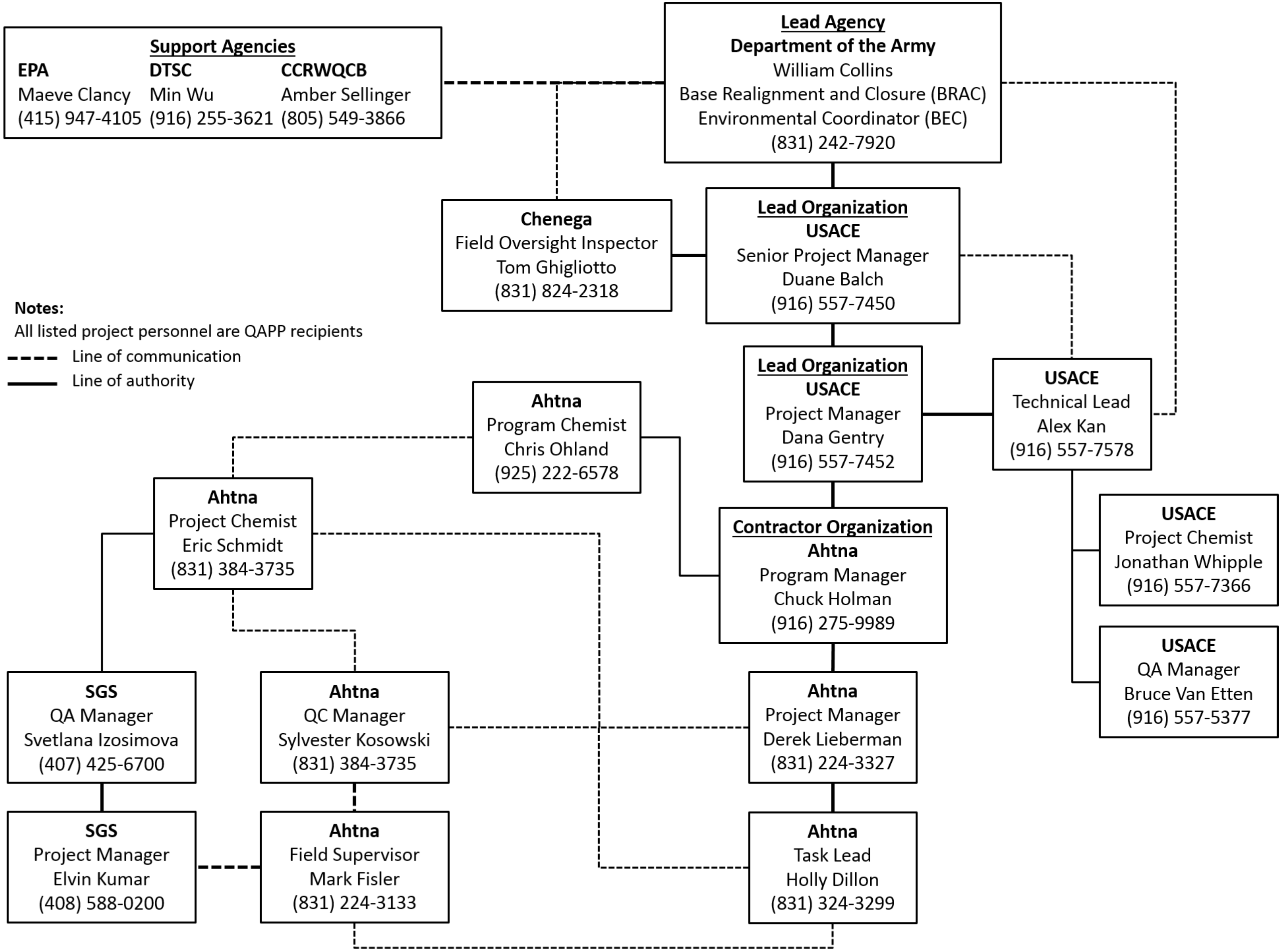
Plans and reports from previous investigations relevant to this project:

Site Name/Project Name:	Former Fort Ord/Superfund Response Actions
Site Location:	Monterey County, California
Site Number/Code:	Not Applicable (N/A)
Operable Units:	OU2, OUCTP, and Sites 2/12
Contractor Name:	Ahtna Environmental, Inc.
Contract Number:	W91238-14-C-0048
Contract Title:	Former Fort Ord Basewide Groundwater and Soil Vapor Treatment and Monitoring, Former Fort Ord, California
Work Assignment Number:	N/A
Guidance used to prepare QAPP:	Uniform Federal Policy for Quality Assurance Project Plans, Optimized UFP-QAPP Worksheets, March 2012, Revision 1. Department of Defense (DoD) Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.1, 2017
Regulatory Program:	Comprehensive Environmental Response Compensation and Liability Act (CERCLA) as amended by Superfund Amendment and Reauthorization Act (SARA)
Approval Entities:	U.S. Environmental Protection Agency (EPA), California Department of Toxic Substance Control (DTSC), and Regional Water Quality Control Board, Central Coast Region (CCRWQCB)
Data Users:	U.S. Department of the Army (Army), USACE, EPA (and its consultant TechLaw, Inc.), DTSC, CCRWQCB, Army/USACE contractors, citizen groups, and members of the public
Organizational partners (stakeholders) and connection with lead organization:	USACE, Army (lead agency/owner), EPA (lead oversight agency), DTSC (support agency), and CCRWQCB (support agency)
The QAPP is (select one):	Generic:____ Project Specific:__X__

Dates and titles of QAPP documents written for previous site work:

Title	**Approval Date**
Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Revision 6	March 2018
Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Revision 5	June 2017
Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Revision 4	March 2016
Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Revision 3	June 2015
Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Revision 2	February 2014
Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Revision 1	December 21, 2012
Draft Final Quality Assurance Project Plan, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Groundwater Extraction and Treatment Systems at Operable Unit 2 and Sites 2 and 12; Groundwater Monitoring Program at Sites 2 and 12, Operable Unit 1, Operable Unit 2, and Operable Unit Carbon Tetrachloride Plume	May 31, 2011
Draft Final, QAPP/CDQMP Groundwater Monitoring Program, Sites 2 and 12, OU2 and OUCTP	January 20, 2010
Final Sampling and Analysis Plan, Operable Unit 2 and Sites 2 and 12 Groundwater Treatment Systems, Former Fort Ord	August 20, 2009

2.2 Worksheets #3 and #5: Project Organization and QAPP Distribution



Notes:
All listed project personnel are QAPP recipients
- - - - Line of communication
—— Line of authority

2.3 Worksheets #4, #7, and #8: Personnel Qualifications and Sign-Off Sheet

Organization: Ahtna

Name	Project Title/Role	Education/ Experience[1]	Specialized Training/ Certifications[2]	Signature[3]	Date
Chuck Holman	Program Manager	Resume on file	HAZWOPER		
Derek Lieberman	Project Manager	Resume on file	First aid, CPR, MEC, PE, H&S, HAZWOPER, CQM		
Christopher Ohland	Program Chemist	Resume on file	H&S, HAZWOPER		
Eric Schmidt	Project Chemist	Resume on file	HAZWOPER, CQM		
Holly Dillon	Task Lead	Resume on file	First aid, CPR, MEC, H&S, HAZWOPER, CQM		
Mark Fisler	Field Supervisor	Resume on file	First aid, CPR, MEC, HAZWOPER, CQM		
Sylvester Kosowski	QC Manager	Resume on file	HAZWOPER, CQM		

Notes:

[1] Resumes available in Attachment B.

[2] Specialized Training/Certifications Key:
CPR: cardiopulmonary resuscitation
CQM: Construction Quality Management.
H&S: health and safety training, including, but not limited to: hazard communication, fire extinguisher use, defensive driving, behavior-based safety, confined spaces.
HAZWOPER: 40-hour and current 8-hour annual refresher Hazardous Waste Operations and Emergency Response
MEC: munitions and explosives of concern recognition and safety training
PE: registered Professional Engineer

[3] Signatures indicate personnel has read and agree to implement this QAPP as written.

Worksheets #4, #7, and #8: Personnel Qualifications and Sign-Off Sheet (Continued)

Organization: Wood Environment & Infrastructure Solutions, Inc. (Wood)

Name	Project Title/Role	Education/ Experience[1]	Specialized Training/ Certifications[2]	Signature[3]	Date
Jeff Fenton	Project Manager	Resume on file	HAZWOPER		
Scott Graham	Field Task Manager	Resume on file	HAZWOPER, first aid, CPR, MEC, CQM		
Kevin Garrett	Project Chemist	Resume on file	Not applicable		
Zachary Carroll	Data Validation Specialist	Resume on file	Not applicable		

Notes:

[1] Resumes available in Attachment B.

[2] Specialized Training/Certifications Key:

CPR: cardiopulmonary resuscitation
CQM: Construction Quality Management.
HAZWOPER: 40-hour and current 8-hour annual refresher Hazardous Waste Operations and Emergency Response
MEC: munitions and explosives of concern recognition and safety training
PE: registered Professional Engineer

[3] Signatures indicate personnel has read and agree to implement this QAPP as written.

Worksheets #4, #7, and #8: Personnel Qualifications and Sign-Off Sheet (Continued)

Organization: SGS

Name	Project Title/Role, Location	Education/ Experience[1]	Specialized Training/ Certifications	Signature[2]	Date
Elvin Kumar	Project Manager, Florida	Resume on file	Not applicable		
Svetlana Izosimova	Quality Assurance Officer, Florida	Resume on file	Not applicable		
Caitlin Brice	General Manager, Florida	Resume on file	Not applicable		
Norman Farmer	Corporate Technical Director, Florida	Resume on file	Not applicable		

Notes:

[1] Resumes available in Attachment B.

[2] Signatures indicate personnel has read and agree to implement this QAPP as written.

2.4 Worksheet #6: Communication Pathways

Communication Driver	Responsible Entity	Name	Telephone Number	Procedure (timing, pathways, documentation, etc.)
Point of Contact with lead support agency (EPA)	Lead Agency – Army BEC	William Collins	(831) 242-7920	Project materials and information will be submitted to the EPA, DTSC, and CCRWQCB as appropriate by William Collins (or designee) via e-mail or hardcopy.
Point of contact with Army Base Realignment and Closure (BRAC) Office	USACE	Alex Kan	(916) 557-7578	Materials and information regarding the project will be forwarded to Army BRAC Office through USACE Technical Lead.
Point of Contact with lead organization (USACE)	Ahtna Program Manager	Chuck Holman	(916) 275-9989	Project materials and information will be submitted to Alex Kan via e-mail or hardcopy.
Manage Project – contractor organization	Ahtna Project Manager	Derek Lieberman	(831) 384-3735	Manage project schedule and budget. Communicate project information to project team and Alex Kan. Ahtna Team liaison to Ahtna Program Manager.
Manage Project – contractor organization	Ahtna Task Lead	Holly Dillon	(831) 384-3735	Manage project fieldwork, data management, and document preparation. Communicate information to Project Manager.
Manage Project – subcontractor	Wood Project Manager	Jeff Fenton	(707) 793-3832	Manage project schedule and budget. Communicate project information to project team and Derek Lieberman.
Status Reports	Ahtna	Derek Lieberman	(831) 384-3735	Derek Lieberman will provide updates to USACE during weekly status meetings.
Stop work due to safety issues	Ahtna	Any person	(831) 384-3735	Any individual has the ability to stop work based on an unsafe work condition, or a potential for an unsafe work condition.
QAPP deviation in field	Wood Field Task Manager / Ahtna O&M Manager	Scott Graham/ Mark Fisler	(707) 364-3620/ (831) 224-3133	Notify Eric Schmidt by telephone or e-mail of variances to QAPP made in the field and the reasons within 24 hours. Eric Schmidt will notify Jonathan Whipple.

Communication Driver	**Responsible Entity**	**Name**	**Telephone Number**	**Procedure (timing, pathways, documentation, etc.)**
QAPP changes in field (modification to QAPP)	Wood Field Task Manager	Scott Graham	(707) 364-3620	Scott Graham will propose modifications to Kevin Garrett, Jeff Fenton, and Holly Dillon prior to implementation. Holly Dillon will propose an appropriate modification to Eric Schmidt and Derek Lieberman for approval. Derek Lieberman will propose a modification to Jonathan Whipple for approval. Communication regarding modification will be in writing (e-mail or hardcopy).
	Wood Project Chemist	Kevin Garrett	(303) 293-6082	
	Ahtna Program Chemist	Christopher Ohland	(925) 222-6593	
	Ahtna Project Chemist	Eric Schmidt	(831) 384-3735	
	USACE Project Chemist	Jonathan Whipple	(916) 557-7366	
QC and contract compliance	Ahtna QC Manager	Sylvester Kosowski	(831) 384-3735	Reviews project plans; assures Ahtna compliance with contract requirements.
Daily Field Progress Reports/Field QA/QC Issues	Wood Field Task Manager	Scott Graham	(707) 364-3620	Scott Graham will report field progress and field QA/QC issues daily by fax or e-mail to Jeff Fenton, Kevin Garrett, and Holly Dillon.
Laboratory Issues	SGS Project Manager	Elvin Kumar	(408) 588-0200	Elvin Kumar to notify Kevin Garrett of any problems with the laboratory (i.e. receipt of samples, instrument problems, detection limits (DLs), or any other issues that will affect the data or turnaround time (TAT) of reported results) within 24 hours of the occurrence, by phone and follow-up written communication (e-mail or hardcopy).
Field and Laboratory Data Quality Issues	Wood Project Chemist	Kevin Garrett	(303) 293-6082	Kevin Garrett will notify Jeff Fenton and Holly Dillon by phone or e-mail of field or lab QA/QC issues within one business day. Holly Dillon will notify Derek Lieberman and Eric Schmidt. Derek Lieberman will notify Jonathan Whipple.

Communication Driver	**Responsible Entity**	**Name**	**Telephone Number**	**Procedure (timing, pathways, documentation, etc.)**
Field and Analytical Corrective Actions[1]	Wood Project Chemist	Kevin Garrett	(303) 293-6082	The need for field or laboratory corrective action will be determined by Kevin Garrett and/or Holly Dillon, which will be communicated in writing to Jeff Fenton, Derek Lieberman, and laboratory contact (when appropriate) within two business days. Derek Lieberman will notify Jonathan Whipple.
Release of Analytical Data	Wood Project Chemist	Kevin Garrett	(303) 293-6082	Analytical data will not be released for use until review or validation is completed, as appropriate. Following Eric Schmidt's approval of validation findings, Kevin Garrett will release the data via e-mail to the project team.
Data import and export	Wood Data Validator	Zack Carroll	(707) 793-3873	Uploads field/fixed lab and data recorder data into the Fort Ord Data Integration System.
Hazardous or unsafe conditions that raise question of stopping work	Wood Field Task Manager / Ahtna O&M Manager	Scott Graham/ Mark Fisler	(707) 364-3620/ (831) 224-3133	Confer with Derek Lieberman and/or the Ahtna Site Safety and Health Officer (SSHO) to determine whether work needs to be stopped; the Ahtna SSHO will report stop-work decision to the Ahtna PM.
Perform field QC checks to ensure proper sampling methods, custody procedures, packaging, and shipment are performed	Ahtna QC Manager	Sylvester Kosowski	(831) 384-3735	Report result of field checks to Derek Lieberman and Eric Schmidt.
Prepare initial write-up of field generated data to be included in final reports	Ahtna Task Lead	Holly Dillon	(831) 384-3735	Confer with Derek Lieberman on questions and resolutions.

Communication Driver	**Responsible Entity**	**Name**	**Telephone Number**	**Procedure (timing, pathways, documentation, etc.)**
Database setup and data management planning	Ahtna Task Lead	Holly Dillon	(831) 384-3735	Provides information on sample and analytical reporting groups, and types of report tables required for the project.
Data verification/data validation	Wood Data Validator	Zack Carroll	(707) 793-3873	Report result of analytical QC checks to Chris Ohland.
Data review issues and corrective actions	Ahtna	Eric Schmidt	(831) 384-3735	Report result of analytical QC corrective action to Christopher Ohland and Derek Lieberman.

Notes:

[1] In the event significant corrective action is required for field or laboratory activities, information concerning the corrective action will be provided to the EPA, DTSC, and CCRWQCB by the Army within 30 days of the event, typically at the next scheduled monthly meeting of the BRAC Cleanup Team (BCT).

2.5 Worksheet #9: Project Planning Session Summary

Project Name: Former Fort Ord Basewide Groundwater and Soil Vapor Treatment and Monitoring **Projected Start Date:** Ongoing **Project Manager:** Derek Lieberman, Ahtna	**Site Name:** Former Fort Ord **Site Location:** Former Fort Ord, CA
Date of Session: October 2, 2018 **Scoping Session Purpose:** Define scope of work to be included in the QAPP	

Name	Title	Affiliation	Telephone #	E-mail Address
Derek Lieberman	Project Manager	Ahtna	(831) 384-3735	dlieberman@ahtna.net
Eric Schmidt	Project Chemist	Ahtna	(831) 384-3735	eschmidt@ahtna.net
Holly Dillon	Task Lead	Ahtna	(831) 384-3735	hdillon@ahtna.net
Andrew Mauck	Field Technician	Ahtna	(831) 384-3735	amauck@ahtna.net

Planning Session Summary:
Reviewed contract to determine QAPP requirements and reviewed QAPP Revision 6 for potential updates needed.

Action Items:
Based on this review, Ahtna will:

- Initiate QAPP Revision 7 update.
- After review of the previous four quarters of data (Fourth Quarter 2017 through Third Quarter 2018) and comparison to decision rules in the QAPP, update the list of monitoring and extraction wells to be sampled quarterly and annually. Remove wells from sampling program as allowed by decision rules. Updates to be proposed for approval by the BCT at the meeting on November 14, 2018 and to be applied to the Fourth Quarter 2018 GWMP event to be conducted in December 2018.
- Update subcontractor from Amec Foster Wheeler to Wood.
- Review SGS changes to QAPP including QSM Version 5.1 changes.

3.0 Project Quality Objectives

3.1 Worksheet #10: Conceptual Site Model

3.1.1 Background and History

The former Fort Ord is located along the Pacific Ocean in northwest Monterey County, approximately 80 miles south of San Francisco, California (Figure 1). The former military installation covered about 28,000 acres, is bounded by Monterey Bay to the west and the Santa Lucia Range to the south, and is surrounded by the cities of Del Rey Oaks, Marina, Sand City, and Seaside. State Highway 1 and the Union Pacific Railroad right-of-way traverse through the western portion of the former Fort Ord, separating the Monterey Bay beach front from the rest of the installation. The former Fort Ord served as a training and staging facility for infantry troops from 1917 until its closure in 1994. In 1990, the former Fort Ord was placed on the EPA's National Priorities List (NPL),[5] primarily due to volatile organic compounds (VOCs) found in groundwater beneath the Fort Ord Landfills. The former Fort Ord was closed in 1994 under the Base Realignment and Closure Act (BRAC).[6] Environmental remediation at the former Fort Ord is being completed pursuant to the CERCLA §121 and the National Oil and Hazardous Substances Contingency Plan.

3.1.2 Sources of Known or Suspected Hazardous Waste

<u>Sites 2/12</u>

When the former Fort Ord was an active military facility, Site 2 consisted of the primary sewage treatment facility for Fort Ord and Site 12 included numerous industrial activities, including vehicle maintenance and repair, furniture repair, storage of motor oils, hazardous material storage, vehicle cleaning and degreasing, and disposal of waste and oil.

<u>OU2</u>

The source of the OU2 groundwater contamination was from the Fort Ord Landfills. No detailed records were kept on the amount or types of wastes disposed of at the Fort Ord Landfills; however, household and commercial refuse, ash from incinerated infectious wastes, dried sewage sludge, demolition material, and small amounts of chemical waste (such as paint, waste oil, pesticides, electrical equipment, ink and epoxy adhesives) are believed to have been disposed of in the Fort Ord Landfills (Dames & Moore, 1993).

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[5] The NPL is the list of national priorities among the known releases or threatened releases of hazardous substances, pollutants, or contaminants throughout the United States and its territories. The NPL is intended primarily to guide the EPA in determining which sites warrant further investigation.

[6] BRAC is the process the Department of Defense (DoD) has used to reorganize its installation infrastructure to more efficiently and effectively support its forces and increase operational readiness.

OUCTP

The apparent source of the OUCTP groundwater plume is located on what is now Lexington Court, a residential area in the northern portion of the former Fort Ord. Historical practices at this site included cleaning electronic equipment and radios.

3.1.3 Known Contaminants

Known contaminants, or COCs, were identified during Remedial Investigations at the sites and documented in the decision documents for each site. The COCs are listed in Worksheet #15a and are summarized below.

Sites 2/12

There are eight COCs for groundwater at Sites 2/12, with the primary COCs (those detected at the highest concentrations over the greatest area) identified as tetrachloroethene (PCE) and trichloroethene (TCE). Additionally, PCE and TCE are the two COCs for soil gas at Sites 2/12, which is described in the QAPP Volume I Appendix C for Soil Gas Monitoring (Ahtna, 2019c).

OU2

There are eleven COCs for groundwater at OU2, with the primary COC identified as TCE. Operations and maintenance (O&M) of the Fort Ord Landfills and the landfill gas extraction and treatment system is described separately in the QAPP Volume I, Appendix D, OU2 Landfills (Ahtna, 2019d).

OUCTP

The primary COC in groundwater at OUCTP is carbon tetrachloride (CT); however, there are eight COCs for the A-Aquifer, one COC for the Upper 180-Foot Aquifer, and two COCs in the Lower 180-Foot Aquifer.

3.1.4 Fate and Transport Considerations

Sites 2/12

There are or have been four potential migration pathways specific to Sites 2/12:

- Leaching of chemicals into underlying unsaturated zone soil.
- Diffusion of vapor phase chemicals in soil gas.
- Partitioning of chemicals between soil gas and groundwater.
- Migration of dissolved phase chemicals in groundwater.

Based on environmental conditions, historical data at Sites 2/12, and chemical-specific properties, PCE and TCE are considered to have medium to high persistence and moderate mobility. Soil types present at the site have a low retardation factor and there is insignificant adsorption of these chemicals. Additionally, PCE and TCE water solubilities and partition coefficients indicate moderate mobility. Persistence of PCE and TCE over time and the relative absence of breakdown products indicate little or no reductive dechlorination of these compounds, particularly in soil gas. Concentration-driven diffusion is likely a continuing process at Site 12 given the variation of concentration gradients in the unsaturated zone over time. Additionally, groundwater and soil gas analytical data and modeling during the Remedial

Investigation/Feasibility Study Addendum at Sites 2/12 indicated the areas of highest concentrations of PCE and TCE in soil gas were associated with concentrations of PCE and TCE in groundwater that exceed Aquifer Cleanup Levels (ACLs; AES, 2015). Groundwater contamination at Sites 2/12 affected the unconfined Upper 180-Foot Aquifer.

OU2

VOCs remaining in waste disposed of at the Fort Ord Landfills and VOCs detected in landfill gas have the potential to travel through soil pore space to exposure points via a number of mechanisms:

- Advection: mass transport due to bulk flow of water in which contaminants are dissolved;
- Dispersion: transport due to the groundwater flow whether or not a compound is dissolved;
- Diffusion: spreading of contaminants due to molecular diffusion in response to concentration gradients; and
- Volatilization: loss of chemical vapor to the atmosphere.

VOCs naturally undergo biological degradation processes in soil, soil gas, and groundwater; however, the rate of such degradation is limited by oxygen and nutrient sources depending upon the type of degradation that is occurring (aerobic vs. anaerobic). Further, degradation of compounds is dependent on the biological pathway available.

Groundwater contamination at OU2 affected the upper three groundwater aquifers: the A-Aquifer, the Upper 180-Foot Aquifer, and the Lower 180-Foot Aquifer (HLA, 1995). In the vicinity of OU2, the tops of each of these aquifers typically are first encountered at depths of about 60 feet bgs, 150 feet bgs, and 250 feet bgs, respectively. In monitoring well MW-OU2-73-A, located at the Fort Ord Landfills Area F source area, PCE and TCE are below their ACLs or not detected, but vinyl chloride is detected at the highest concentrations for the OU2 A-Aquifer. Vinyl chloride is a breakdown product in the natural reductive dechlorination process and may indicate this process is occurring locally at Fort Ord Landfills Area F.

With implementation of the remedy as prescribed in the OU2 Fort Ord Landfills Record of Decision (OU2 ROD; Army, 1994; engineered landfill cover system, and groundwater extraction and treatment system) in addition to operation of the landfill gas extraction and treatment system, impacts to the underlying groundwater from the Fort Ord Landfills have been greatly mitigated.

OUCTP

There are or have been four potential migration pathways specific to OUCTP:

- Leaching of chemicals into underlying unsaturated zone soil.
- Diffusion of vapor phase chemicals in soil gas.
- Partitioning of chemicals between soil gas and groundwater.
- Migration of dissolved phase chemicals in groundwater.

The CT plume appears to have originated from a training facility referred to in 1958 as “ST-11”, near what is now Lexington Court (Figure 8A), and migrated through the vadose zone beneath the vicinity of this facility and into groundwater of the A-Aquifer, the Upper 180-Foot Aquifer, and the Lower 180-Foot Aquifer; CT has not been detected in the 400-Foot Aquifer.

Hydraulic communication between the A-Aquifer and the underlying aquifers is limited to those areas west of OUCTP where the Fort Ord-Salinas Valley Aquitard (FO-SVA) clay unit pinches out, or where it was penetrated by wells without adequate sanitary seals. Two such vertical conduits were identified that resulted in the migration of CT from the A-Aquifer to the underlying Upper and Lower 180-Foot Aquifers. All identified vertical conduits have been destroyed (grouted and sealed) eliminating hydraulic communication between the A-Aquifer and the underlying aquifers. Groundwater in the Upper 180-Foot Aquifer flows to the southeast toward the apparent discontinuity in the underlying Intermediate 180-Foot Aquitard where it then recharges the Lower 180-Foot Aquifer. Groundwater in the Lower 180-Foot Aquifer primarily migrates to the east (Army, 2008).

In addition to CT, chloroform, TCE, and PCE were also present both within the vadose zone (vapor phase) and in the A-Aquifer near the source (dissolved phase). Chloroform is a biodegradation product of CT whose presence in OUCTP suggests there are native microbial bacteria acting within the subsurface to biodegrade CT. The presence of PCE and TCE in soil gas near the source area suggests these compounds were also disposed of in this area, presumably during the use of the same training facility.

In addition to CT, TCE is also present in the Lower 180-Foot Aquifer, which suggests groundwater originating from OU2 in the Upper 180-Foot Aquifer may be flowing from the southwest toward the apparent discontinuity in the Intermediate 180-Foot Aquitard (Ahtna, 2019b).

3.1.5 Potential Receptors and Exposure Pathways

Groundwater at Sites 2/12, OU2 and OUCTP currently is not used by residents within the Fort Ord area for domestic household purposes. Drinking water in the Fort Ord area is provided by the Marina Coast Water District (MCWD) and is pumped from wells that are located east of the Sites 2/12, OU2 and OUCTP areas. These supply wells are screened in the Lower 180-Foot Aquifer or deeper aquifers. Groundwater within the Sites 2/12, OU2 and OUCTP areas is located in the Prohibition Zone of the Special Groundwater Protection Zone at the former Fort Ord, within which the installation of new supply wells is restricted by Monterey County. According to Monterey County Code Title 15 Section 15.08.140, a prohibition zone is an area overlying or adjacent to a contaminant plume where water well construction is prohibited and applications for water wells will not be accepted; therefore, direct contact groundwater exposure pathways for residents potentially exposed to groundwater from the Sites 2/12, OU2 and OUCTP areas are currently incomplete and are expected to remain so in the future.

3.1.6 Land Use Considerations

Sites 2/12

In March 2004, the Army transferred the property at Site 12 and the land was redeveloped into a commercial retail area, which included construction of several big-box stores, a movie theater complex, food services, and a large parking area which is identified as The Dunes on Monterey Bay. The Army transferred the property at Site 2 in September 2006 and this land remains undeveloped and open to the general public as part of Fort Ord Dunes State Park. The Site 2 area was proposed for reuse as an aquaculture and oceanographic research facility, and later as a desalination plant (Fort Ord Reuse Authority [FORA], 1997); however, the site remains unused with the derelict sewage treatment plant facilities still onsite.

OU2

The OU2 area consists of the Fort Ord Landfills, which encompass approximately 120 acres of undeveloped land, as well as mixed-use residential, commercial, and undeveloped areas.

OUCTP

The apparent source of the OUCTP is located on what is now Lexington Court, part of the Abrams Housing Development, in the northern portion of the former Fort Ord. A groundwater contaminant plume emanating from this area ultimately extends across an area bounded by Del Monte Boulevard,

Abrams Drive, Neeson Road, and Blanco Road. The OUCTP area consists of mixed-use residential, commercial, light industrial, and undeveloped areas including habitat reserve areas.

3.1.7 Physiography and Topography

The predominant topography of the area reflects a morphology typical of the dune sand deposits that underlie the western and northern portions of the former Fort Ord. In these areas, the ground surface slopes gently to the west and northwest, draining toward Monterey Bay. Runoff is minimal because of the high rate of surface-water infiltration into the permeable dune sand. Consequently, well-developed natural drainages are absent throughout much of this area. Closed drainage depressions typical of dune topography are common. Elevations at the former Fort Ord range from approximately 50 feet above mean sea level (MSL) at Site 2 to 250 feet above MSL at the Fort Ord Landfills.

3.1.8 Geology and Hydrology

The predominant lithology is a loose, well-sorted (poorly graded) fine to medium sand. The sands represent active and recently active dunes and Pleistocene-age older dune sands. The active dune sands parallel the beach and extend several hundred feet inland. The older dune sands cover most of the northern and western portions of the former Fort Ord. Paleosols, representing former ground surfaces (silty sands) exist within these sands. These paleosols indicate that one or more cycles of dune deposition have occurred with intervening periods of soil development. The paleosols in the dunes bordering the beach indicate that older dune sand is locally present beneath the recent dune sand.

Three groundwater aquifers are in the remediation phase of cleanup activities at the former Fort Ord: the unconfined A-Aquifer, the unconfined and confined Upper 180-Foot Aquifer, and the confined Lower 180-Foot Aquifer. The aquifers consist predominantly of fine to coarse-grained sands which are separated by silty clay or clayey fine-grained sand aquitards. The A-Aquifer is located within the recent dune sands and is perched above the regional FO-SVA. To the west where the FO-SVA pinches out, the unconfined A-Aquifer and confined Upper 180-Foot Aquifer combine to form a continuous, unconfined hydrostratigraphic unit (identified as the unconfined Upper 180-Foot Aquifer). A north-trending groundwater divide in the unconfined Upper 180-Foot Aquifer exists midway between the FO-SVA and

Monterey Bay. Groundwater in the unconfined Upper 180-Foot Aquifer west of the divide flows west and discharges to the Monterey Bay. Groundwater in the unconfined Upper 180-Foot Aquifer east of the divide flows under the FO-SVA (becoming confined) toward the Salinas Valley. The Upper and Lower 180-Foot Aquifers, and portions of the 400-Foot Aquifer (locally) are contained within valley fill deposits. The Upper 180-Foot Aquifer is separated from the Lower 180-Foot Aquifer by the Intermediate 180-Foot Aquitard, which appears to be laterally discontinuous in the eastern portion of the former Fort Ord near the OU2 and OUCTP areas creating a natural conduit between the aquifers (Army, 2008).

3.2 Worksheet #11: Project/Data Quality Objectives

Data quality objectives (DQOs) are qualitative and quantitative statements that outline the decision-making process and specify the data required to support corrective actions. DQOs specify the level of uncertainty that will be accepted in results derived from data. The DQO process used for developing data quality criteria and performance specifications for decision-making is consistent with the *Guidance on Systematic Planning Using the Data Quality Objectives Process*, EPA QA/G-4 (EPA, 2006). The DQO process consists of the following seven steps:

Step 1: State the problem

Step 2: Identify the goals of the study

Step 3: Identify information inputs

Step 4: Define the boundaries of the study

Step 5: Develop the analytical approach

Step 6: Specify performance or acceptance criteria

Step 7: Develop the plan for obtaining data

The DQOs steps are presented below for the five operable units (OUs):

- Sites 2/12
- OU2
- OUCTP A-Aquifer
- OUCTP Upper 180-Foot Aquifer
- OUCTP Lower 180-Foot Aquifer

3.2.1 Step 1: State the Problem

Concentrations of VOCs (primarily PCE, TCE and related breakdown products, and CT) are present in groundwater at the former Fort Ord at concentrations above the ACLs prescribed in the relevant RODs or Explanations of Significant Differences (ESDs), thereby requiring periodic monitoring and reporting of groundwater conditions and VOC concentrations to the CCRWQCB, DTSC, EPA, and USACE. Groundwater contamination is present in three aquifers within and adjacent to the former Fort Ord footprint: A-Aquifer, Upper 180-Foot Aquifer, and the Lower 180-Foot. Three main study areas have been identified, and comprise the majority of the GWMP: Sites 2/12 (one aquifer: Upper 180-Foot Aquifer), OU2 (two aquifers: A-Aquifer and Upper 180-Foot Aquifer) and OUCTP (three aquifers: A-Aquifer, Upper 180-Foot Aquifer, and Lower 180-Foot).

<u>Sites 2/12</u>

Groundwater in the Upper 180-Foot Aquifer beneath Sites 2/12 has been adversely impacted by eight VOCs (Worksheet #15a) that are identified in the Basewide Remedial Investigation Sites Record of Decision (RI Sites ROD; Army, 1997). These compounds are identified as COCs because they are present in groundwater at levels that pose an unacceptable risk to human health or the environment. As a result, the RI Sites ROD and the RI Sites ESD (Army, 2016) require remediation of the Upper 180-Foot Aquifer beneath and downgradient of Sites 2/12 using groundwater extraction with liquid-phase granular activated carbon (GAC) treatment and soil gas extraction with vapor-phase GAC treatment (Ahtna, 2019c). Figure 2 shows the Sites 2/12 monitoring and extraction well locations by sampling schedule, Figure 3 shows the Sites 2/12 GWTS configuration with current extraction well status, and Figure 4 shows the Sites 2/12 GWTP schematic and sampling locations. A detailed discussion of the soil vapor extraction and treatment system can be found in the Soil Gas QAPP (Ahtna, 2019c).

Improper disposal of solvents from former activities in this area led to contamination of the groundwater by COCs at concentrations above ACLs. The extent of the plume is defined by the detectable presence of PCE in groundwater, as it is the most common and widespread chemical constituent in this area. Active remedial action at Sites 2/12 consists of groundwater extraction and treatment by liquid-phase GAC since 1999, and soil gas extraction and treatment by vapor-phase GAC since 2015. Additionally, monitoring wells at Sites 2/12 are subject to seawater intrusion due to their proximity to Monterey Bay; as a result, chloride concentrations are monitored annually at select wells.

<u>OU2</u>

Groundwater in the A-Aquifer and Upper 180-Foot Aquifer beneath and downgradient from the Fort Ord Landfills has been adversely impacted by 11 VOCs. These compounds were identified as COCs (Worksheet #15a) in the OU2 ROD (Army, 1994*)* because they are present in groundwater at levels that pose an unacceptable risk to human health or the environment. As a result, the OU2 ROD and the OU2 ESD (Army, 1995) require remediation of the A-Aquifer and Upper 180-Foot Aquifer beneath and downgradient of OU2 using groundwater extraction with GAC treatment and treated water recharged to the aquifer or reused at the surface. Figures 5A and 5B show the OU2 monitoring and extraction well locations by sampling schedule, Figure 6 shows the OU2 GWTS configuration with current extraction well status, and Figure 7 shows the OU2 GWTP schematic and sampling locations.

COC migration from landfills covering 150 acres in the area has led to contamination of the groundwater by COCs at concentrations above ACLs. Three water supply wells (FO-29, FO-30, and FO-31), which MCWD owns and operates as part of the drinking water supply system for the former Fort Ord and the City of Marina, are also located near the OU2 area. The extent of the plume is defined by the detectable presence of TCE in groundwater, as it is the most common and widespread chemical constituent in this area. Active and ongoing (since 1995) remediation at OU2 consists of extraction and GAC treatment of groundwater.

Disposal of spent small arms ammunition in the Fort Ord Landfills was also identified as a possible source for metals (antimony, copper, and lead) contamination of the groundwater. Metals are not identified as COCs for groundwater in the OU2 ROD and therefore do not have ACLs. However, metals (antimony, copper, and lead) concentrations are monitored at select wells around the Fort Ord Landfills annually to validate that groundwater is not impacted by soil and spent small arms ammunition disposed of in the Fort Ord Landfills during remediation of small arms firing ranges at Fort Ord.

<u>OUCTP A-Aquifer</u>

Improper disposal of CT, used as a cleaning solvent for activities conducted in this area, lead to contamination of the groundwater (Army, 2008). The extent of the OUCTP in the A-Aquifer is defined by the detectable presence of CT in groundwater, as it is the most common and widespread chemical constituent in this area. Remedial action at OUCTP includes a combination of enhanced *in situ* bioremediation (EISB) and monitored natural attenuation (MNA). EISB treatment began with the pilot study starting in 2008 and completed in 2012 at Deployment Areas 1 and 2. Post-treatment and long-term groundwater monitoring have been conducted since 2012 (AES, 2014).

Additional monitoring wells were installed in 2011 and 2015 to close data gaps for the MNA remedy. The wells installed in 2015 indicated the CT groundwater plume was migrating northeast of the A-Aquifer groundwater divide (Figure 11) and construction of EISB Treatment Area #3 was recommended as shown in Figure 14. EISB Deployment Area 3A construction was completed and remedial operations began on December 1, 2016. Operations were completed on August 4, 2017 and post-treatment long-term performance monitoring is continuing according to the *Final Operable Unit Carbon Tetrachloride Plume Remedial Action Work Plan Addendum, Former Fort Ord, California* (Ahtna, 2016).

The effectiveness of EISB treatment is determined through periodic monitoring and reporting of groundwater quality parameters (dissolved oxygen [DO] and oxidation-reduction potential [ORP] in specific wells listed in Worksheet #17c3) and VOC concentrations (Worksheet #15a) to the CCRWQCB, DTSC, EPA, and USACE. Figure 8A shows the OUCTP A-Aquifer monitoring well locations by sampling schedule.

<u>OUCTP Upper 180-Foot Aquifer</u>

Groundwater in the Upper 180-Foot Aquifer at OUCTP has been adversely impacted by CT (Worksheet #15a) as identified in the OUCTP ROD (Army, 2008). This compound is identified as a COC because it is present in groundwater at levels that pose an unacceptable risk to human health or the environment. As a result, the OUCTP ROD requires remediation of OUCTP in the Upper 180-Foot Aquifer using groundwater extraction and treatment via the existing OU2 GWTS. Figure 8B shows the OUCTP Upper 180-Foot Aquifer monitoring well locations by sampling schedule. Figure 6 shows the location of the OUCTP Upper 180-Foot Aquifer extraction well, EW-OU2-09-180.

<u>OUCTP Lower 180-Foot Aquifer</u>

Groundwater in the Lower 180-Foot Aquifer at OUCTP has been adversely impacted by CT (Worksheet #15a) as identified in the OUCTP ROD (Army, 2008). The remediation of the Lower 180-Foot Aquifer includes MNA and contingency wellhead treatment of the nearby MCWD supply wells. Figure 8C shows the OUCTP Lower 180-Foot Aquifer monitoring well locations by sampling schedule. Groundwater in the Lower 180-Foot Aquifer has been adversely impacted by TCE at concentrations exceeding the maximum contaminant level (MCL) for drinking water, which suggests groundwater originating from OU2 in the Upper 180-Foot Aquifer may be flowing from the southwest toward the apparent discontinuity in the Intermediate 180-Foot Aquitard (Army, 2008 and Ahtna, 2019b).

3.2.2 Step 2: Identify the Goals of the Study

The primary goals associated with the Sites 2/12, OU2, and OUCTP remediation projects are to monitor the programs and verify they reflect current site conditions and whether the sites are in continued compliance with the RI Sites ROD (Army, 1997) and ESD (Army, 2016), OU2 ROD (Army, 1994) and ESD (Army, 1995), and the OUCTP ROD (Army, 2008), respectively.

OU2 and Sites 2/12 GWTSs

Data collected from the Sites 2/12 and OU2 GWTS will be used to perform the following assessments:

- Evaluate whether the GWTS are effectively and efficiently reducing concentrations of COCs in the aquifers of concern.
- Assess whether GWTS effluent meets discharge requirements before it is used for groundwater recharge or onsite for non-potable construction purposes (dust control, soil compaction, etc.).
- Evaluate when the GWTS GAC requires change-out.
- Evaluate whether the GWTS provides adequate hydraulic containment of the COC plume and prevents its migration.
- Assess whether ACLs have been achieved for COCs within project boundaries and whether closure of the site or OU is warranted.
- Assess whether the current extraction well sampling frequency is adequate to meet project objectives.

OU2, Sites 2/12, and OUCTP GWMP

The data collected from the Fort Ord GWMP are used to evaluate the following decisions:

- Are concentrations of COCs in groundwater above the relevant ROD- or ESD-prescribed ACLs?
- What is the vertical and lateral extent of relevant ROD-specified COCs in groundwater?
- Are concentrations of TCE in the Lower 180-Foot Aquifer above the MCL?
- What is the vertical and lateral extent of TCE in the Lower 180-Foot Aquifer?
- What is the source of TCE in the Lower 180-Foot Aquifer?
- What are the groundwater and aquifer conditions relative to the stability of the contaminant plumes, and what trends and temporal changes in groundwater levels and COC concentrations are taking place?
- Does the conceptual site model need to be updated or verified?
- Is closure of the site or OU, or a hydraulic zone within the site or OU, warranted if concentrations of COCs in groundwater are less than or equal to the relevant ROD- or ESD-prescribed ACLs?
- Are concentrations of chloride in monitoring wells at Sites 2/12 above the Monterey County Water Resources Agency threshold of 500 mg/L for classification as “seawater intruded”?
- Are concentrations of dissolved antimony, copper, and lead above MCLs for drinking water in wells associated with the Fort Ord Landfills?[7]

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[7] Antimony, copper, and lead are the primary metals found in spent ammunition deposited in the Fort Ord Landfills, but are not identified as COCs for groundwater in the OU2 ROD and do not have ACLs; therefore, detected concentrations are compared to MCLs for drinking water. The Federal and California MCLs for antimony, copper and lead are the same numerical value (see Worksheet #15c). The MCL is the maximum concentration of a chemical that is allowed in public drinking water systems, though the groundwater being monitored is within the Prohibition Zone and is not intended for use as drinking water (see Section 3.1.5).

- Do post-treatment DO and ORP measurements in the OUCTP A-Aquifer monitoring wells indicate biodegradation is still occurring in the EISB Deployment Areas?

3.2.3 Step 3: Identify Information Inputs

<u>OU2 and Sites 2/12 GWTSs</u>

Inputs to decisions for the Sites 2/12 and OU2 GWTS are as follows:

- COC concentration data from extraction well samples collected to assess relative concentrations in the aquifer and whether ACLs have been met for COCs.
- COC concentration data from locations within the GWTS collected to assess whether the GWTS is operating effectively and efficiently.
- COC concentration data from TS-212-INJ and TS-OU2-INJ to confirm whether site-specific discharge requirements (Worksheet #15a) are met.
- COC concentration data from GAC treatment effluent collected to determine whether a GAC change-out is required.
- GWTS flow rate data collected to evaluate and document system operation.
- Groundwater monitoring data and/or groundwater flow modeling results to determine whether the plume is hydraulically contained.

<u>OU2, Sites 2/12, and OUCTP GWMP</u>

Decision inputs for the Fort Ord GWMP are as follows:

- Historical groundwater monitoring results and archived information.
- Historical knowledge of geologic and hydrologic conditions at Fort Ord.
- Groundwater modeling data from recent trend analysis.
- Statistical analysis of COC concentration trends on a well-by-well basis.
- ROD- or ESD-prescribed ACLs.
- State of California MCLs for drinking water.
- Fort Ord GWTS operational data and monitoring results.
- Drinking water production well data from local districts and municipalities.

3.2.4 Step 4: Define the Boundaries of the Study

The physical study boundaries for the Sites 2/12, OU2, and OUCTP groundwater remedies are described below and shown in Figure 1. Study boundaries are further divided into hydraulic zones based on the zone of groundwater with COC concentrations above ACLs and influenced by the groundwater remedy; therefore, hydraulic zones and study boundaries may be revised depending on changes in the extent of groundwater with COC concentrations above ACLs and modifications to the groundwater remedies. The long-term temporal boundaries for the remedies are indefinite; however, groundwater monitoring should continue at the sites in accordance with the decision rules presented in Step 5 of Worksheet #11 until the project objectives are met.

The overall geographic boundary for the site is the Main Garrison at the former Fort Ord including the Fritzsche Army Airfield area,[8] and the adjacent portion of the City of Marina. The lateral boundary is defined by the zone of groundwater impacted or potentially impacted by VOCs. The vertical boundary is defined by the zone of contaminated groundwater in the following aquifers or hydrogeologic units.

- A-Aquifer
- Upper 180-Foot Aquifer
- Lower 180-Foot Aquifer

The extent of groundwater with COC concentrations above ACLs is represented by the COC concentration contours shown on figures presented in quarterly and annual reports. COC analytical data are grouped by site for COC concentrations above ACLs and ArcGIS Desktop 10.4 (ESRI, 2017) is used to generate shapefiles depicting the COC concentration contours. Adjustments are made to the contours based on comparative evaluation of current COC concentrations and contours from previous quarters. If more than one sample is collected from a well in a quarterly monitoring event, the sample with the highest detected COC concentration will be used for generating the contour. The COC concentration contours can be compared to historical contours and used to optimize hydraulic zones and study boundaries, and interpret progress toward achieving remedial action objectives.

Groundwater elevations in each aquifer are represented by groundwater elevation contours shown on figures presented in quarterly and annual reports. Groundwater levels are measured each quarter at the wells listed in Worksheet #17 and compared to the wells' known top of casing elevation to determine the groundwater elevation at each well. For multi-port wells that have multiple ports in one aquifer, the groundwater level data from all the ports is averaged to determine the groundwater elevation at that location. Groundwater elevation data sets are imported into the Surfer® 15 (Golden Software, LLC) software application. Within Surfer® 15, the geostatistical gridding method (i.e., kriging) is used to interpolate a gridded surface from the groundwater elevation data. Point kriging, with a circular search ellipse and without a drift type (i.e., ordinary kriging), is used to estimate grid node values based on the known data points near the node with the data points weighted by their distance from the node. The size of the grid cells is set to approximately 30 feet by 30 feet. Once the grid is constructed, Surfer® 15 uses linear interpolation to generate contour lines of equal elevation based on the grid node values. Contour lines for each aquifer are exported from Surfer® 15 as shapefiles and imported into ArcGIS Desktop 10.4 (ESRI, 2017) for final manual adjustments, such as trimming the extents of the contours and smoothing curves. Finally, extraction well operation data are compared to measured groundwater levels at those wells and cones of depression are added manually around operating extraction wells. Groundwater elevation contours can then be used to interpret the flow characteristics of groundwater in each of the aquifers.

The time frame for decision-making relates to the quarterly monitoring and reporting schedule and periodic (e.g., annual) reporting and review cycles. With the exception of certain times of the year when

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[8] Now the Marina Municipal Airport.

the presence of sensitive biological resources requires modification to the site or well access procedures, practical constraints on data collection are not applicable to this project.

Sites 2/12

Study boundaries at Sites 2/12 are as follows:

- The overall geographic boundary for the site is within the western Main Garrison area at the former Fort Ord.
- The lateral boundary is defined by the zone of groundwater impacted by COCs. The vertical boundary is defined by the zone of contaminated groundwater in the Upper 180-Foot Aquifer.
- Because the zone of contaminated groundwater is relatively small, limited to a single aquifer, and within the capture area of the existing extraction well network, there is currently only one hydraulic zone at Sites 2/12.

OU2

Study boundaries at OU2 are as follows:

- The overall geographic boundary for the site is the Main Garrison area and the Fort Ord Landfills at the former Fort Ord.
- The lateral boundary is defined by the zone of groundwater impacted by COCs. The vertical boundary is defined by the zone of contaminated groundwater in the A-Aquifer and Upper 180-Foot Aquifer.
- The study boundaries for OU2 are further divided into eight hydraulic zones based on the extent of the COC plumes in the A-Aquifer and Upper 180-Foot Aquifer, and groundwater extraction well network capture areas (Figures 9 and 10).

OUCTP

Study boundaries at OUCTP are as follows:

- The overall geographic boundary for the site is the Main Garrison area north of the Fort Ord Landfills at the former Fort Ord.
- The lateral and vertical boundaries are defined by the zone of groundwater impacted by COCs in the A-Aquifer, Upper 180-Foot Aquifer, and Lower 180-Foot Aquifer.
- The study boundaries for OUCTP are further divided into seven hydraulic zones based on the extent of the COC plumes in the A-Aquifer, Upper 180-Foot Aquifer and Lower 180-Foot Aquifer, and the areas of groundwater remedy influence for each aquifer (Figures 11, 12 and 13).

3.2.5 Step 5: Develop the Analytical Approach

The analytical approach has been developed by using decision rules on information inputs to support the goals of the project for the GWTSs and GWMP.

OU2 and Sites 2/12 GWTSs

Decision rules for the Sites 2/12 and OU2 GWTS have been developed to address the five major components of treatment system operation: discharge limit compliance; GAC change-out; hydraulic containment; sampling frequency; and plume remediation. Each of these components is described below.

Discharge Limit Compliance

- If analytical results indicate COC discharge limits (Worksheet #15a) are being met, then the system will continue to operate and GWTS effluent will be recharged to the aquifer.
- If analytical results indicate the discharge limit for any COC other than methylene chloride[9] is not met, then a confirmation sample will be collected and analyzed with a 24-hour TAT.
- If analytical results indicate the discharge limit for methylene chloride is not met, then the analytical results will be evaluated against QC sample analytical results associated with the same sampling event.
    - If the evaluation indicates the presence of methylene chloride above the discharge limit is not representative of groundwater conditions due to associated QC sample detections, then the OU2 GWTS will continue to operate and effluent will be recharged to the aquifer.
    - If the evaluation indicates the concentration of methylene chloride above the discharge limit is representative of groundwater conditions, then a confirmation sample will be collected from the OU2 GWTS discharge point of compliance and analyzed with a 24-hour TAT.
- If confirmation sample analytical results indicate the discharge limit for any COC is not met, then the affected GWTS will be shut down, operating conditions and GAC loading evaluated, extraction well flow rates adjusted as necessary and a variance report issued for any out-of-limits operation. Following operational changes, which may include GAC change-out, the GWTS will be restarted and re-sampled to verify compliance.
- If verification sample analytical results indicate discharge limits for COCs are being met, then the system will continue to operate and system effluent will be recharged to the aquifer.
- If verification sample analytical results indicate the discharge limit for any COC is not met, then the affected GWTS will be shut down, and operating conditions and GAC loading re-evaluated. Following operational changes, the GWTS will be restarted and re-sampled to verify compliance.

GAC Change-out

The decision rules for determining when a GAC change-out is needed at the Sites 2/12 GWTP are:

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[9] Methylene chloride is a COC for OU2 and OUCTP in the A-Aquifer. EPA Method 8260-SIM, Analysis of Volatile Organics by GC/MS, Select Ion Monitoring (SIM) (Attachment A, SGS SOP# MS010) identifies methylene chloride as a common laboratory contaminant detected in the analysis for volatile organics.

- If analytical results for TCE and PCE from a process sample collected immediately downstream of the GAC vessel (upstream of the air stripper) are less than or equal to 90 percent (%) of ACLs, then a GAC change-out is not necessary. The Sites 2/12 system will continue to operate and the final effluent stream will continue to be recharged to the aquifer.
- If the analytical result for TCE or PCE from a process sample collected immediately downstream of the GAC vessel (upstream of the air stripper) is greater than 90% of ACLs, then a GAC change-out will be scheduled.

The *Operations and Maintenance Manual, Operable Unit 2 (OU 2) Groundwater Treatment Plant, Former Fort Ord* (OU2 GWTP O&M Manual; JV, 2018) provides procedures for O&M of the OU2 GWTS. The OU2 GWTP O&M Manual describes the conditions required for GAC change-out, but those instructions are superseded by the following based on Ahtna's experience operating GWTS using liquid-phase GAC as the primary treatment technology. At the OU2 GWTP, the average concentration of each COC in the lead GAC vessel effluent will be calculated based on analytical results from process samples collected immediately downstream of the lead GAC vessel (upstream of the second GAC vessel) during each process sampling event (where such samples are collected). Decision rules for determining when a GAC change-out at OU2 is necessary are:

- If the average concentration of each COC is less than 90% of its respective ACL (Worksheet #15a), then a GAC change-out is not necessary. The OU2 system will continue to operate and the final effluent stream will continue to be recharged to the aquifer.
- If the average concentration of any COC other than methylene chloride is equal to or greater than 90% of its ACL, a GAC change-out will be scheduled.
- If the average concentration of methylene chloride is equal to or greater than 90% of its ACL, then the analytical results for lead GAC vessel effluent sample will be evaluated against the analytical results for QC samples associated with the same sampling event.
    - If the evaluation indicates an average concentration of methylene chloride greater than 90% of its ACL is not representative of groundwater conditions due to associated QC sample detections, then a GAC change-out is not necessary. The system will continue to operate and OU2 GWTS effluent will be recharged to the aquifer.
    - If the evaluation indicates the concentration of methylene chloride above the discharge limit is representative of groundwater conditions and the average concentration of methylene chloride is equal to or greater than 90% of its ACL, a GAC change-out will be scheduled.

Hydraulic Containment

During remediation system operation, specific decision rules must be followed to demonstrate COC plume capture. The decision rules are:

- If groundwater monitoring and/or groundwater flow modeling demonstrate plume capture is occurring, then system operation will continue as currently configured. During operation, extraction well flow rates may be optimized to reduce O&M costs while maintaining plume capture.

- If the system flow rate data, in conjunction with the groundwater flow model, indicate the plume is being hydraulically contained, then the system will continue to operate.
- If groundwater monitoring and/or groundwater flow modeling indicate plume capture is not occurring, additional groundwater flow modeling will be conducted to determine whether adjustment of either extraction or recharge flow rates will improve capture or whether additional extraction wells or recharge points are required. Based on this evaluation, system reconfiguration may be recommended.

Plume Remediation

Assessment of aquifer cleanup resulting from the Sites 2/12 and OU2 GWTS is conducted through a GWMP that evaluates plume migration and COC concentrations. Extraction well monitoring data will be used for evaluating the operational status of individual extraction wells and for statistical evaluations of remediation progress. The decision rules for determining the operational status of groundwater extraction wells with respect to plume remediation are:

- An extraction well will continue to operate if any COC detected is greater than the corresponding ACL (Worksheet #15a).
- An extraction well will continue to operate if the extraction well flow rate data and analytical data from nearby wells, in conjunction with groundwater flow modeling, indicate operation of the extraction well is necessary for hydraulic containment of the plume.
- An extraction well will be shut off if COCs detected are less than the ACL for two consecutive quarterly monitoring events, and if the extraction well flow rate data and analytical data from nearby wells, in conjunction with groundwater flow modeling, indicate operation of the extraction well is no longer necessary for hydraulic containment of the plume.
- Following termination of pumping at an extraction well, the well will be incorporated into the GWMP.

Sampling Frequency

Extraction wells will be sampled quarterly when operating as part of the GWTS. The decision rules for determining the sampling frequency and monitoring status for groundwater extraction wells following termination of operation are:

- If four consecutive quarters of monitoring data show concentrations of COCs are below their respective limits of quantitation (LOQs) (Worksheet #15a) or below 10% of their respective ACLs (Worksheet #15a), whichever is greater, an annual monitoring schedule may be proposed.
- If two annual monitoring results show concentrations of COCs are below their respective LOQs or below 10% of their respective ACLs, whichever is greater, then the well may be proposed for removal from the sampling program.

- If wells adjacent to a well sampled annually, or no longer sampled, show detections of any COCs equal to or greater than their ACLs, then the well monitoring frequency may be increased to quarterly.
- If an annual well monitoring result shows a detection of any COC equal to or greater than its ACL, then the well monitoring frequency may be increased to quarterly.
- If a well is no longer needed for the program, it will be proposed for decommissioning.

Implementation of agency-approved exit strategies for Sites 2/12, OU2 and OUCTP, or portions thereof, may result in modification of these decision rules.

The statistical parameter of interest is the maximum value detected in the well or monitoring point compared to the ACLs or historical trend for that well or monitoring point. For perimeter control, the minimum value detected in the monitoring point (e.g., non-detect [ND] at the limit of detection [LOD]) is the statistical parameter of interest.

OU2, Sites 2/12, and OUCTP GWMP

The decision rules for groundwater monitoring are:

- If four consecutive quarters of monitoring data show concentrations of COCs below their respective LOQs, or below 10% of their respective ACLs (Worksheet #15a), whichever is greater, then an annual sampling schedule may be proposed.
- If two consecutive annual monitoring results show concentrations of COCs below their respective LOQs or below 10% of their respective ACLs, whichever is greater, then the well may be proposed for removal from the sampling program.[10]
- If wells adjacent to a well sampled annually, or no longer sampled, show detections of any COCs equal to or greater than their ACLs, then the well monitoring frequency may be increased to quarterly.
- If an annual well monitoring result shows a detection of any COC equal to or greater than its ACL, then the well monitoring frequency may be increased to quarterly.
- If monitoring or modeling input indicates the groundwater monitoring network no longer provides vertical or lateral control of COCs, then additional groundwater wells may be proposed to be added to the program.
- If a groundwater monitoring well is no longer needed for the program, it will be proposed for decommissioning.
- If a monitoring well in Sites 2/12 is determined to be intruded by seawater based on chloride data, the GWTS operator and Project Manager will be notified to implement possible GWTS changes.
- If concentrations of dissolved copper, lead, and antimony in select A-Aquifer wells (Worksheet #17c) exceed MCLs, the BCT will be notified.

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[10] The well will continue to be monitored for depth to water until it is decommissioned or determined to be redundant or unnecessary water elevation data.

Decisions regarding application of passive diffusion bags (PDBs) are described in the *Technical Memorandum Passive Diffusion Bag Pilot Study Results and Recommendations* (Harding ESE, 2001).

OUCTP A-Aquifer EISB Post-Treatment Water Quality Parameter Monitoring

The parameters of interest for the OUCTP A-Aquifer are DO and ORP levels compared to the baseline values or historical trend for that well or monitoring point to evaluate the effectiveness of EISB. The decision rules for determining the monitoring frequency for post-treatment groundwater quality parameters are:

- Continue quarterly monitoring of post-treatment groundwater quality parameters if measurements indicate continued aquifer conditions are affected by the associated EISB treatment at the well; or measurements at one or more adjacent wells indicate aquifer conditions are affected by the associated EISB treatment; or measurements at one or more wells in an immediately upgradient Deployment Area indicates aquifer conditions are affected by the associated EISB treatment;
- If two consecutive quarters of post-treatment water quality parameter monitoring data show both DO and ORP measurements have returned to the approximate levels of recorded baseline conditions,[11] then water quality parameter monitoring may be reduced to an annual frequency at the well; or,
- If four consecutive quarters of post-treatment water quality parameter monitoring data show there has been no effect on the well by EISB treatment (i.e., there has been no significant deviation from recorded baseline conditions),[12] then water quality parameter monitoring may be reduced to an annual frequency at the well.
- If two consecutive annual monitoring periods of post-treatment water quality monitoring at an OUCTP A-Aquifer well show both DO and ORP have returned to the approximate levels of recorded baseline conditions,[13] then water quality parameter monitoring may be discontinued.
- If sampling a well for VOC analyses has been discontinued in accordance with the decision rules for the GWMP, then discontinuing post-treatment water quality parameter monitoring may be considered on a case-by-case basis in consultation with the BCT.

Measurement of post-treatment groundwater quality parameters in an OUCTP A-Aquifer well may be reinstated or increased in frequency should conditions change in an adjacent well or immediately upgradient Deployment Area, including additional EISB treatment.

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[11] As presented in the *Final OUCTP Remedial Action Work Plan, Former Fort Ord, California; Appendix A OUCTP A-Aquifer Remedial Design Addendum* (OUCTP RAWP RD Addendum; AES, 2014)

[12] As presented in the OUCTP RAWP RD Addendum (AES, 2014).

[13] As presented in the OUCTP RAWP RD Addendum (AES, 2014).

Completion of Groundwater Restoration Remedial Actions[14]

The decision rules for determining when groundwater remedial actions are complete in a particular site or OU, or a hydraulic zone within the site or OU, are:

- If data collected during the GWMP indicate potential uncertainties regarding the remedy's effectiveness and/or current site conditions, or potential key data gaps, then the conceptual site model will be re-evaluated and updated.
- If COC concentrations in a well are above ACLs, then the well and its respective hydraulic zone will remain in the remediation monitoring phase.[15]
- If four consecutive quarters of monitoring data show concentrations of COCs in a well are less than or equal to their respective ACLs, the well may be evaluated for completion of the remediation monitoring phase.
    - If non-statistical data review shows all COCs in the well are ND, all detected COC concentrations are less than or equal to the ACLs, or a combination of the two, then the remediation monitoring phase is complete in the well.
    - If groundwater monitoring data do not lend themselves to a non-statistical review, then statistical analysis of the data set may be used (e.g., mean test or trend test).
    - If the selected statistical method demonstrates the 95% upper confidence limit (UCL) value is equal to or less than the ACL for the COCs where a statistical analysis was used, then the remediation monitoring phase is complete in the well.
- If a well has completed the remediation monitoring phase, then the well will enter the attainment monitoring phase.[16]
- If monitoring data show concentrations of COCs in a well are less than or equal to their respective ACLs, and it can be demonstrated COC concentrations will continue to be less than or equal to ACLs in the future, then the attainment monitoring phase is complete under any of the following conditions.
    - If all COCs in the well are ND, the LOQ is below the ACL, or a combination of ND sampling results and all detected COC concentrations are below the ACLs for eight consecutive sampling events, then a non-statistical or visual review of the COC data will be sufficient to conclude the attainment monitoring phase is complete in the well.

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[14] Adapted from EPA, 2014a and EPA, 2014b.

[15] The remediation monitoring phase refers to the phase of the remedy where remedial activities are being implemented to reach groundwater cleanup levels selected in a remedy decision document. During this phase, groundwater sampling and monitoring data are collected to evaluate COC migration and changes in COC concentrations over time. The completion of this phase at a monitoring well typically occurs when the data collected and evaluated demonstrate that the groundwater has reached the cleanup levels for all COCs, as they are stated in the remedy decision document (EPA, 2013).

[16] The attainment monitoring phase typically occurs after it is determined the remediation monitoring phase is complete. When the attainment phase begins, data are collected to evaluate if the well has reached post remediation conditions (i.e., steady state conditions) where remediation activities, if employed, are no longer influencing the groundwater in the well (EPA, 2013).

  - If all COCs in the well are less than or equal to their respective ACLs for eight consecutive sampling events, and a statistical analysis (i.e., trend analysis) demonstrates COCs will remain less than or equal to ACLs in the future (the trend line has a statistically significant zero [steady state] or negative [decreasing] slope, and the 95% UCL value is less than or equal to the ACL), then the attainment monitoring phase is complete in the well.
  - If the well is removed from the sampling program in accordance with the decision rules applicable to GWMP decision rules presented above, then the attainment monitoring phase is complete in the well.
- If a well has completed the attainment monitoring phase and it is not needed for groundwater elevation data, then it will be proposed for decommissioning.
- If all the wells at particular site or OU, or a hydraulic zone within the site or OU have completed the attainment monitoring phase, then the attainment monitoring phase is complete for the particular site or OU, or hydraulic zone within the site or OU and the decision rules for GWMP no longer apply (i.e., sampling for COC analysis may be discontinued and the wells may be proposed for decommissioning unless needed for groundwater elevation data).
- If the attainment monitoring phase is complete at all the hydraulic zones within a site or OU, then the site or OU will be proposed for closure in a remedial action completion report.

The decision rules for the GWMP and for Completion of Groundwater Restoration Remedial Actions will be implemented concurrently; however, decision rules for determining when groundwater remedial actions are complete take precedence over the decision rules applicable to groundwater monitoring (e.g., if the attainment monitoring phase is complete at all wells in a hydraulic zone, then sampling for COC analysis is no longer necessary).

Exit strategy decision logic related to remedial process optimization and contingency measures should the remedies not progress as expected are presented in the *Final Technical Memorandum, Groundwater Remediation Exit Strategy, Sites 2/12 and OU2, Former Fort Ord, California* (MACTEC, 2009).

3.2.6 Step 6: Specify Performance or Acceptance Criteria

<u>OU2 and Sites 2/12 GWTSs</u>

The null hypotheses for the Sites 2/12 and OU2 GWTS are:

1) Concentrations of VOCs in groundwater entering the GWTS exist above the action levels
2) Concentrations of VOCs at the discharge points of compliance for the GWTS effluents are below discharge limits

The two types of decision errors that could result are a false acceptance decision error and a false rejection decision error. A false acceptance decision error for each null hypothesis would be to:

1) Assume a measured concentration is above the action level when in fact it is not.
2) Assume a measured concentration at a discharge point of compliance is below discharge limits when in fact it is not.

Consequences of the first false acceptance error might include unnecessarily treating groundwater that is not above action levels or continuation of remediation system operation after applicable ACLs have been met.

Consequences of the second false acceptance error might include delay of timely GAC change-out, resulting in discharge of water from the GWTS above discharge limits, or discontinuation of remediation system operation when applicable ACLs have not been met.

A false rejection error for each null hypothesis would be to:

1) Assume a measured concentration is not above the action level when in fact it is.
2) Assume a measured concentration at a discharge point of compliance is above the discharge limit when in fact it is not.

Consequences of the first false rejection error might include premature removal of extraction wells from the remediation system program before ACLs have been met.

Consequences of the second false rejection error might include unnecessarily performing or initiating confirmation sampling of GWTS effluent that actually met discharge limits during normal operation or remediation system shutdown, GAC change-out, and variance report issuance for effluent that met discharge limits after GAC vessel backwashing activities.

Decision errors are most likely to occur when the measured concentration is near the action level, or in the case of NDs, when the LOQ is near the action level. To control decision errors when the LOQ is near the action level, the laboratory is required to report any detections below the LOQ (but above the DL), thereby giving the data user additional information regarding trace level contamination. To control decision errors when the measured concentration is near the action level, the program is very conservative about making recommendations or changes based on individual sampling events and will require data from additional sampling or subsequent sampling events before modifying the treatment system network.

<u>OU2, Sites 2/12, and OUCTP GWMP</u>

VOCs in groundwater at the former Fort Ord range in concentration from ND to 12.3 micrograms per liter (µg/L) PCE (at Sites 2/12), 16.5 µg/L TCE (at site OU2), and 7.4 µg/L CT (at OUCTP), the primary COCs at these sites (as measured in the Third Quarter 2018 GWMP).

The null hypothesis for this project is that concentrations of VOCs in groundwater exist above the action levels. A false acceptance decision (i.e., false positive decision error) would be to assume a measured concentration is above the action level, when in fact, it is not. The consequences of this decision error would be to incur unnecessary expense to study and potentially modify the monitoring network to address an extent of contamination that does not exist.

A false rejection decision error (i.e., false negative decision error) would be to assume a measured concentration is not above the action level when in fact it is. The consequences of this decision error would be to not study or potentially modify the monitoring network, thereby resulting in an incomplete understanding of the extent of contamination and potential threat to groundwater quality.

Decision errors are most likely to occur when the measured concentration is near the action level, or in the case of NDs, when the LOQ is near the action level. To control decision errors when the LOQ is near the action level, the laboratory is required to report any detections below the LOQ (but above the DL), thereby giving the data user additional information regarding trace level contamination. To control decision error when the measured concentration is near the action level, the program is very conservative about making recommendations or changes based on individual monitoring events and will require data from additional sampling or subsequent sampling events before modifying the monitoring network.

In addition, trend analysis provides a valuable tool for assessing reliability of reporting concentrations. Furthermore, data are subjected to automated data review using an electronic system of QC checks, under the direction of a qualified chemist, using USACE and industry standards of analytical QC.

The null hypothesis is that EISB is not occurring in the Deployment Areas. A false acceptance decision (i.e., false positive decision error) would be to assume measured DO and ORP indicates there are no reducing conditions in the aquifer, when in fact there are. The consequences of this decision error would be to incur unnecessary expense to potentially perform additional EISB to establish reducing conditions in areas where they already exist.

A false rejection decision error (i.e., false negative decision error) would be to assume measured DO and ORP indicates there are reducing conditions in the aquifer, when in fact there are not. The consequences of this decision error would be to not perform additional EISB, thereby resulting in a longer period to achieve remedial action objectives.

Decision errors are most likely to occur when measured DO and ORP are near zero. To control such decision errors, the program is very conservative about making recommendations or changes based on individual monitoring events and will require data from additional sampling or subsequent sampling events before modifying the monitoring network. In addition, trend analysis provides a valuable tool for assessing reliability of reporting groundwater quality parameters.

3.2.7 Step 7: Develop the Plan for Obtaining Data

As a result of the DQO process, the optimum sampling design is derived for the Sites 2/12, OU2, and OUCTP remedies. Sample collection locations, rationales, and frequencies were established to achieve discharge compliance and provide a cost-effective means to evaluate the treatment of the impacted groundwater, and can be found in Worksheets #17a1 and #17a2 for Sites 2/12, and Worksheets #17b1 and #17b2 for OU2 and OUCTP. The EPA Method 8260-SIM (selected ion monitoring) analytical procedure for this project was selected to accurately quantify the chemicals of interest at the levels of concern. Method performance criteria for EPA Method 8260-SIM are presented in Worksheets #24 and #28a.

The overall sampling network design is described in Worksheet #17c1 through #17c5.

Sampling design considerations regarding application of PDBs are described in the *Technical Memorandum Passive Diffusion Bag Pilot Study Results and Recommendations* (Harding ESE, 2001).

3.3 Worksheet #12: Measurement Performance Criteria

The measurement performance criteria (MPC) for chemical analyses being performed for each matrix and analytical parameter are summarized in the tables below in Worksheet #12. The MPCs follow those defined in the referenced EPA method or laboratory standard operating procedures (SOPs). The quality of the data to be collected for this project will be verified through appropriate MPCs established for both sampling procedures and analytical methods. The criteria relate to data quality indicators (DQIs) consisting of precision, accuracy, representativeness, comparability, completeness, and sensitivity, commonly referred to as PARCCS parameters. The DQIs are defined as follows:

- Precision refers to the reproducibility of measurements. Precision is usually expressed as standard deviation, variance, percent difference, or range, in either absolute or relative terms.
- Accuracy refers to the degree of agreement between an observed value (such as sample results) and an accepted reference value. A measurement is considered accurate when the reported value agrees with the true value or known concentration of the spike or standard within acceptable limits.
- Representativeness describes the extent to which a sampling design adequately reflects the environmental conditions of a site. Representativeness is determined by appropriate program design, with consideration of elements such as proper well locations, drilling and installation procedures, operations process locations, and sampling locations.
- Comparability addresses the degree to which different methods or data agree or can be represented as similar. Comparability is achieved by using standard methods (SM) for sampling and analysis, reporting data in standard units, normalizing results to standard conditions, and using standard and comprehensive reporting formats.
- Completeness is a measure of the amount of valid data collected using a measurement system. Completeness is expressed as a percentage of the number of measurements that are specified in this QAPP.
- Sensitivity is the ability of a method or instrument to detect the target analytes at the level of interest. Sensitivity can be measured by calculating the percent recovery of the analytes at the LOQ, which is the minimum concentration of an analyte that can be routinely identified and quantified above the method LOQ by a laboratory.

The quality of the sampling procedures and laboratory results will be evaluated for compliance with project DQOs through a review of overall PARCCS, in accordance with procedures described in Worksheet #37 (Data Usability Assessment). The results will be summarized in an overall data usability report.

3.3.1 Worksheet #12a: VOCs - Sites 2/12 and OU2 GWTS and Sites 2/12, OU2, and OUCTP GWMP

Analytical Group/Method: VOCs by EPA Method 8260-SIM

Matrix: Groundwater (µg/L)

S&A SOPs	DQIs	MPC	QC Sample or Activity Used to Assess MPC	QC Sample Assesses (S, A, or S&A)
S: SOPs #1-5	Precision	RPD ≤ 30%	Field Duplicate	S
A: SGS SOP#MS010.7		Analyte RPD 1,1-DCA ≤ 15% 1,1-DCE ≤ 18% 1,2-DCA ≤ 14% 1,2-DCE (total) ≤ 17% 1,2-DCPA ≤ 14% 1,3-DCPE (total) ≤ 23% Benzene ≤ 14% CT ≤ 23% Chloroform ≤ 15% cis-1,2-DCE ≤ 15% MC ≤ 16% PCE ≤ 16% TCE ≤ 15% VC ≤ 18%	8260-SIM: LCS/LCSD and MS/MSD	A
A: SGS SOP#MS010.7	Accuracy / Precision	Analyte Recovery 1,1-DCA 81-122% 1,1-DCE 78-137% 1,2-DCA 75-125% 1,2-DCE (total) 76-127% 1,2,-DCPA 76-124% 1,3-DCPE (total) 75-120% Benzene 81-122% CT 76-136% Chloroform 80-124% cis-1,2-DCE 78-120% MC 69-135% PCE 76-135% TCE 81-126% VC 69-159%	8260-SIM: LCS and MS	A
A: SGS SOP#MS010.7	Bias	Analyte: Recovery 1,2-Dichloroethane-$_{d4}$: 74-125% Toluene-$_{d8}$: 88-111%	8260-SIM: Surrogates	A

S&A SOPs	DQIs	MPC	QC Sample or Activity Used to Assess MPC	QC Sample Assesses (S, A, or S&A)
S: SOPs #1-5 A: SGS SOP#MS010.7	Bias / Contamination	No analytes detected > ½ LOQ or > ⅒ the amount measured in any sample or > ⅒ the regulatory limit, whichever is greater. Common contaminants must not be detected > LOQ.	Method blank, field blank, trip blank	S&A
S: SOPs #1-5	Representative-ness	> 0°C ≤ 6°C	Cooler Temperature Blank	S
		Samples preserved to pH < 2.0	Measure pH of samples after analysis	
S: SOPs #1-5 A: SGS SOP#MS010.7	Comparability	Reasonableness	Historical data	S&A
		Qualitative measure for field sampling procedures	LCS/LCSD and MS/MSD	A
S: SOPs #1-5	Completeness	≥ 95% field completeness	Number of samples collected out of total samples planned	S
A: SGS SOP#MS010.7		≥ 90% analytical completeness	Evaluation of number of unqualified[17] results out of the total results reported	A
A: SGS SOP#MS010.7	Sensitivity	Evidence of shift in instrument response or zero setting	LCS, ICAL, CCAL	A
		Limit of quantitation	LOQ studies	

Notes on next page.

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[17] Results qualified as estimated due to detected quantities between the LOQ and LOD will not be counted in the analytical completeness quantity assessment.

Notes:
<: less than
≤: less than or equal to
>: greater than
≥: greater than or equal to
%: percent
°C: degrees Celsius
CCAL: continuing calibration
1,1-DCA: 1,1-dichloroethane
1,1-DCE: 1,1-dichloroethene
1,2-DCA: 1,2-dichloroethane
1,2-DCE (total): total 1,2-dichloroethene
1,2-DCPA: 1,2-dichloropropane
1,3-DCPE: 1,3-dichloropropene
A: analytical
cis-1,2-DCE: cis-1,2-dichloroethene
CT: carbon tetrachloride
DL: detection limit
DQI: data quality indicator
ICAL: initial calibration
LCS: laboratory control samples
LCSD: laboratory control sample duplicate
LOQ: limit of quantitation
MC: methylene chloride
MPC: measurement performance criteria
MS: matrix spike
MSD: matrix spike duplicate
PCE: tetrachloroethene
QC: quality control
RPD: relative percent difference
S: sampling
S&A: sampling and analytical
SIM: selected ion monitoring
SOP: standard operating procedure
TCE: trichloroethene
trans-1,2-DCE: trans-1,2-dichloroethene
VOC: volatile organic compound
VC: vinyl chloride

3.3.2 Worksheet #12b: Metals - OU2 GWMP

Analytical Group: Metals by EPA Method 6010D

Matrix: Groundwater (µg/L)

S&A SOPs	DQIs	MPC	QC Sample or Activity Used to Assess MPC	QC Sample Assesses (S, A, or S&A)
S: SOP #3	Precision	RPD ≤ 30%	Field Duplicate	S
A: SGS SOP#MET 108.03		RPD ±20%	LCS/LCSD and MS/MSD	A
A: SGS SOP#MET 108.03	Accuracy / Bias	MS and LCS: Antimony 80-120% Copper 80-120% Lead 80-120%	LCS and MS	A
S: SOP #3 A: SGS SOP#MET 108.03		The absolute values of all analytes must be < ½ LOQ or < ⅒ the amount measured in any sample or ⅒ the regulatory limit, whichever is greater.	Method blank and field blank	S&A
S: SOP #3	Representativeness	Samples preserved to pH < 2.0	Measure pH of samples upon receipt	S
		> 0°C ≤ 6°C	Cooler Temperature Blank	
S: SOP #3	Comparability	Reasonableness	Historical data	S
A: SGS SOP#MET 108.03		Qualitative measure for field sampling procedures	LCS/LCSD and MS/MSD	A
S: SOP #3	Completeness	≥ 95% field completeness	Number of samples collected out of total samples planned	S
A: SGS SOP#MET 108.03		≥ 90% analytical completeness	Evaluation of number of unqualified results out of the total results reported[18]	A

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[18] Results qualified as estimated due to detected quantities between the LOQ and LOD will not be counted in the analytical completeness quantity assessment.

S&A SOPs	DQIs	MPC	QC Sample or Activity Used to Assess MPC	QC Sample Assesses (S, A, or S&A)
A: SGS SOP#MET 108.03	Sensitivity	Evidence of shift in instrument response or zero setting	LCS, ICAL, CCAL	A
		Limit of quantitation	LOQ studies	

Notes:

≤: less than or equal to
≥: greater than or equal to
A: analytical
°C: degrees Celsius
CCAL: continuing calibration
DL: detection limit
ICAL: initial calibration
LCS/LCSD: laboratory control sample/laboratory control sample duplicate
LOQ: limit of quantitation
MS/MSD: matrix spike/matrix spike duplicate
RPD: relative percent difference
S: sampling
S&A: sampling and analytical
SOP: standard operating procedure

3.3.3 Worksheet #12c: Wet Chemistry - Sites 2/12 GWTS and Sites 2/12 GWMP

Analytical Group: Chloride by EPA Method 9056A

Matrix: Groundwater (mg/L)

S&A SOPs	DQIs	MPC	QC Sample or Activity Used to Assess MPC	QC Sample Assesses (S, A, or S&A)
S: SOPs #3&5	Precision	RPD ≤ 30%	Field Duplicate	S
A: SGS SOP#GN22 8.9		Analyte RPD Chloride ≤ 20%	Laboratory duplicates and MS/MSD (chloride only)	A
A: SGS SOP#GN22 8.9	Accuracy / Bias	Analyte Recovery Chloride 90-110%	LCS and MS	A
S: SOPs #3&5 A: SGS SOP#GN22 8.9		No analytes detected > ½ LOQ or > ⅒ the amount measured in any sample or > ⅒ the regulatory limit, whichever is greater. Common contaminants must not be detected > LOQ.	Method blank and field blank	S&A
S: SOPs #3&5	Representativeness	> 0°C ≤ 6°C	Cooler Temperature Blank	S
S: SOPs #3&5	Comparability	Reasonableness	Historical data	S
A: SGS SOP#GN22 8.9		Qualitative measure for field sampling procedures	LCS/LCSD and MS/MSD	A
S: SOPs #3&5	Completeness	≥ 95% field completeness	Number of samples collected out of total samples planned	S
A: SGS SOP#GN22 8.9		≥ 90% analytical completeness	Evaluation of number of unqualified results out of the total results reported[19]	A
	Sensitivity	Evidence of shift in instrument response or zero setting	LCS, ICAL, CCAL	A

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[19] Results qualified as estimated due to detected quantities between the LOQ and LOD will not be counted in the analytical completeness quantity assessment.

S&A SOPs	DQIs	MPC	QC Sample or Activity Used to Assess MPC	QC Sample Assesses (S, A, or S&A)
A: SGS SOP#GN228.9		Limit of quantitation	LOQ studies	

Notes:

≤: less than or equal to
≥: greater than or equal to
A: analytical
°C: degrees Celsius
CCAL: continuing calibration
ICAL: initial calibration
DL: detection limit
LCS/LCSD: laboratory control sample/laboratory control sample duplicate
LOQ: limit of quantitation
MS/MSD: matrix spike/matrix spike duplicate
RPD: relative percent difference
S: sampling
S&A: sampling and analytical
SOP: standard operating procedure

3.4 Worksheet #13: Secondary Data Uses and Limitations

Since the groundwater sampling activities for the Sites 2/12 and OU2 GWTS and the Sites 2/12, OU2, and OUCTP GWMP are both long-term remedial action and monitoring programs and not active investigative programs, the secondary data that will be used to evaluate performance and concentration trends for both programs consist of the most recent annual monitoring reports as listed below. Secondary data and information that will be used, including originating sources, are identified below. How the secondary data will be used and the limitations on their uses are specified. Data from these documents will be utilized as appropriate.

Data Source	Data Generator	How Data Will be Used	Limitations on Data Use
Final Sites 2 and 12 Fourth Quarter 2017 through Third Quarter 2018 Groundwater and Soil Gas Monitoring and Treatment System Report, Former Fort Ord, California (Ahtna, 2019a)	Ahtna/Amec	Historical data used to evaluate GWTS performance over time	None
Final Operable Unit 2 Fourth Quarter 2017 through Third Quarter 2018 Groundwater Monitoring and Treatment System Report, Former Fort Ord, California (Ahtna, 2019e)	Ahtna/Amec	Historical data used to evaluate GWTS performance over time	None
Final Operable Unit Carbon Tetrachloride Plume Fourth Quarter 2017 through Third Quarter 2018 Groundwater Monitoring Report, Former Fort Ord, California (Ahtna, 2019b)	Ahtna/Amec	Historical data used to evaluate concentration trends	None

Note:
Amec: Amec Foster Wheeler

3.5 Worksheets #14 and #16: Project Tasks & Schedule

3.5.1 Project Tasks

Applicable SOP(s) for the project tasks outlined in this worksheet are listed in Worksheet #21 and provided in detail in Attachment A. The sampling tasks are described in Worksheets #17 and #18.

3.5.2 Waste and Equipment Decontamination

Wastewater generated during decontamination will be disposed of at the OU2 or Sites 2/12 GWTS and treated with the influent groundwater. Personal protective equipment and miscellaneous waste will be placed in large garbage bags, sealed, and disposed of in facility trash receptacles.

3.5.3 Quality Control Tasks

Implement field SOPs. Field QC samples will be collected at the frequency indicated in Worksheet #20. Samples will be analyzed by the laboratory in accordance with the stated method and the DoD QSM and this QAPP. For items related to QC, see Worksheets #11, #12, #15, #22, #24, #25, #27, and #28.

3.5.4 Secondary Data

See Worksheet #13.

3.5.5 Data Management Tasks

The following are the team members and their responsibilities for the data management process:

Program Chemist. Responsible for reviewing chain of custody forms and establishing the sample tracking system. Oversees proper use of Ahtna's sample management system and accuracy of the information entered. Reviews laboratory data for accuracy and quality and compares electronic outputs for accuracy to laboratory electronic copies. Conducts tracking of samples, forwards tracking information and received data to the database manager, and identifies the data inputs (for example, sample numbers) to use in generating tables and figures.

Database Manager. Responsible for setting up the data management system in consultation with the program chemist at the beginning of the data evaluation task. Also oversees the data management process, including data conversion/manual entry into the data management system, QC of the entered data, and preparation of the required tables and plots of the data. Coordinates with the person responsible for reviewing the entered data for QC purposes. Forwards all deliverables to the Project Manager.

Geographic Information System (GIS) Manager. Responsible for coordinating with the Project Manager to set up the geodatabase prior to sampling. Maintains spatial layers and overall geodatabase integrity and accuracy. Provides all GIS-related outputs for reports.

3.5.6 Sample Tracking

The program chemist is responsible for tracking samples in the sample tracking database to ensure that the analytical results for all samples sent for analysis are received. Copies of chains of custody from the field team are used to enter in sample identifications (IDs), collect data, and for analyses. Upon receipt of a sample receipt notice from the laboratory, the date received by the laboratory, and a date the electronic copy is due will be entered. Likewise, upon receipt of the electronic copy and electronic data deliverable (EDD), the date they are received will also be entered. The EDDs will be uploaded when received from the laboratory and will be tracked in the sample tracking table. Validation qualifiers will be added to the database and results qualified accordingly.

3.5.7 Data Types

The data will be added to the project database as they become available. The data will include new data collected in the laboratory and validated by Ahtna. The data source will be noted in the database.

3.5.8 Data Tracking and Management

Every data set received from analytical laboratories will be tracked individually. Analytical laboratory reports of chemical analysis results will be tracked in a consistent fashion. Every data set will be assigned a unique identifier. The date of receipt, status of data validation, and status of database entry for each data set will all be tracked and recorded in the project database.

Hard/Electronic Copy. Measurements made during field data collection activities will be recorded in field logbooks and sample processing logs. Field data will be reduced and summarized, tabulated, and stored along with the field logbooks and sample processing logs. All raw analytical laboratory data are stored electronically.

Data Input Procedures. Sampling information, analytical results, applicable QA/QC data, data validation qualifiers, and other field-related information will be entered into the project database for storage and retrieval during data evaluation and report development. The analytical data will be loaded into the database using EDD files received from the analytical laboratory. Validation qualifiers will be entered manually. Other available field-related data collected will be manually entered onto standard EDD templates for loading into the database. Historical data, either in hard copy or electronic form, will be manually entered on or formatted to standard EDD templates for database loading.

3.5.9 Computer Database

The technical data, field observations, laboratory analytical results, and analytical data validation will be managed using Ahtna's and Wood's database to store and analyze project data submissions.

The database must be protected from unauthorized access, tampering, accidental deletions or additions, and data or program loss that can result from power outages or hardware failure. The following procedures will be adopted to ensure protection:

- The master database will be stored on a network file server local to the installation of the Ahtna and Wood data management system. Members of the data management team involved in loading, modifying, or querying the database will be given access through user accounts and passwords, as well as the appropriate network server permissions.
- Copies of the master database will be stored on the local area network for access by project staff through reporting tools developed to minimize possible database corruption by users. Whenever the master database is updated or modified, it will be recopied to the local area

network to ensure that the current copy is available to users.

- Backups of the master database and its copies will be made to ensure that the data will not be lost due to problems with the network.

In addition to the internal computer database, EDDs will be uploaded to the BRAC Fort Ord Data Integration System (FODIS) database and the CCRWQCB GeoTracker database.

3.5.10 Geographic Information System Description

A project geodatabase will be set up prior to sampling by the Project Manager, database technician, and GIS technician. Ahtna will adhere to all applicable federal, DoD, and Army geospatial data standards for tasks and deliverables in this QAPP and will meet the minimum requirements for spatial data in accordance with Spatial Data Standards for Facilities, Infrastructure and Environment, current version whenever possible. Ahtna will submit the native GIS files that will include map data (.mxd) and geodatabase (.dbf) format. Ahtna will provide validated geospatial data to USACE for submission by BRAC to the FODIS database.

Each geospatial data set shall be accompanied by metadata conforming to the Federal Geographic Data Committee Content Standard for Digital Geospatial Metadata and the Army Installation Geospatial Information & Services Metadata Standard, v1. The horizontal accuracy of any geospatial data created shall be tested and reported in accordance with the National Standard for Spatial Data Accuracy and the results shall be recorded in the metadata. All data will have a datum of GCS_North American_1983 and a projection of North American Datum 1983 State Plane California Zone 4. The sea level datum used will be the National Geodetic Vertical Datum 1929 to conform with historical former Fort Ord data.

In addition to laboratory data, other physical data will be collected during field efforts. The information will be stored in the project database. Other types of data elements may be added as the field investigation needs and activities evolve.

3.5.11 Documentation

Documentation of data management activities is critical because it provides the following:

- An electronic copy record of project data management activities
- Reference information critical for database users
- Evidence that the activities have been properly planned, executed, and verified
- Continuity of data management operations when personnel changes occur

The data management plan will serve as the initial general documentation of the project data management efforts. Additional documentation will be maintained to document specific issues such as database structure definitions, database inventories, database maintenance, user requests, database issues and problems, and client contact.

3.5.12 Presentation of Data

Depending on data user needs, data presentation may consist of any of the following formats:

- Tabulated results of data summaries or raw data
- Figures showing concentration isopleths or location-specific concentrations
- Tables providing statistical evaluation or calculation results
- Presentation tools, such as ArcMap or similar analysis/presentation aids

In addition to laboratory data, other physical data will be collected during field efforts. The information will be stored in the project database. Other types of data elements may be added as the field investigation needs and activities evolve.

3.5.13 Assessment and Audit Tasks

See Worksheets #31, #32, and #33.

3.5.14 Data Review Tasks

The laboratory will make sure that the data are complete for all samples received. Laboratory data will be validated by Ahtna or Wood. Validated data and field logs will be reviewed to assess total measurement error and determine the overall usability of the data for project purposes. Final data are placed in the database with qualifiers. See Worksheets #34 though #37 for the tasks.

3.5.15 Documentation and Records

Records and field measurements of all samples will be collected in notebooks. Chains of custody and sample logs will be prepared and retained for each sample. A copy of the final QAPP will be kept at the Ahtna Marina office. Field forms are shown in Attachment C.

3.5.16 Project Schedule

A general project schedule for long-term monitoring is presented below.

Activity	Responsible Party	Frequency	Deliverable(s)	Deliverable Due Date
OU2 GWTS O&M	Ahtna	Ongoing	Quarterly and Annual Reports	Quarterly Report (Final only) due 60 days after sampling event concludes* Annual Report (Pre-Draft) due 75 days after sampling event concludes*
Sites 2/12 GWTS O&M				
OU2 GWMP		Quarterly		
Sites 2/12 GWMP				
OUCTP GWMP				

Notes:
* The conclusion of the sampling event is defined as the last day samples are collected for the event.

3.6 Worksheet #15: Laboratory-Specific Detection/Quantitation Limits

3.6.1 Worksheet #15a: VOCs by EPA Method 8260-SIM

Matrix: Groundwater (µg/L)

Analyte	CAS #	Project Action Limits[1] (µg/L)								Project LOQ (µg/L)	Analytical Method Limits[2] (µg/L)		Achievable Laboratory Limits[3] (µg/L)		
		Sites 2/12		OU2		OUCTP					DL	LOD and LOQ	DL	LOD	LOQ
						A-Aquifer	Upper 180-Foot Aquifer		Lower 180-Foot Aquifer						
		ACL	DCL[4]	ACL	DCL	ACL	ACL	DCL	ACL						
1,1-Dichloroethane	75-34-3	-	-	5	5[5]	-	-	-	-	0.50	0.03	NP	0.10	0.25	0.50
1,1-Dichloroethene	75-35-4	6	6	-	-	6	-	-	-	0.50	0.12		0.10	0.25	0.50
1,2-Dichloroethane	107-06-2	0.5	0.5	0.5	0.5	-	-	-	0.5	0.50	0.02		0.10	0.25	0.50
1,2-Dichloroethene (total)[6]	540-59-0	-	-	-	-	6	-	-	-	1.0	0.49		0.10	0.25	0.50
1,2-Dichloropropane	78-87-5	-	-	1	0.5	-	-	-	-	0.50	0.02		0.10	0.25	0.50
1,3-Dichloropropene (total)[6]	542-75-6	0.5	0.5	-	-	-	-	-	-	0.50	0.27		0.10	0.25	0.50
Benzene	71-43-2	-	-	1	0.5	-	-	-	-	0.50	0.03		0.10	0.25	0.50
Carbon Tetrachloride	56-23-5	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0.50	0.02		0.10	0.25	0.50
Chloroform	67-66-3	2	2	2	2[5]	2	-	-	-	0.50	0.04		0.10	0.25	0.50
cis-1,2-Dichloroethene	156-60-5	6	6	6	6[5]	-	-	-	-	0.50	0.06		0.10	0.25	0.50
Methylene chloride	75-09-2	-	-	5	0.5	5	-	-	-	2.0	0.62		0.50	0.50	2.0
Tetrachloroethene	127-18-4	5	5	3	0.5	5	-	-	-	0.50	0.05		0.10	0.25	0.50
Trichloroethene	79-01-6	5	5	5	0.5	5	-	-	-	0.50	0.02		0.10	0.25	0.50
Vinyl Chloride	75-01-4	0.1	0.1	0.1	0.1	0.1	-	-	-	0.10	0.04		0.050	0.050	0.10

Notes on next page.

Notes:
µg/L: micrograms per liter
ACL: Aquifer Cleanup Level
CAS #: Chemical Abstracts Service Number
DCL: discharge limit
DL: detection limit
LOD: limit of detection
LOQ: limit of quantitation
NP: not provided in method
OU: Operable Unit
OUCTP: Operable Unit Carbon Tetrachloride Plume
-: not applicable

[1] ACLs and discharge limits are site-specific and identified in the relevant decision documents (Army, 1994; Army, 1995, Army, 1997; Army, 2008; and Army, 2016).

[2] Analytical method DLs, LODs and LOQs are those documented in published methods.

[3] Achievable DLs, LODs, and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method. An analyte is ND at the LOD, and a measurable detection above the DL and less than the LOQ is estimated ("J-qualified").

[4] Discharge limit for the applicable groundwater treatment system using groundwater extraction and treatment with granular activated carbon (GAC). For Sites 2/12 GWTS, discharge to areas overlying the contaminated groundwater plume need only meet ACLs (HLA, 1999).

[5] Discharge limit revised to ACL for this COC to optimize GAC usage (HLA, 1999).

[6] Total of cis- and trans- isomers.

3.6.2 Worksheet #15b: Ion Chromatography by EPA Method 9056A

Matrix: Groundwater (mg/L)

Analyte	CAS Number	Project Action Limits[1] (mg/L) Sites 2/12	Project LOQ (mg/L)	Analytical Method Limits[2] (mg/L)		Achievable Laboratory Limits[3] (mg/L)		
				DL	LOD and LOQ	DL	LOD	LOQ
Chloride	16887-00-6	250	250	0.02	Not Provided in Method	0.80	1.0	2.0

Notes:
CAS: Chemical Abstracts Service
DL: detection limit
LOD: limit of detection
LOQ: limit of quantitation
mg/L: milligrams per liter
[1] Project Action Limits are National Secondary MCLs for Drinking Water Quality.
[2] Analytical method DLs, LODs and LOQs are those documented in published methods.
[3] Achievable DLs, LODs, and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method. An analyte is ND at the LOD, and a measurable detection above the DL and less than the LOQ is estimated (“J-qualified”).

3.6.3 Worksheet #15c: Dissolved Metals by ICP by EPA Method 6010D

Matrix: Groundwater (µg/L)

Analyte	**CAS Number**	**Project Action Limits[1] (µg/L) OU2**	**Project LOQs (µg/L)**	**Analytical Method Limits[2] (µg/L)**			**Achievable Laboratory Limits[3] (µg/L)**		
				DL	**LOD**	**LOQ**	**DL**	**LOD**	**LOQ**
Antimony	7803-52-3	6.0	6.0	21	Not Provided in Method	Not Provided in Method	1.0	5.0	6.0
Copper	7440-50-8	1,000	25	3.6			1.0	2.0	25
Lead	7439-92-1	15	10	28			1.1	2.0	5.0

Notes:

CAS: Chemical Abstracts Service

DL: detection limit

LOD: limit of detection

LOQ: limit of quantitation

µg/L: micrograms per liter

[1] Project Action Limits are state or federal MCLs (whichever is lower) for drinking water in OU2 wells associated with the Fort Ord Landfills. Antimony, copper, and lead are the primary metals found in spent ammunition deposited in the Fort Ord Landfills. MCLs are used to evaluate concentrations of these dissolved metals in groundwater near the Fort Ord Landfills; however, the groundwater being monitored is not intended for use as drinking water.

[2] Analytical method DLs, LODs and LOQs are those documented in published methods.

[3] Achievable DLs, LODs, and LOQs are limits that an individual laboratory can achieve when performing a specific analytical method. An analyte is ND at the LOD, and a measurable detection above the DL and less than the LOQ is estimated (“J-qualified”).

4.0 Sample Design

4.1 Worksheet #17: Sampling Design and Rationale

A summary of existing monitoring locations is listed in the worksheets below separated by site and aquifer accordingly.

4.1.1 Worksheet #17a1: Sites 2/12 GWTS Part I

Sampling Location	Activity	EPA Method	Comments/Rationale[4]	SOP Reference
TS-212-INF	GWTS monitoring[1]	8260-SIM	To measure influent COC concentrations and evaluate GWTS efficiency.	SOP #5
TS-212-GAC A			To measure COC concentrations downstream from the GAC vessel and evaluate GAC efficiency.	
TS-212-EFF			To measure COC concentrations downstream from the air stripper unit and evaluate air stripper efficiency.	
TS-212-INJ			To comply with discharge limits.	
EW-12-03-180U[6]	Groundwater Monitoring[2]	8260-SIM EPA Method 9056A SM 9056A	To measure changes in groundwater COC concentrations. To evaluate general inorganic constituents.	
EW-12-03-180M[5]				
EW-12-04-180U[6]				
EW-12-04-180M[6]				
EW-12-05-180M[3]				
EW-12-06-180M[3]				
EW-12-07-180M[3]				
EW-12-08-180U[3]				

Notes:

COC: chemical of concern	INF: influent
EFF: effluent	INJ: injection
EW: extraction well	TS: treatment system sampling port
GAC: granular activated carbon	SOP: standard operating procedure

[1] The sampling frequency is variable based on historical GAC breakthrough rates, as shown on Worksheet #17a2.

[2] Samples and water level measurements are collected quarterly or annually from the extraction wells based on the decision rules identified in Worksheet #10a.

[3] During the 3rd Quarter (Annual) sampling event, chloride is analyzed.

[4] The rationale for sampling locations and frequency is based on the RI Sites ROD and RI Sites ESD, program history and precedent established by the BCT, which includes the Army, USACE, EPA, DTSC, and CCRWQCB.

[5] Pump removed from the inoperable extraction well, groundwater sampling conducted with PDBs as identified in Worksheet #17c.

[6] Well no longer sampled per decision rules (Worksheet #10a).

4.1.2 Worksheet #17a2: Sites 2/12 GWTS Part II

The *Final Operations and Maintenance Manual Volume II, Sites 2 and 12 Groundwater Remedy, Former Fort Ord, California* (Sites 2/12 GWTS O&M Manual; AES, 2009) provides procedures for O&M of the Sites 2/12 GWTS. The Sites 2/12 GWTS O&M Manual also describes the conditions required for GAC change-out in Section 4.2.3, but those instructions are superseded by Worksheet #17a2.

Sites 2/12 GWTS Sampling Frequencies[3]

	Weeks after GAC change-out[4]								
Sample Point	**0**	**12**	**21**	**30**	**36**	**42**	**44**	**46**	**48[4]**
TS-212-INF			xx		x	xx	x	xx	x
TS-212-GAC-A[1]	x[2]		x	x	x	x	x	x	x
TS-212-EFF						x	x	x	x
TS-212-INJ		x	x	x	x	x	x	x	x

Notes:

≥: greater than or equal to

%: percent

x: sample collected

xx: sample and duplicate collected

[1] Sample point immediately downstream of the GAC vessel.

[2] Sample collected no less than 2 hours after bringing a newly repacked GAC vessel online.

[3] The sampling frequency is determined based on historical COC breakthrough rates; however, the sampling frequency may be altered if there are significant operational changes.

[4] If GAC change-out is not indicated by Week 48, further sampling will be performed weekly, or at a frequency determined by the Project Manager, until GAC effluent PCE or TCE concentration is ≥ 90% of the discharge limit.

4.1.3 Worksheet #17b1: OU2 GWTS Part I

Sampling Location	Activity	Test Methods	Comments/Rationale[3]	SOP Reference
TS-OU2-INF-01*	GWTS Monitoring[1]	EPA Method 8260-SIM	To measure influent COC concentrations and evaluate GWTS efficiency.	SOP #5
TS-OU2-INF-02*				
TS-OU2-EFF-1A*			To measure COC concentrations downstream from a GAC vessel and evaluate GAC efficiency.	
TS-OU2-EFF-1B*				
TS-OU2-EFF-1C*				
TS-OU2-EFF-2A*				
TS-OU2-EFF-2B*				
TS-OU2-EFF-2C*				
TS-OU2-INJ-01*			To measure COC concentrations downstream from the GAC vessels. To comply with discharge limits (point of compliance).	
EW-OU2-01-A[5]	Groundwater Monitoring[2]	EPA Method 8260-SIM	To evaluate changes in groundwater COC concentrations.	SOP #5
EW-OU2-02-A				
EW-OU2-03-A[5]				
EW-OU2-04-A				
EW-OU2-05-A				
EW-OU2-06-A				
EW-OU2-07-A[5]				
EW-OU2-09-A				
EW-OU2-10-A				
EW-OU2-11-AR				
EW-OU2-12-A				
EW-OU2-13-A				
EW-OU2-14-A				
EW-OU2-16-A				
EW-OU2-17-A				
EW-OU2-18-A				
EW-OU2-19-A				
EW-OU2-20-A				
EW-OU2-01-180[4]				
EW-OU2-02-180R				
EW-OU2-03-180				
EW-OU2-04-180[5]				
EW-OU2-05-180				
EW-OU2-06-180				
EW-OU2-07-180[4]				
EW-OU2-08-180				
EW-OU2-09-180[6]				

Sampling Location	Activity	Test Methods	Comments/Rationale[3]	SOP Reference
EW-OU2-10-180	Groundwater Monitoring[2]	EPA Method 8260-SIM	To evaluate changes in groundwater COC concentrations.	
EW-OU2-11-180				
EW-OU2-12-180				

Notes:

COC: chemical of concern

EFF: effluent

EW: extraction well

GAC: granular activated carbon

INF: influent

INJ: injection

TS: treatment system sampling port

[1] The sampling frequency is variable based on historical GAC breakthrough rates, as shown in Worksheet #17b2.

[2] Groundwater samples and water level measurements are collected quarterly or annually from the extraction wells based on the decision rules identified in Worksheet #10a.

[3] The rationale for sampling locations and frequency is based on the OU2 ROD, OU2 ESD, program history and precedent established by the BCT, which includes the Army, USACE, EPA, DTSC, and CCRWQCB.

[4] Pump removed from the inoperable extraction well, groundwater sampling conducted with PDBs as identified in Worksheet #17c5.

[5] Well no longer sampled per decision rules (Worksheet #10).

[6] Well operated to remediate the OUCTP Upper 180-Foot Aquifer as listed in Worksheet #17c4.

* The OU2 GWTP sampling locations were renamed as listed below.

New Name	Former Name
TS-OU2-INF-01	SP-IN-01
TS-OU2-INF-02	SP-IN-02
TS-OU2-EFF-1A	SP-1A-EF
TS-OU2-EFF-1B	SP-1B-EF
TS-OU2-EFF-1C	SP-1C-EF
TS-OU2-EFF-2A	SP-2A-EF
TS-OU2-EFF-2B	SP-2B-EF
TS-OU2-EFF-2C	SP-2C-EF
TS-OU2-INJ-01	SP-EF-01

4.1.4 Worksheet #17b2: OU2 GWTS Part II

The OU2 GWTP O&M Manual (JV, 2018) provides procedures for sampling of the OU2 GWTP and describes the conditions required for GAC change-out, but those instructions are superseded by Worksheet #17b2.

OU2 GWTS Sampling Frequencies[3,4]
Median GAC Cycle to be determined[5]

Sampling Point		**Weeks after GAC change-out[6]**												
		0	**1**	**2**	**3**	**4**	**5**	**9**	**13**	**16**	**19**	**22**	**24**	**26**
TS-OU2-INF-01	GAC change-out	x	x	xx	x	x	x	xx		x		xx		x
TS-OU2-INF-02		xx	x	x	x	xx	x			xx		x		xx
TS-OU2-EFF-1A[1]		x	x	x	x	x	x			x	x	x	x	x
TS-OU2-EFF-1B[1]		x								x		x		x
TS-OU2-EFF-1C[1]		x								x		x		x
TS-OU2-EFF-2A[1]		x	x	x	x	x	x			x	x	x	x	x
TS-OU2-EFF-2B[1]		x								x		x		x
TS-OU2-EFF-2C[1]		x								x		x		x
TS-OU2-INJ-01		x[2]	x	x	x	x	x	x	x	x	x	x	x	x

Notes:

TS-OU2-INF-01 (formerly SP-IN-01) = Eastern Main influent
TS-OU2-INF-02 (formerly SP-IN-02) = Western Main influent
TS-OU2-EFF-1A (formerly SP-1A-EF) = GAC 1A effluent
TS-OU2-EFF-1B (formerly SP-1B-EF) = GAC 1B effluent
TS-OU2-EFF-1C (formerly SP-1C-EF) = GAC 1C effluent
TS-OU2-EFF-2A (formerly SP-2A-EF) = GAC 2A effluent
TS-OU2-EFF-2B (formerly SP-2B-EF) = GAC 2B effluent
TS-OU2-EFF-2C (formerly SP-2C-EF) = GAC 2C effluent
TS-OU2-INJ-01 (formerly SP-EF-01) = discharge point of compliance
x: sample collected
xx: sample and duplicate collected

[1] Sample point to be immediately downstream of the lead GAC vessel.

[2] Sample collected no less than 2 hours after bringing a newly repacked GAC vessel on-line.

[3] The sampling frequency is determined based on historical COC breakthrough rates at the old OU2 GWTP; however, the sampling frequency may be altered at the discretion of the Project Manager if there are significant differences in operational conditions at the new OU2 GWTP.

[4] The sampling schedule assumes vessels GAC 1A and GAC 2A are in the lead position.

[5] The median GAC cycle for the new OU2 GWTP based on analytical results for process samples collected during the first year of operation.

[6] If GAC change-out is not indicated by Week 26, further sampling will be performed weekly or at a frequency determined by the direction of the Project Manager.

4.1.5 Worksheet #17c1: Sites 2/12 GWMP

Well Name	Cl	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
EW-12-03-180M		Q	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-02-05-180	A	A	Q	HydraSleeve™, PDB/ SOP #3,2	RI Sites ROD/ESD
MW-02-13-180M	A	Q	Q	HydraSleeve™, PDB/ SOP #3,2	RI Sites ROD/ESD
EW-12-05-180M	A	Q	Q	Pump Spigot/SOP #5	RI Sites ROD/ESD
EW-12-06-180M	A	Q	Q	Pump Spigot/SOP #5	RI Sites ROD/ESD
EW-12-07-180M	A	Q	Q	Pump Spigot/SOP #5	RI Sites ROD/ESD
EW-12-08-180U	A	Q	Q	Pump Spigot/SOP #5	RI Sites RI/FS Addendum
MW-12-01-180		Q	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-12-05-180	A		Q	HydraSleeve™/ SOP #3	RI Sites ROD/ESD
MW-12-09R-180		Q	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-12-14-180M		Q	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-12-15-180M		Q	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-12-16-180M		Q	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-12-18-180U		A	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-12-20-180U		Q	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-12-21-180U		Q	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-12-22-180U		Q	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-12-24-180U		Q	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-12-25-180U		A	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-12-26-180U		A	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-12-28-180U		Q	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-12-29-180U		Q	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-12-30-180U		Q	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-12-31-180M		A	Q	PDB/SOP #2	RI Sites ROD/ESD
MW-12-32-180U		Q	Q	PDB/SOP #2	RI Sites ROD/ESD
The Following Wells Are Measured for Groundwater Elevation Data Only:					
EW-12-03-180U			Q	SOP #5	Groundwater elevation trend analysis
EW-12-04-180M			Q	SOP #5	Groundwater elevation trend analysis

Well Name	Cl	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
EW-12-04-180U			Q	SOP #5	Groundwater elevation trend analysis
MW-02-06-180			Q	SOP #5	Groundwater elevation trend analysis
MW-02-10-180			Q	SOP #5	Groundwater elevation trend analysis
MW-02-13-180U			Q	SOP #5	Groundwater elevation trend analysis
MW-12-07-180			Q	SOP #5	Groundwater elevation trend analysis
MW-12-08-180			Q	SOP #5	Groundwater elevation trend analysis
MW-12-12-180L			Q	SOP #5	Groundwater elevation trend analysis
MW-12-17-180U			Q	SOP #5	Groundwater elevation trend analysis
MW-12-19-180U			Q	SOP #5	Groundwater elevation trend analysis
MW-12-19-180M			Q	SOP #5	Groundwater elevation trend analysis
MW-12-23-180U			Q	SOP #5	Groundwater elevation trend analysis
MW-12-27-180U			Q	SOP #5	Groundwater elevation trend analysis

Notes:

A: sampled on an annual basis
Cl: chloride
ESD: Explanation of Significant Differences
PDB: passive diffusion bag
Q: sampled on a quarterly basis
RI: Remedial Investigation
ROD: Record of Decision
SIM: selected ion monitoring
SOP: standard operating procedures
VOCs: volatile organic compounds

[1] The rationale for sampling locations and frequency is based on the applicable program RODs, ESDs, program history and precedent established by the BCT, which includes the Army, USACE, EPA, DTSC, and CCRWQCB.

4.1.6 Worksheet #17c2: OU2 GWMP

Well Name	Cu, Pb, Sb (6010D)	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
EW-OU2-01-180		Q	Q	PDB/SOP #2	OU2 ESD
EW-OU2-02-180R[2]		Q	Q	Pump Spigot/SOP #5	OU2 GWTP Relocation
EW-OU2-02-A		Q	Q	Pump Spigot/SOP #5	OU2 ROD
EW-OU2-03-180		Q	Q	Pump Spigot/SOP #5	OU2 ROD
EW-OU2-04-A		Q	Q	Pump Spigot/SOP #5	OU2 ROD
EW-OU2-05-180		Q	Q	PDB/SOP #2	OU2 ROD
EW-OU2-05-A		Q	Q	Pump Spigot/SOP #5	OU2 ROD
EW-OU2-06-180		Q	Q	Pump Spigot/SOP #5	OU2 ROD
EW-OU2-06-A		Q	Q	Pump Spigot/SOP #5	OU2 ROD
EW-OU2-08-180		Q	Q	Pump Spigot/SOP #5	OU2 ROD
EW-OU2-09-A		Q	Q	Pump Spigot/SOP #5	OU2 ROD
EW-OU2-10-180[2]		Q	Q	Pump Spigot/SOP #5	OU2 GWTP Relocation
EW-OU2-10-A		Q	Q	Pump Spigot/SOP #5	OU2 GWTP Relocation
EW-OU2-11-180[2]		Q	Q	Pump Spigot/SOP #5	OU2 GWTP Relocation
EW-OU2-11-AR[2]		Q	Q	Pump Spigot/SOP #5	OU2 GWTP Relocation
EW-OU2-12-180[2]		Q	Q	Pump Spigot/SOP #5	OU2 GWTP Relocation
EW-OU2-12-A		Q	Q	Pump Spigot/SOP #5	OU2 ROD
EW-OU2-13-A		Q	Q	Pump Spigot/SOP #5	OU2 ROD
EW-OU2-14-A		Q	Q	Pump Spigot/SOP #5	OU2 ROD
EW-OU2-15-A		Q	Q	PDB/SOP #2	OU2 ESD
EW-OU2-16-A		Q	Q	Pump Spigot/SOP #5	OU2 ROD
EW-OU2-17-A[2]		Q	Q	Pump Spigot/SOP #5	OU2 GWTP Relocation
EW-OU2-18-A[2]		Q	Q	Pump Spigot/SOP #5	OU2 GWTP Relocation
EW-OU2-19-A[2]		Q	Q	Pump Spigot/SOP #5	OU2 GWTP Relocation
EW-OU2-20-A[2]		Q	Q	Pump Spigot/SOP #5	OU2 GWTP Relocation
MW-BW-02-180		Q	Q	PDB/SOP #2	OU2 ESD/OUCTP ROD
MW-BW-13-A		Q	Q	PDB/SOP #2	OU2 ROD

Well Name	**Cu, Pb, Sb (6010D)**	**VOCs (8260-SIM)**	**Water Levels**	**Sampling Methods/SOP**	**Rationale[1]**
MW-BW-14-180		Q	Q	PDB/SOP #2	OU2 ESD
MW-BW-50-A		Q	Q	PDB/SOP #2	OU2 ROD
MW-OU2-01-A	A	Q	Q	HydraSleeve™, PDB/ SOP #2, 3	OU2 ROD
MW-OU2-02-A	A	Q	Q	HydraSleeve™, PDB/ SOP #2, 3	OU2 ROD
MW-OU2-04-A		Q	Q	PDB/SOP #2	OU2 ROD
MW-OU2-06-180R2		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-06-AR		Q	Q	PDB/SOP #2	OU2 ROD
MW-OU2-07-180R		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-07-A		A	Q	PDB/SOP #2	OU2 ROD
MW-OU2-08-A		Q	Q	PDB/SOP #2	OU2 ROD
MW-OU2-12-A		Q	Q	PDB/SOP #2	OU2 ROD
MW-OU2-20-180		Q	Q	PDB/SOP #2	OU2 ROD
MW-OU2-23-180		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-24-180		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-25-A		Q	Q	PDB/SOP #2	OU2 ROD
MW-OU2-27-A		Q	Q	PDB/SOP #2	OU2 ROD
MW-OU2-28-180		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-28-A		Q	Q	PDB/SOP #2	OU2 ROD
MW-OU2-30-180		A	Q	PDB/SOP #2	OU2 ESD
MW-OU2-34-A		Q	Q	PDB/SOP #2	OU2 ROD
MW-OU2-39-180		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-40-A		Q	Q	PDB/SOP #2	OU2 ROD
MW-OU2-43-180		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-44-A		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-44-180		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-45-A		Q	Q	PDB/SOP #2	OU2 ROD
MW-OU2-46-A		Q	Q	PDB/SOP #2	OU2 ROD
MW-OU2-46-180		Q	Q	PDB/SOP #2	OU2 ESD

Well Name	Cu, Pb, Sb (6010D)	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MW-OU2-47-180		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-50-180		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-51-180		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-53-180		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-56-180		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-61-180		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-62-180		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-63-180		A	Q	PDB/SOP #2	OU2 ESD
MW-OU2-73-A	A	Q	Q	HydraSleeve™, PDB/ SOP #2, 3	OU2 ROD
MW-OU2-74-A	A	Q	Q	HydraSleeve™, PDB/ SOP #2, 3	OU2 ROD
MW-OU2-75-A		Q	Q	PDB/SOP #2	OU2 ROD
MW-OU2-79-A		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-80-A		Q	Q	PDB/SOP #2	OU2 ROD
MW-OU2-81-A		Q	Q	PDB/SOP #2	OU2 ROD
MW-OU2-81-180		Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-83-A		Q	Q	PDB/SOP #2	Well Install Completion Report (Ahtna, 2019f)
The Following Wells Are Measured for Groundwater Elevation Data Only:					
EW-OU2-01-A			Q	SOP #5	Groundwater elevation trend analysis
EW-OU2-03-A			Q	SOP #5	Groundwater elevation trend analysis
EW-OU2-04-180			Q	SOP #5	Groundwater elevation trend analysis
EW-OU2-07-A			Q	SOP #5	Groundwater elevation trend analysis
MW-14-03-180			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-01-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-11-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-12-180			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-03-A			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-05-A			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-05-180			Q	SOP #5	Groundwater elevation trend analysis

Well Name	Cu, Pb, Sb (6010D)	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MW-OU2-09-A			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-09-180R			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-13-A			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-20-180X			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-21-A			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-23-A			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-29-180			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-29-A			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-30-A			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-31-180R			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-32-A			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-35-A			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-36-180			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-49-180			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-52-180			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-54-180			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-55-180			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-57-A			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-58-A			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-76-A			Q	SOP #5	Groundwater elevation trend analysis
MW-OU2-77-A			Q	SOP #5	Groundwater elevation trend analysis
PZ-OU2-06-180			Q	SOP #5	Groundwater elevation trend analysis

Notes:

A: sampled on an annual basis
Cu: copper
ESD: Explanation of Significant Differences
PB: lead
PDB: passive diffusion bag
Q: sampled on a quarterly basis
ROD: Record of Decision
Sb: antimony
SIM: selected ion monitoring
SOP: standard operating procedures
VOCs: volatile organic compounds

[1] The rationale for sampling locations and frequency is based on the applicable program RODs, ESDs, program history and precedent established by the BCT, which includes the Army, USACE, EPA, DTSC, and CCRWQCB.

[2] New wells installed in 2016 to be operated and sampled once the new OU2 GWTP is online in 2018.

4.1.7 Worksheet #17c3: OUCTP A-Aquifer GWMP

Well Name	DO ORP	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
EISB-EW-01		Q	Q	PDB/SOP #2	OUCTP ROD
EISB-EW-02		A	Q	PDB/SOP #2	OUCTP ROD
EISB-EW-09		Q	Q	PDB/SOP #2	OUCTP ROD
EISB-EW-12	Q		Q	PTM/SOP #6/7	OUCTP ROD
EISB-EW-15	Q		Q	PTM/SOP #6/7	OUCTP ROD
EISB-MW-01		A	Q	PDB/SOP #2	OUCTP ROD
EW-BW-109-A		Q	Q	PTM/SOP #6/7; PDB/SOP #2	OUCTP ROD
EW-BW-112-A	Q	A	Q	PTM/SOP #6/7; PDB/SOP #2	OUCTP ROD
EW-BW-119-A	Q	A	Q	PTM/SOP #6/7; PDB/SOP #2	OUCTP ROD
EW-BW-124-A	Q	Q	Q	PTM/SOP #6/7; PDB/SOP #2	OUCTP ROD
EW-BW-132-A		A	Q	PDB/SOP #2	OUCTP ROD
EW-BW-135-A	Q	Q	Q	PTM/SOP #6/7; PDB/SOP #2	OUCTP ROD
EW-BW-144-A	Q		Q	PTM/SOP #6/7	OUCTP ROD
EW-BW-149-A	Q	Q	Q	PTM/SOP #6/7; PDB/SOP #2	OUCTP ROD
EW-BW-150-A	Q	A	Q	PTM/SOP #6/7; PDB/SOP #2	OUCTP ROD
EW-BW-155-A	Q	Q	Q	PTM/SOP #6/7; PDB/SOP #2	OUCTP ROD
EW-BW-159-A	Q		Q	PTM/SOP #6/7	OUCTP ROD
EW-BW-160-A	Q	Q	Q	PDB/SOP #2	OUCTP ROD
EW-BW-161-A	Q		Q	SOP #5	OUCTP ROD
EW-BW-164-A	Q		Q	SOP #5	OUCTP ROD
EW-BW-165-A		A	Q	PDB/SOP #2	OUCTP ROD
EW-BW-166-A	Q	Q	Q	PDB/SOP #2	OUCTP ROD
EW-BW-167-A		A	Q	PDB/SOP #2	OUCTP ROD
EW-BW-168-A		A	Q	PDB/SOP #2	OUCTP ROD
EW-BW-169-A		A	Q	PDB/SOP #2	OUCTP ROD
MP-BW-46-095		A	Q	Westbay Port/SOP #1	OUCTP ROD
MW-B-12-A		Q	Q	PDB/SOP #2	OUCTP ROD

Well Name	DO ORP	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MW-B-14-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-15-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-17-A		A	Q	PDB/SOP #2	OUCTP ROD
MW-BW-24-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-26-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-27-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-28-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-30-A		A	Q	SOP #5	Groundwater elevation trend analysis
MW-BW-31-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-32-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-35-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-36-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-39-A		A	Q	PDB/SOP #2	OUCTP ROD
MW-BW-42-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-43-A		A	Q	PDB/SOP #2	OUCTP ROD
MW-BW-44-A		A	Q	PTM/SOP #6/7; PDB/SOP #2	OUCTP ROD
MW-BW-48-A		A	Q	PDB/SOP #2	OUCTP ROD
MW-BW-49-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-56-A		A	Q	PDB/SOP #2	OUCTP ROD
MW-BW-58-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-60-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-65-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-66-A		Q	Q	PTM/SOP #6/7; PDB/SOP #2	OUCTP ROD
MW-BW-74-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-75-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-77-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-78-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-79-A		Q	Q	PDB/SOP #2	OUCTP ROD

Well Name	DO ORP	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MW-BW-80-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-83-A		A	Q	PDB/SOP #2	OUCTP ROD
MW-BW-85-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-86-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-87-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-88-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-89-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-90-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-91-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-92-A		Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-93-A		Q	Q	PDB/SOP #2	Well Install Completion Report (Ahtna, 2019f)
MW-BW-94-AR		Q	Q	PDB/SOP #2	Well Install Completion Report (Ahtna, 2019f)
MW-BW-95-A		Q	Q	PDB/SOP #2	Well Install Completion Report (Ahtna, 2019f)
The Following Wells Are Measured for Groundwater Elevation Data Only:					
EISB-EW-03			Q	SOP #5	Groundwater elevation trend analysis
EISB-MW-04			Q	SOP #5	Groundwater elevation trend analysis
EW-BW-92-A			Q	SOP #5	Groundwater elevation trend analysis
EW-BW-93-A			Q	SOP #5	Groundwater elevation trend analysis
EW-BW-100-A			Q	SOP #5	Groundwater elevation trend analysis
EW-BW-104-A			Q	SOP #5	Groundwater elevation trend analysis
EW-BW-126-A			Q	SOP #5	Groundwater elevation trend analysis
MP-BW-46-080			Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-48-113			Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-48-133			Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MW-40-01-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-16-A			Q	SOP #5	OUCTP ROD
MW-BW-18-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-25-A			Q	SOP #5	Groundwater elevation trend analysis

Well Name	DO ORP	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MW-BW-34-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-38-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-41-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-45-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-46-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-51-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-53-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-54-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-57-A			Q	SOP #5	OUCTP ROD
MW-BW-59-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-63-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-67-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-71-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-81-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-82-A			Q	SOP #5	Groundwater elevation trend analysis

Notes:
A: sampled on an annual basis
DO: dissolved oxygen
ORP: oxidation-reduction potential
PDB: passive diffusion bag
PTM: post-treatment monitoring
Q: sampled on a quarterly basis
ROD: Record of Decision
SIM: selected ion monitoring
SOP: standard operating procedures
[1] The rationale for sampling locations and frequency is based on the applicable program RODs, ESDs, program history and precedent established by the BCT, which includes the Army, USACE, EPA, DTSC, and CCRWQCB.

4.1.8 Worksheet #17c4: OUCTP Upper 180-Foot Aquifer GWMP

Well Name	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
EW-OU2-09-180	Q	Q	Pump Spigot/SOP #5	OUCTP ROD
MP-BW-41-231	A	Q	Westbay Port/SOP #1	OUCTP ROD
MP-BW-46-170	Q	Q	Westbay Port/SOP #1	OUCTP ROD
MW-BW-52-180	Q	Q	PDB/SOP #2	OUCTP ROD
MW-BW-57-180	Q	Q	PDB/SOP #2	Well Install Completion Report (Ahtna, 2019f)
MW-BW-58-180	Q	Q	PDB/SOP #2	Well Install Completion Report (Ahtna, 2019f)
MW-OU2-64-180	Q	Q	PDB/SOP #2	OUCTP ROD
MW-OU2-67-180	Q	Q	PDB/SOP #2	OUCTP ROD
MW-OU2-70-180	A	Q	PDB/SOP #2	OUCTP ROD
<u>The Following Wells Are Measured for Groundwater Elevation Data Only</u>:				
MP-BW-30-282		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-32-287		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-33-272		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-35-242		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-37-178		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-37-193		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-41-202		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-41-256		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-42-195		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-42-215		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-42-235		Q	Westbay Port/SOP #1	Groundwater elevation trend analysis
MP-BW-46-185		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-46-200		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-46-215		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MW-B-05-180		Q	SOP #5	Groundwater elevation trend analysis
MW-BW-21-180		Q	SOP #5	Groundwater elevation trend analysis
MW-BW-26-180		Q	SOP #5	Groundwater elevation trend analysis

Well Name	**VOCs (8260-SIM)**	**Water Levels**	**Sampling Methods/SOP**	**Rationale[1]**
MW-BW-43-180		Q	SOP #5	Groundwater elevation trend analysis
MW-BW-44-180		Q	SOP #5	Groundwater elevation trend analysis
MW-BW-45-180		Q	SOP #5	Groundwater elevation trend analysis
MW-BW-47-180		Q	SOP #5	Groundwater elevation trend analysis
MW-BW-49-180		Q	SOP #5	Groundwater elevation trend analysis
MW-BW-50-180		Q	SOP #5	Groundwater elevation trend analysis
MW-BW-51-180		Q	SOP #5	Groundwater elevation trend analysis
MW-BW-53-180		Q	SOP #5	Groundwater elevation trend analysis
MW-BW-54-180		Q	SOP #5	Groundwater elevation trend analysis
MW-BW-55-180		Q	SOP #5	Groundwater elevation trend analysis
MW-BW-56-180		Q	SOP #5	Groundwater elevation trend analysis

Notes:

A: sampled on an annual basis
PDB: passive diffusion bag
PTM: post-treatment monitoring
Q: sampled on a quarterly basis
ROD: Record of Decision
SIM: selected ion monitoring
SOP: standard operating procedures

[1] The rationale for sampling locations and frequency is based on the applicable program RODs, ESDs, program history and precedent established by the BCT, which includes the Army, USACE, EPA, DTSC, and CCRWQCB.

4.1.9 Worksheet #17c5: OUCTP Lower 180-Foot Aquifer GWMP

Well Name	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
Airfield	Q	Q	PDB/SOP #2	OUCTP ROD
EW-OU2-07-180	Q	Q	PDB/SOP #2	OUCTP ROD
FO-29	Q		Sampling Port/SOP #4	OUCTP ROD
FO-30	Q		Sampling Port/SOP #4	OUCTP ROD
FO-31	Q		Sampling Port/SOP #4	OUCTP ROD
Mini-storage	A		Sampling Port/SOP #4	OUCTP ROD
MP-BW-31-292	A	Q	Westbay Port/SOP #1	OUCTP ROD
MP-BW-41-318	Q	Q	Westbay Port/SOP #1	OUCTP ROD
MP-BW-41-353	Q	Q	Westbay Port/SOP #1	OUCTP ROD
MP-BW-42-345	Q	Q	Westbay Port/SOP #1	OUCTP ROD
MP-BW-49-287	Q	Q	Westbay Port/SOP #1	OUCTP ROD
MP-BW-49-316	Q	Q	Westbay Port/SOP #1	OUCTP ROD
MP-BW-49-368	Q	Q	Westbay Port/SOP #1	OUCTP ROD
MP-BW-49-400	Q	Q	Westbay Port /SOP #1	OUCTP ROD
MP-BW-50-339	Q	Q	Westbay Port /SOP #1	OUCTP ROD
MP-BW-50-384	Q	Q	Westbay Port /SOP #1	OUCTP ROD
MP-BW-51-405	Q	Q	Westbay Port /SOP #1	OUCTP ROD
MW-BW-04-180	A	Q	PDB/SOP #2	OUCTP ROD
MW-BW-59-180	Q	Q	PDB/SOP #2	Well Install Completion Report (Ahtna, 2019f)
MW-OU2-66-180	Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-69-180	Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-72-180	Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-78-180	Q	Q	PDB/SOP #2	OU2 ESD
MW-OU2-82-180	Q	Q	PDB/SOP #2	OU2 ESD
<u>The Following Wells Are Measured for Groundwater Elevation Data Only</u>:				
MCWD-08A		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-30-317		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis

Well Name	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MP-BW-30-342		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-30-397		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-30-467		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-30-537		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-31-332		Q	Westbay Port/SOP #1	Groundwater elevation trend analysis
MP-BW-31-362		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-31-407		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-31-457		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-31-522		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-32-332		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-32-366		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-32-412		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-32-472		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-32-522		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-33-317		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-33-352		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-33-397		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-34-292		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-34-357		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-34-422		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-34-492		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-34-537		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-35-312		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-35-366		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-35-402		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-35-467		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-35-527		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-35-562		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis

Well Name	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MP-BW-37-328		Q	Westbay Port/SOP #1	Groundwater elevation trend analysis
MP-BW-37-303		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-37-368		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-37-398		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-37-460		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-38-327		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-38-341		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-38-353		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-38-368		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-38-418		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-39-310		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-39-330		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-39-350		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-39-395		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-40-333		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-40-353		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-40-375		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-40-400		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-41-286		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-41-396		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-42-295		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-42-314		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-42-400		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-49-336		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-50-289		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-50-309		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-50-359		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-51-315		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis

Well Name	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale[1]
MP-BW-51-340		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-51-370		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-52-323		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-52-338		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-52-363		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-52-388		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-52-408		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MW-BW-03-400		Q	SOP #7	Groundwater elevation trend analysis
MW-OU2-07-400		Q	SOP #7	Groundwater elevation trend analysis
MW-OU2-28-400		Q	SOP #7	Groundwater elevation trend analysis
MW-OU2-68-180		Q	SOP #7	Groundwater elevation trend analysis
MW-OU2-71-180		Q	SOP #7	Groundwater elevation trend analysis
Test 2		Q	SOP #7	Groundwater elevation trend analysis

Notes:

A: sampled on an annual basis	Q: sampled on a quarterly basis	SOP: standard operating procedures
PDB: passive diffusion bag	ROD: Record of Decision	
PTM: post-treatment monitoring	SIM: selected ion monitoring	

[1] The rationale for sampling locations and frequency is based on the applicable program RODs, ESDs, program history and precedent established by the BCT, which includes the Army, USACE, EPA, DTSC, and CCRWQCB.

4.2 Worksheet #18: Sampling Locations and Methods

This Worksheet was not used. Information that would be included in this worksheet is incorporated into Worksheets #17a through #17c.

5.0 Sampling Requirements

5.1 Worksheets #19 and #30: Sample Container, Preservation, and Hold Times

Laboratory: SGS

Florida:
4405 Vineland Rd, Suite C-15
Orlando, FL 32811

Telephone: 407-425-6700
Point of Contact: Svetlana Izosimova
E-mail: Svetlana.Izosimova@sgs.com

Sample Delivery Method: Courier to San Jose, CA distribution center or FedEx overnight shipment to Florida

Matrix	Analytical Group	Preparation/Analytical Method	Sample Volume	Containers	Preservation	Holding Time[1]	SGS Laboratory
Water	VOCs	EPA 5030/8260-SIM	120 mL	Three 40-mL Teflon-lined® VOA Vials	HCl to pH < 2 Sample temp > 0°C ≤ 6°C	14 days	Florida
	Dissolved Metals	EPA 3010A/6010D	500 mL	Two 250-mL HDPE bottles	HNO_3 to pH < 2 after field filtering Sample temp > 0°C ≤ 6°C	6 months	
	Chloride	EPA 9056A	100 mL	One 100-mL HDPE bottle	Sample temp > 0°C ≤ 6°C	28 days	

Notes:
°C: degrees Celsius
HCl: hydrochloric acid
HDPE: high-density polyethylene
HNO_3: nitric acid
mL: milliliter
VOA: volatile organic analysis
VOCs: volatile organic compounds
[1] Data package TAT is 15 business days

5.2 Worksheet #20: Field Quality Control Summary

Matrix	Analytical Group (Method)	Frequency of Field Duplicate Samples	Frequency of Trip Blanks	Frequency of Field Blanks	Frequency of Equip Blanks	Frequency of MS/MSD
Water	VOCs (8260-SIM)	10% of field samples collected	1 set per cooler /day	1 per sampling day	1 per sampling event (Westbay sampling only[1])	5% of field samples collected
	Metals (6010D)	10% of field samples collected	N/A	N/A	N/A	5% of field samples collected
	Cl (9056A)	10% of field samples collected	N/A	N/A	N/A	5% of field samples collected

Notes:

Cl: chloride

MS/MSD: matrix spike/matrix spike duplicate

N/A: not applicable

VOCs: volatile organic compounds

[1] Sampling at Westbay wells requires reuse and decontamination of sampling equipment. Sampling with PDBs, HydraSleeves and from sampling ports is performed with non-reusable sampling equipment, and no decontamination of field equipment is required. Westbay sample locations are identified as “Westbay Port” in the “Sampling Method” column of Worksheet #17c.

5.3 Worksheet #21: Field SOPs/Methods

SOP Reference Number	Title	Organization	Revision Date	Equipment Type	Modified for Project Work?	Comments
SOP #1	Westbay MOSDAX Sampler Probe – Model 2531 Operations Manual	Schlumberger	Oct. 20, 2006	Westbay Multi-port Wells	No	
SOP #2	PDB Sampling Protocol	Wood/U.S. Geological Survey (USGS)	2001	PDBs	Yes	Project-specific procedures are appended to USGS User’s Guide
SOP #3	HydraSleeve Field Manual	GeoInsight	2006	HydraSleeve	No	
SOP #4	Supply and Irrigation Well Sampling Protocol	Wood/Ahtna	2016	Sampling Ports	Yes	GWMP project-specific procedures
SOP #5	OU2 and Sites 2/12 GWTSs and OUCTP EISB Extraction Well Sample Handling and Custody Requirements	Ahtna	2016	Sampling Ports	Yes	GWTS project-specific procedures
SOP #6	Low Flow Groundwater Quality Parameter Collection	Ahtna	2016	Horiba Multi-Meter and Low Flow Pump	Yes	OUCTP GWMP project-specific procedures
SOP #7	Downhole Meter Groundwater Quality Parameter Collection	Ahtna	2016	YSI Sonde Downhole Meter	Yes	OUCTP GWMP project-specific procedures

Note: SOPs are provided in Attachment A.

5.4 Worksheet #22: Field Equipment Calibration, Maintenance, Testing, and Inspection

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Electric Water Level Sounder	Calibrated against steel tape	Maintain in proper working order, store in a secure location, decon after each use	Check battery and sensitivity daily prior to use	Inspect tape for damage prior to use	Quarterly prior to use	Calibrates with steel tape to within 0.05 ft/100 feet depth to water	Send into factory for repair	Field Supervisor	SOPs #2 & #5
YSI Sonde Downhole Meter	Calibrated with solutions	Decon after each use, store according to manufacturer directions	Check battery prior to use	Inspect for damage prior to use	Quarterly prior to use	According to manufacturer instructions	Check manual or send into factory for repair	Field Supervisor	SOP #7
Digital Thermometer	Factory calibrated, ice-point method per HACCP-based SOP	Store in a secure location, avoid excessive heat	Check battery prior to use	Inspect for damage prior to use	Annually	Factory calibration, temperature reading = $0^{o}C \pm 1^{o}C$	Replace with new unit	Field Supervisor	SOPs #2 & #5

Notes:
°C: degrees Celsius
HACCP: Hazard Analysis & Critical Control Points (Title 9 Code of Federal Regulations Part 417)
N/A: not applicable
SOP: standard operating procedures

6.0 Analytical Requirements

6.1 Worksheet #23: Analytical SOPs

The SOPs referenced below are the laboratory-specific procedures for the tests for which the laboratory is certified under DoD Environmental Laboratory Accreditation Program (ELAP). Laboratories with the DoD ELAP certificate undergo annual audits by the independent accrediting bodies responsible for the DoD ELAP certification. Copies certifications including the specifically referenced methods are included in Attachment F.

Data will be evaluated based on the guidance provided in the DoD QSM Version 5.1, the published methods, and the laboratory Quality Assurance Manual.

SOP Reference Number	Title	Organization	Revision Date	Equipment Type	Modified for Project Work?	Comments
SGS SOP# MS010.7	Analysis of Volatile Organics by GC/MS Select Ion Monitoring (SIM) (VOCs by 8260 SIM)	SGS	Aug 30, 2017	Analytical Instruments	No	
SGS SOP# MET108.03	Metals by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP) (Metals by 6010D)	SGS	Feb 22, 2018	Analytical Instruments	No	
SGS SOP# GN228.9	Determination of Inorganic Anions by Ion Chromatography (Chloride by 9056A)	SGS	April 4, 2018	Analytical Instruments	No	
SGS SOP# SAM101.19	Sample Receipt and Storage	SGS	Oct 29, 2018	None	No	
SGS SOP# SAM108.10	Sample and Laboratory Waste Disposal	SGS	Jan 21, 2016	None	No	

6.2 Worksheet #24: Analytical Instrument Calibration

Instrument/ Analysis	Calibration Requirements	Frequency of Calibration	Acceptance Criteria	Corrective Action	Responsible Person
GC/MS – VOCs by EPA Method 8260-SIM	Check of instrument tuning using BFB	Prior to ICAL and every 12 hours	Refer to method for specific ion criteria	Re-tune instrument Re-analyze affected	GC/MS Analyst
	Multipoint calibration (minimum of five points), lowest point at or below LOQ	Initially and as required	Minimum RF per method. Each analyte must meet one of the three options below: Option 1: RSD for each analyte ≤ 15% Option 2: linear least squares regression $r^2 \geq$ 0.99 Option 3: non-linear regression – coefficient of determination (COD) $r^2 \geq$ 0.99 (six points shall be used for second order, seven for third order)	Correct problem, then repeat ICAL	GC/MS Analyst
	Second Source - ICV Standard	Once after each ICAL	Analytes within ± 20% of true value	Correct problem and verify second source standard. Re-run second source verification. If that fails, correct the problem and repeat ICAL.	GC/MS Analyst
	Instrument blanks and method blanks	After initial calibration and daily, prior to sample analysis (instrument blank) and with each	No analytes detected > ½ LOQ or > 1⁄10 the amount measured in any sample or 1⁄10 the regulatory limit, whichever is greater.	Re-analyze blank Clean system Re-analyze affected samples	GC/MS Analyst

Instrument/ Analysis	Calibration Requirements	Frequency of Calibration	Acceptance Criteria	Corrective Action	Responsible Person
		batch of samples (method blank)	Common contaminants must not be detected > LOQ.		
GC/MS – VOCs by EPA Method 8260-SIM (continued)	Continuing calibration verification (CCV) standard	Daily before sample analysis and every 12 hours of analysis time, and at the end of the analytical run	RF criteria per method. All reported analytes and surrogates within ± 20% of true value All reported analytes and surrogates within ± 50% for end of analytical batch CCV	Correct problem, then re-run the CCV. If that fails, repeat ICAL. Re-analyze samples run since last successful CCV.	GC/MS Analyst
ICP Metals by EPA Method 6010D	ICAL: Single or multipoint calibration. Minimum one high standard and a calibration blank	Daily ICAL prior to sample analysis	If more than one calibration standard is used, $r^2 \geq 0.99$	Correct problem, then repeat ICAL	ICP Analyst
	Second Source (ICV) Standard	Once after each ICAL, prior to sample analysis	Value of second standard source for target analytes within ± 10% of true value	Correct the problem and verify second source standard. Re-run ICV. If that fails, correct problem and repeat ICAL.	ICP Analyst
	CCV	After analysis of every 10 samples and at the end of the analytical sequence	Within ± 10% of true value	Correct problem, then re-run the CCV. If that fails, repeat ICAL. Re-analyze samples run since last successful CCV.	ICP Analyst
	Low-level calibration check standard (LOQ low point standard from calibration)	Daily, following one point ICAL	Within ± 20% of true value	Correct problem, then re-analyze.	ICP Analyst

Instrument/ Analysis	Calibration Requirements	Frequency of Calibration	Acceptance Criteria	Corrective Action	Responsible Person
	ICS (Interference check sample)	After ICAL and prior to sample analysis	ICS-A: Absolute value of concentration for all non-spiked project analytes < ½ LOQ (unless they are a verified trace impurity from one of the spiked analytes)	Terminate analysis. Locate and correct problem. Re-analyze ICS and samples.	ICP Analyst
ICP Metals by EPA Method 6010D (continued)	Calibration blanks	Immediately after the ICV and Immediately after every CCV.	The absolute values of all analytes must be < ½ LOQ or < ⅒ the amount measured in any sample.	Calibration blanks: Correct the problem. Re-prep and re-analyze calibration blank. Samples following the last acceptable calibration blank must be re-analyzed.	ICP Analyst
Ion Chromatography – Chloride by EPA Method 9056A	Initial Calibration (minimum three standards and one calibration blank)	ICAL prior to sample analysis	$r^2 \geq 0.99$	Correct problem, then repeat ICAL.	IC Analyst
	ICV	After each ICAL and prior to sample analysis	Analytes within ± 10% of true values and retention times within appropriate windows	Correct problem and verify second source standard. Re-run ICV. If that fails, correct the problem and repeat ICAL.	IC Analyst
	Retention time window position establishment	Once per multipoint calibration	Retention time width is set using the midpoint standard of the ICAL for each analyte when ICAL is performed. On days when ICAL is not performed, the initial CCV is used	If the retention time shifts by more than 10%, a new ICAL is performed.	IC Analyst

Instrument/ Analysis	Calibration Requirements	Frequency of Calibration	Acceptance Criteria	Corrective Action	Responsible Person
Ion Chromatography – Chloride by EPA Method 9056A (continued)	CCV	After ICAL, after every ten samples, and at end of run	Analytes within established retention time windows and within ± 10% of true value	Correct problem, then re-run the CCV. If that fails, repeat ICAL. Re-analyze samples run since last successful CCV.	Wet Chemistry Analyst

Notes:

%D: percent difference / percent drift
BFB: 4-bromofluorobenzene
CCC: continuing calibration check compounds
CCV: continuing calibration verification
COD: coefficient of determination
GC/MS: gas chromatography / mass spectrometry
ICAL: initial calibration
ICP: inductively coupled plasma atomic emission spectroscopy
ICS: interference check sample
ICS-A: interference check standard A
ICS-AB: interference check standard AB
ICV: initial calibration verification
LOD: limit of detection
LOQ: limit of quantitation
N/A: not applicable
RF: response factor
RSD: relative standard deviation
SIM: selected ion monitoring
VOCs: volatile organic compounds

[1] Normal balance and thermometer calibration applies (Worksheet #25).

6.3 Worksheet #25: Analytical Instrument and Equipment Maintenance, Testing and Inspection

Analytical instruments used for this project will be maintained in accordance with the requirements presented in the SGS QA Manual and the individual analytical method SOPs. The SGS QA Manual also presents the documentation requirements for maintenance activities.

Instrument/Equipment	Maintenance/Inspection Activity	Frequency	Person Responsible for Corrective Action
GC/MS	Inspect/replace column Clean ion source Inspect, clean concentrator trap Change electron multiplier Backflush purge and trap Change rough oil pump	As required. Refer to Analytical Method and instrument manufacturer.	GC/MS Analyst
ICP	Inspect/replace tubing and pump Inspect/replace windings Inspect/replace torch and injector	As required. Refer to Analytical Method and instrument manufacturer.	ICP Analyst
IC	Inspect/perform column cleanup	As required. Refer to Analytical Method and instrument manufacturer.	IC Analyst

Notes:
GC/MS: gas chromatography/mass spectrometry
IC: ion chromatography
ICP: inductively coupled plasma

6.4 Worksheets #26 and #27: Sample Handling, Custody, and Disposal

Groundwater samples will be collected in laboratory-provided bottles using methods described in Worksheets #17a through #17c and #19, and SOPs #1 through #5. Samples will be received and logged into the laboratory information management system for analysis as described in the DoD QSM Version 5.1. Chain of custody procedures will be performed in accordance with Worksheet #29.

Sample organization: Ahtna/ Wood

Laboratory: SGS

Method of sample delivery (shipper/carrier): SGS courier or FedEx overnight shipping

Number of days from reporting until sample disposal: No less than 30 days after final report sent to the client

Activity	Organization and Title or Position of Person Responsible for the Activity	SOP Reference
Sample Labeling	Ahtna/ Wood Field Technicians	SOP #5
Chain of custody form completion	Ahtna/ Wood Field Technicians	SOP #5
Packaging	Ahtna/ Wood Field Technicians	SOP #5
Shipping coordination	Ahtna/ Wood Field Technicians	SOP #5
Sample receipt, inspection, & log-in	SGS Sample Management Supervisor	SOP #SAM101.19
Sample custody and storage	SGS Sample Management Supervisor	SOP #SAM101.19
Sample disposal	SGS Sample Management Supervisor	SOP #SAM108.10

Notes:
N/A: not applicable
O&M: operation and maintenance

6.5 Worksheet #28: Analytical Quality Control and Corrective Action

6.5.1 Worksheet #28a: VOCs

Matrix: Groundwater (µg/L)

Analytical Group/Test Method: VOCs by EPA Method 8260-SIM

QC Sample	Frequency	Acceptance Limits	Source of Acceptance Limits	Corrective Action	Responsible Person	Data Quality Indicator
Method Blank	1 per analytical batch	No analytes detected > ½ LOQ or > ⅒ the amount measured in any sample or ⅒ the regulatory limit, whichever is greater. Common contaminants must not be detected > LOQ.	DoD QSM 5.1 App B Table 4	Re-analyze method blank. If fails, clean system and re-analyze blank and affected samples.	GC/MS Analyst	Accuracy/ Bias Contamination
Laboratory Control Sample (LCS)/ LCSD	1 set per analytical batch. Spike target compounds. VC to be spiked at DL of 0.1 µg/L.	Analyte Recovery RPD 1,1-DCA 81-122% ≤ 15% 1,1-DCE 78-137% ≤ 18% 1,2-DCA 75-125% ≤ 14% 1,2-DCE (total) 76-127% ≤ 17% 1,2-DCPA 76-124% ≤ 14% 1,3-DCPE (total) 75-120% ≤ 23% Benzene 81-122% ≤ 14% CT 76-136% ≤ 23% Chloroform 80-124% ≤ 15% cis-1,2-DCE 78-120% ≤ 15% MC 69-135% ≤ 16% PCE 76-135% ≤ 16% TCE 81-126% ≤ 15% VC 69-159% ≤ 18%	Lab-derived	Re-prep and re-analyze LCS/LCSD and associated batch samples	GC/MS Analyst	Bias Accuracy/ Precision

QC Sample	Frequency	Acceptance Limits	Source of Acceptance Limits	Corrective Action	Responsible Person	Data Quality Indicator
MS/MSD	1 per analytical batch spike target compounds. VC to be spiked at DL of 0.1 µg/L.	Same as LS/LCSD acceptance limits for 8260-SIM.	Lab-derived	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. If the concentration in parent sample is > 4x the spiked amount, include in case narrative. No CA required.	GC/MS Analyst	Bias/Precision
Surrogates	Field samples and laboratory QC	1,2-Dichloroethane-$_{d4}$ 74-125% Toluene-$_{d8}$ 88-111%	Lab-derived	Re-prep and re-analyze affected samples unless matrix interference is present.	GC/MS Analyst	Bias
Internal Standards	Field samples, standards, and laboratory QC	Retention time ±10 seconds from retention time of the midpoint standard in the ICAL; extracted ion current profile area within -50% to +100% of ICAL midpoint standard. On days when ICAL is not performed, the daily initial CCV can be used.	DoD QSM 5.1 App B Table 4	Inspect mass spectrometer and GC for malfunction. Re-analysis of samples analyzed while system was malfunctioning is mandatory.	GC/MS Analyst	Bias/Precision

Notes on next page.

Notes:

%: percent
µg/L: micrograms per liter
cis-1,2-DCE: cis-1,2-dichloroethene
CT: carbon tetrachloride
1,1-DCA: 1,1-dichloroethane
1,1-DCE: 1,1-dichloroethene
1,2-DCA: 1,2-dichloroethane
1,2-DCE (total): total 1,2-dichloroethene
1,2-DCPA: 1,2-dichloropropane
1,3-DCPE (total): total 1,3-dichloropropene
DL: detection limit
DoD: Department of Defense
GC/MS: gas chromatography/mass spectrometry
ICAL: initial calibration
LCS: laboratory control sample
LCSD: laboratory control sample duplicate
LOQ: limit of quantitation
MC: methylene chloride
MS: matrix spike
MSD: matrix spike duplicate
N/A: not applicable
PCE: tetrachloroethene
QC: quality control
QSM: Quality Systems Manual
RPD: relative percent difference
TCE: trichloroethene
VC: vinyl chloride

6.5.2 Worksheet #28b: Metals

Matrix: Groundwater (µg/L)

Analytical Group/Test Method: Metals by EPA Method 6010D

QC Sample	Frequency	Acceptance Limits	Source of Acceptance Limits	Corrective Action	Responsible Person	Data Quality Indicator
Method Blank	1 per analytical batch	Absolute values of analytes detected < ½ LOQ or < ⅒ the amount measured in any sample or ⅒ the regulatory limit, whichever is greater.	DoD QSM 5.1 App B Table 8	Correct problem. Re-prep and re-analyze method blank and affected samples.	ICP Analyst	Accuracy/Bias Contamination
Laboratory Control Sample (LCS)	1 per analytical batch. Spike target compounds.	Analyte Recovery Antimony 80-120% Copper 80-120% Lead 80-120%	DoD QSM 5.1 App B Table 8 and App C Table 4	Re-prep and re-analyze LCS and associated batch samples	ICP Analyst	Bias Accuracy/ Precision
Laboratory Duplicate Sample	1 per analytical batch	≤ 20%	DoD QSM 5.1 App B Table 8	Narrate outliers in case narrative. No CA	ICP Analyst	Precision
MS/MSD	1 per analytical batch	Analyte Recovery RPD Antimony 80-120% ≤20% Copper 80-120% ≤20% Lead 80-120% ≤20%	DoD QSM 5.1 App C Table 4	Perform additional QC test (dilution test and/or post-digestion spike [PDS]) unless concentrations in parent sample are > 4x the spiked amount (no corrective action required). Perform PDS.	ICP Analyst	Bias/Precision
Dilution Test	1 per prep batch	5-fold dilution must agree within ± 10% of the original measurement	DoD QSM 5.1 App B Table 8	Perform post-digestion spike	ICP Analyst	Bias/Precision

QC Sample	Frequency	Acceptance Limits	Source of Acceptance Limits	Corrective Action	Responsible Person	Data Quality Indicator
Post-Digestion Spike (PDS)	Perform if MS/MSD fails, 1 per analytical batch	Recovery within 80-120%	DoD QSM 5.1 App B Table 8	Run associated samples by method of standard addition or flag data	ICP Analyst	Bias/Precision

Notes:

µg/L: micrograms per liter
ICP: inductively coupled plasma
LOQ: limit of quantitation
PDS: post-digestion spike
RPD: relative percent difference

6.5.3 Worksheet #28c: Wet Chemistry

Matrix: Groundwater (mg/L)

Analytical Group/Test Method: Chloride by EPA Method 9056A

QC Sample	Frequency	Acceptance Limits	Source of Acceptance Limits	Corrective Action	Person Responsible for Corrective Action	Data Quality Indicator
Method Blank	1 per analytical batch	No analytes detected > ½ the LOQ or > ⅒ the amount measured in any sample or ⅒ the regulatory limit	Laboratory limits	Correct problem. Re-prep and re-analyze method blank and affected samples.	Wet Chemistry Analyst	Accuracy/Bias Contamination
Laboratory Control Sample (LCS)	1 per analytical batch.	EPA 9056A: 90-110%	Laboratory performance-based limits	Re-prep and re-analyze LCS and associated batch samples.	Wet Chemistry Analyst	Bias Accuracy/ Precision
MS/MSD	1 set per analytical batch.	90-110% and RPD ±20%	Lab performance-based limit	Re-prep and re-analyze MS/MSD samples and report both sets of data. If concentration in parent sample is > 4x the spiked amount, include in case narrative. No CA required.	Wet Chemistry Analyst	Bias/Precision

Notes:

%: percent

LCS: laboratory control sample

mg/L: milligrams per liter

MS/MSD: matrix spike/ matrix spike duplicate

N/A: not applicable

RPD: relative percent difference

7.0 Data Management and Data Review

7.1 Worksheet #29: Project Documentation and Records

Project data and information will be documented, tracked, and managed in a manner to ensure data integrity, defensibility, and retrievability. Project records will be generated from various aspects of the project, including 1) Sample Collection and Field Measurement Records, 2) Analytical Records, and 3) Data Assessment Records. Project data and information are stored in the Fort Ord Administrative Record located at Building 4463, Room 101, Gigling Road, Seaside, California. The Administrative Record is managed by the Army and will be maintained until site closure, at which time disposition of site records will be determined by the Army.

7.1.1 Sample Collection and Field Measurement Records

At a minimum, the following documentation will be used for sample collection and field measurement activities. Examples of field forms are presented in Attachment C.

- <u>Field Activity Daily Logbook</u> – A bound, Field Activity Daily Logbook (FADL), with sequentially numbered pages will be used for field documentation of key sampling and analytical activities associated with the Sites 2/12 and OU2 GWTS and the Sites 2/12, OU2, and OUCTP GWMP. The FADL will contain information to include:
    - Name and company of sampling technician
    - Date, time, and location of sample collection
    - Site observations and remarks related to sampling activities
    - Field equipment calibration documentation
- <u>Groundwater Level Field Data Sheets</u> – are used to record depth to groundwater measurements, and include the following information:
    - Sampling station name, date, and time of measurement
    - Depth to water (DTW) sounder serial number and documented calibration differential from steel tape
    - Samplers initials
    - Measured depth to water
    - Historical average DTW and total depth of well which are used to verify the measured reading in the field
- <u>Groundwater Sampling Forms</u> – are used to record collection of groundwater samples. Groundwater samples from the Sites 2/12, OU2 and OUCTP GWMP are collected via PDBs, Westbay multi-port wells, and sampling ports, while samples from the Sites 2/12 and OU2 GWTS are primarily collected via sampling ports. Each of these sampling systems has a designated groundwater sampling form, specific to the data needed for each sampling method; however, each groundwater sampling form will contain the same essential information:

  - Name of sampling technician
  - Date and time of sample collection
  - Depth to water (where applicable)
  - Depth of sample collection (or port number, or bag number)
  - Method of sample collection
  - Volume of sample collected
  - Preservation of samples (if any)
  - Analysis requested
  - QC samples collected at the sampling station

- Sample Labels – Sample labels will be affixed to each sample container upon collection and prior to transfer to the laboratory. Each sample will be assigned a unique sample identification number. The sample label will include the following information:
  - Project name, number, and location
  - Site name
  - Name of collector
  - Date and time of collection
  - Sample identification number
  - Sample preservation

- Chain of Custody Forms - A chain of custody form will be completed for every sample collected and submitted to the analytical laboratory to document custody of the sample from the time of collection to receipt at the laboratory. Chain of custody forms will be completed in triplicate (at a minimum) so one copy is kept at the field site, one copy is sent to the Project Manager or designee, and one copy accompanies the samples submitted to the analytical laboratory. The laboratory will send the project chemist, or designee, a copy of the completed chain of custody along with a completed Cooler Receipt Form (CRF) and completed log-in information within 24 hours of sample receipt and log-in. The chain of custody will include the following information:
  - Name, number, and location of project
  - Project Manager or "Report to" contact
  - Name and signature of sample collector, sampler, or recorder
  - Date and time of sample collection
  - Sample type/matrix
  - Number of containers submitted and preservative used (if any)
  - Analyses requested and TAT requirements
  - Signature trail of persons relinquishing and receiving samples
  - Receiving laboratory address and contact information
  - Date and time of sample receipt

7.1.2 Analytical Records

The analytical laboratory will maintain and submit the following records as part of the data deliverable for each sample. These records together make up the Comprehensive Certificate of Analysis, which is a required deliverable to report results and is used in the data validation process.

- Chain of custody records
- Sample/Cooler Receipt Forms (SRFs/CRFs) documenting the general condition of the samples upon receipt including temperature, sample preservation, and number of containers received as well as any discrepancies or issues
- Sample tracking forms
- Sample preparation and analysis forms/logbooks
- Tabulated data summary forms and raw data for field samples, QC samples, and standards. If manual integration is performed on project samples, raw data to include chromatographs from before and after manual integration is applied. The case narrative will also address the reason manual integration was performed on each affected sample
- Case narrative
- Date and times of sample receipt, extraction, and analysis
- QC sample results
- Communication logs
- Corrective action reports
- Definitions of laboratory qualifiers
- Instrument calibration data and summary reports
- Signatures for laboratory sign-off

7.1.3 Project Data Assessment Records

Project data assessment records will be generated and submitted as part of the quarterly or annual reporting requirements for the Sites 2/12, OU2, OUCTP GWMP and the Sites 2/12 and OU2 GWTS as necessary. Project Data Assessment reports may be created at any time throughout the project, and typically consist of the following:

- Field Sampling Audit Report (if applicable)
- Laboratory Audit Report (if applicable)
- Data Validation Summary Report

7.2 Worksheets #31, #32, and #33: Assessments and Corrective Action

Planned project assessments will be completed for the Sites 2/12 and OU2 GWTS and Sites 2/12, OU2, and OUCTP GWMP through the Three Phase Quality Control Process, as follows:

- Preparatory Phase: Activities and assessments conducted during the preparatory phase are conducted prior to the start of a feature of work to ensure technical requirements and work prerequisites have been completed. Discrepancies will be resolved and corrective actions implemented and verified prior to the start of work.
- Initial Phase: Activities and assessments conducted during the initial phase are performed during the first day of the feature of work to verify compliance with the specifications and requirements described in this QAPP and approved project plans and procedures. Discrepancies will be resolved and corrective actions implemented and verified prior to work proceeding.
- Follow-Up and Reporting Phase: Activities and assessments performed during the follow-up and reporting phase are conducted to verify continued compliance with project requirements and to verify project reports meet client and regulatory requirements.

An overview of the Three Phase Quality Control Process and related forms used to document the process are provided in Attachment D. The activities and assessments conducted during each phase of the Three Phase Quality Control Process are described below.

7.2.1 Assessments and Corrective Action

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Organization)	Timeframe for Response
Phase I - Preparatory Phase						
Planning Document review	Internal Memo	Document Author	Prior to the start of field activities	Response to comments documentation and USACE approval of document as applicable	Derek Lieberman, PM, Ahtna Jeff Fenton, PM, Wood	One week
Planning document (QAPP) sign-off by field and laboratory	Memo	Scott Graham, Field Task Manager, Wood Mark Fisler, O&M Manager, Ahtna Elvin Kumar, PM, SGS	Prior to the start of field activities	Obtain sign-off that document has been read and understood by field and lab personnel	Christopher Ohland, Program Chemist, Ahtna Kevin Garrett, Project Chemist, Wood	One week
Review of lab and field personnel readiness	Memo	Scott Graham, Field Task Manager, Wood Mark Fisler, O&M Manager, Ahtna Elvin Kumar, PM, SGS	Prior to the start of field activities	Provide kickoff meeting notes from field and lab meetings	Christopher Ohland, Program Chemist, Ahtna Kevin Garrett, Project Chemist, Wood	One week
Review of field equipment	Memo	Scott Graham, Field Task Manager, Wood Mark Fisler, O&M Manager, Ahtna	Prior to the start of field activities	Provide checklist documenting field equipment is available and in good working order	Christopher Ohland, Program Chemist, Ahtna Kevin Garrett, Project Chemist, Wood	Prior to the start of field activities

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Organization)	Timeframe for Response
Phase II – Initial Phase						
Field and laboratory audit	Field and lab audit report	Scott Graham, Field Task Manager, Wood Mark Fisler, O&M Manager, Ahtna Elvin Kumar, PM, SGS Eric Schmidt, Project Chemist, Ahtna Jeff Fenton, PM, Wood Derek Lieberman, PM, Ahtna	Within 48 hours of audits	Field and laboratory to issue formal response to audit findings requiring corrective action	Christopher Ohland, Program Chemist, Ahtna Kevin Garrett, Project Chemist, Wood	One week
Review of Contractor QC Reports	Memo	Scott Graham, Field Task Manager, Wood Mark Fisler, O&M Manager, Ahtna Sylvester Kosowski, QC Manager, Ahtna	Within 48 hours of review	Revision of Contractor Quality Control Reports (CQCRs) as needed	Derek Lieberman, PM, Ahtna Jeff Fenton, PM, Wood	One week

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title, Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title, Organization)	Timeframe for Response
Review of project plans to reflect current site or lab activities	Memo	Holly Dillon, Task Lead, Ahtna Scott Graham, Field Task Manager, Wood Mark Fisler, O&M Manager, Ahtna Elvin Kumar, PM SGS	Within 10 days of observations	Update project plans to reflect current conditions (may be addendum to existing document) or documentation of changes to field or lab protocol to be in accordance with project plans	Derek Lieberman, PM, Ahtna Jeff Fenton, PM, Wood	Prior to next scheduled sampling event
Phase III – Follow-Up and Reporting Phase						
Review of Data Reports	Internal comments from staff and external comments from client and regulatory agencies	Document Author Derek Lieberman, PM, Ahtna Jeff Fenton, PM, Wood	Internal = prior to issuance of report External = within 30 days of receipt of report	Provide response to comments and revise report as needed	Commenting client and/or agencies Alex Kan, Technical Lead, USACE	30 days

7.2.2 QA Management

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Sites 2/12 GWMP and GWTS O&M Reports	Quarterly	Final 60 days after end of quarterly sampling event	Derek Lieberman, PM, Ahtna Holly Dillon, Task Lead, Ahtna	USACE: Dana Gentry – PM, Jonathan Whipple – Project Chemist, Alex Kan – Technical Lead Fort Ord BRAC: William Collins – BEC Chenega: Tom Ghigliotto – Field Oversight Inspector Fort Ord Administrative Record EPA: Maeve Clancy – PM TechLaw: Robert Young CCRWQCB: Amber Sellinger – PM DTSC: Min Wu – PM
	Annually	Preliminary Draft 75 days after end of annual sampling event		
OU2 GWMP and GWTS O&M Reports	Quarterly	Final 60 days after end of quarterly sampling event	Derek Lieberman, PM, Ahtna Holly Dillon, Task Lead, Ahtna	
	Annually	Preliminary Draft 75 days after end of annual sampling event		
OUCTP GWMP Reports	Quarterly	Final 60 days after end of quarterly sampling event	Derek Lieberman, PM, Ahtna Holly Dillon, Task Lead, Ahtna	
	Annually	Preliminary Draft 75 days after end of annual sampling event		
CQCR	Quarterly, following each sampling event	Within 60 days of completion of field sampling event	Jeff Fenton, Project Manager, Wood	USACE: Dana Gentry – PM, Jonathan Whipple – Project Chemist, Alex Kan– Technical Lead Chenega: Tom Ghigliotto – Field Oversight Inspector Ahtna: Derek Lieberman, Project Manager

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (Title and Organizational Affiliation)	Report Recipient(s) (Title and Organizational Affiliation)
Non-Routine Occurrences Report	As needed	Within 48 hours of a Non-Routine Occurrence in the field or laboratory. A copy of this report will also be included in the CQCR	Kevin Garrett, Project Chemist, Wood	USACE: Dana Gentry – PM, Jonathan Whipple – Project Chemist, Alex Kan– Technical Lead Chenega: Tom Ghigliotto – Field Oversight Inspector Ahtna: Christopher Ohland, Program Chemist Wood: Jeff Fenton, PM
Field Work Variance Report	As needed	Prior to implementation of proposed change or immediately following a variance implemented in the field. A copy of the Field Work Variance will also be included in the CQCR	Scott Graham, Field Task Manager, Wood	USACE: Dana Gentry – PM, Jonathan Whipple – Project Chemist, Alex Kan- Technical Lead Ahtna: Derek Lieberman - PM, Christopher Ohland - Program Chemist Wood: Jeff Fenton - PM, Kevin Garrett - Project Chemist Chenega: Tom Ghigliotto – Field Oversight Inspector
Validation Summary Report	Quarterly, following each sampling event	Produced as part of the Quarterly Monitoring Report	Kevin Garrett, Project Chemist, Wood	USACE: Dana Gentry – PM, Jonathan Whipple – Project Chemist, Alex Kan– Technical Lead Fort Ord BRAC: William Collins – BEC Fort Ord Administrative Record EPA: Maeve Clancy – PM TechLaw: Robert Young CCRWQCB: Amber Sellinger – PM DTSC: Min Wu – PM

7.3 Worksheet #34: Data Verification and Validation Inputs

Verification Input	Description	Internal / External	Responsible for Verification (Name, Organization)
Chain of custody and shipping forms	Chain of custody forms will be reviewed internally upon their completion and verified against the packed sample coolers they represent. When everything is verified, the shipper's signature on the chain of custody form will be initialed by the reviewer. A copy of the form will be retained in the site file, and the original and remaining copies will be taped inside the cooler for shipment. Refer to Attachment A for SOPs #4 and #7 for further detail.	I	Sites 2/12 and OU2 GWTS: Mark Fisler, O&M Manager, Ahtna
			Sites 2/12, OU2, OUCTP GWMP: Scott Graham, Field Task Manager, Wood
	Receiving laboratory will verify chain of custody forms with contents of coolers. Wood project chemist will be notified of any discrepancies or issues within 24 hours of sample receipt. Resolution will be documented in writing and submitted with final data package.	E	Elvin Kumar, Project Manager, SGS Laboratory
	Laboratory receipt/log-in report will be reviewed against chain of custody internally.	I	Sites 2/12 and OU2 GWTS: Holly Dillon, Data Manager, Ahtna Sites 2/12, OU2, OUCTP GWMP Zack Carroll, Data Validator, Wood
Field Notes	Field notes will be reviewed internally by the field supervisor for consistency with the chain of custody forms and SOPs. One copy of the field notes will be retained in the onsite project file, and originals will be forwarded to the Project Manager for review.	I	Sites 2/12, OU2 GWTS: Mark Fisler, O&M Manager, Ahtna Sites 2/12, OU2, OUCTP GWMP: Scott Graham, Field Task Manager, Wood

Verification Input	Description	Internal / External	Responsible for Verification (Name, Organization)
Laboratory Data	Analytical data packages will be verified by the laboratory performing the work for completeness prior to submittal.	I	Svetlana Izosimova, Quality Assurance Officer, SGS
	Received data packages will be verified according to the data validation procedures specified in Worksheet #35. Laboratory electronic deliverables will be verified against the data package hard copy reports.	I	Sites 2/12, OU2 GWTS: Christopher Ohland, Program Chemist, Ahtna Sites 2/12, OU2, OUCTP GWMP: Zack Carroll, Project Database Analyst, Wood

7.4 Worksheet #35: Data Verification Procedures

Stage 2A/2B	**Validation Input**	**Description**	**Responsible for Verification – GWTS**	**Responsible for Verification – GWMP**
2A	Methods used for sample collection	Field data notes will be reviewed for compliance with published methods and SOPs. Deviations from SOPs and methods described in this QAPP will be summarized and provided to the Project Manager in writing.	Mark Fisler, O&M Manager, Ahtna	Scott Graham, Field Task Manager, Wood
2A	Methods used for analysis	Laboratory data packages will be reviewed to verify the methods specified in this QAPP were followed. Deviations shall be documented in writing.	Eric Schmidt, Project Chemist, Ahtna	Zack Carroll, Project Database Analyst, Wood
2A	Sampling SOPs and Analytical Compliance	Review field notes for compliance with SOPs. Review laboratory data deliverables for compliance with QAPP and published methods.	Mark Fisler, O&M Manager, Ahtna Eric Schmidt, Project Chemist, Ahtna	Scott Graham, Field Task Manager, Wood Zack Carroll, Project Database Analyst, Wood
2A	Documentation of method QC results	Review laboratory data packages to determine if QC parameters required by the referenced methods were performed and reported. The QC forms will be reviewed to determine if method acceptance criteria were met. Method QC outliers will be identified by the laboratory in the case narrative. Reviewer will determine if data will require qualification due to outliers.	Eric Schmidt, Project Chemist, Ahtna	Zack Carroll, Project Database Analyst, Wood
2B	Documentation of QAPP QC sample results	Verify QC samples specified in this QAPP were analyzed and reported. Reviewer will identify QAPP QC sample results in the data validation report.	Eric Schmidt, Project Chemist, Ahtna	Zack Carroll, Project Database Analyst, Wood

Stage 2A/2B	Validation Input	Description	Responsible for Verification – GWTS	Responsible for Verification – GWMP
2B	Laboratory data package documentation	Laboratory data packages will be reviewed to ensure documentation requirements specified in the QAPP have been met. If deficiencies are found, the Data Reviewer will document the issue in a memorandum to the laboratory. The laboratory will address deficiencies in writing or submit a revised data package correcting the deficiencies.	Christopher Ohland, Program Chemist, Ahtna	Zack Carroll, Project Database Analyst, Wood
2B	Target analyte list	Laboratory report summary forms will be reviewed to verify the target compounds and parameters specified in the QAPP were reported.	Christopher Ohland, Program Chemist, Ahtna	Zack Carroll, Project Database Analyst, Wood
2B	LOQs	Determine quantitation limits were achieved, as outlined in the QAPP. Verify the laboratory analyzed a low standard at the quantitation limit in the initial calibration.	Christopher Ohland, Program Chemist, Ahtna	Zack Carroll, Project Database Analyst, Wood
2A	Raw data and laboratory transcription errors	Ten percent (10%) of raw data will be reviewed to confirm laboratory calculations and that there are no transcription errors. Chromatographs containing manual integrations, if any, will be evaluated as part of the raw data review.	Christopher Ohland, Program Chemist, Ahtna	Zack Carroll, Project Database Analyst, Wood
2A and 2B	Data Validation Report	Summarize deviations from the referenced methods, SOPS, and QAPP-specific requirements. Include qualified data and explanations of all data qualifiers.	Christopher Ohland, Program Chemist, Ahtna	Zack Carroll, Wood
2A and 2B	Data Validation Report Review	Review validation reports and Validation Summary Report.	Christopher Ohland, Program Chemist, Ahtna	Kevin Garrett Project Chemist, Wood

7.5 Worksheet #36: Data Validation Procedures

Stage 2A/2B	**Matrix**	**Analytical Group**	**Validation Criteria**	**GWTS Validator**	**GWMP Validator**
2A	Aqueous	VOCs	EM-200-1-10. *Guidance for Evaluating Performance-based Chemical Data* (USACE, June 2005) and SW-846 Method 8260-SIM	Eric Schmidt, Project Chemist, Ahtna	Zack Carroll, Project Database Analyst, Wood
2B	Aqueous	VOCs	QAPP Worksheets and ADR Library	Eric Schmidt, Project Chemist, Ahtna	Zack Carroll, Project Database Analyst, Wood
2A	Aqueous	Dissolved metals	EM-200-1-10 and SW-846 Method 6010D	Eric Schmidt, Project Chemist, Ahtna	Zack Carroll, Project Database Analyst, Wood
2B	Aqueous	Dissolved Metals	QAPP Worksheets and ADR Library	Eric Schmidt, Project Chemist, Ahtna	Zack Carroll, Project Database Analyst, Wood
2A	Aqueous	Wet Chemistry	EM-200-1-10, EPA Method 9056A (chloride)	Eric Schmidt, Project Chemist, Ahtna	Zack Carroll, Project Database Analyst, Wood
2B	Aqueous	Wet Chemistry	QAPP Worksheets and ADR Library	Eric Schmidt, Project Chemist, Ahtna	Zack Carroll, Project Database Analyst, Wood

Notes:
ADR: Automated Data Review program

7.5.1 Stage 1 Validation

Stage 1 validation of the laboratory analytical data package consists of verification and validation checks for the compliance of sample receipt conditions, sample characteristics (e.g., percent moisture), and analytical results (with associated information). The following minimum baseline checks (as relevant) will be performed on the laboratory analytical data package received for a Stage 1 validation:

1) Documentation identifies the laboratory receiving and conducting analyses and includes documentation for all samples submitted by the project or requester for analyses.
2) Requested analytical methods were performed and the analysis dates are present.
3) Requested target analyte results are reported along with the original laboratory data qualifiers and data qualifier definitions for each reported result.
4) Requested target analyte result units are reported.
5) Requested LOQs for all samples are present and results at and below the requested (required) LOQs are clearly identified (including sample DLs if required).
6) Sampling dates (including times if needed), date and time of laboratory receipt of samples, and sample conditions upon receipt at the laboratory (including preservation, pH, and temperature) are documented.
7) Sample results are evaluated by comparing sample conditions upon receipt at the laboratory (e.g., preservation checks) and sample characteristics (e.g., percent moisture) to the requirements and guidelines present in national or regional data validation documents, analytical method(s) or contract.

7.5.2 Stage 2A Validation

Stage 2A validation builds on the validation conducted in Stage 1. Stage 2A validation of the laboratory analytical data package consists of the Stage 1 validation plus the verification and validation checks for the compliance of sample-related QC. The following additional minimum baseline checks (as relevant) will be performed on the laboratory analytical data package received for a Stage 2A validation:

1) Requested methods (handling, preparation, cleanup, and analytical) are performed.
2) Method dates (including dates, times and duration of analysis for radiation counting measurements and other methods, if needed) for handling (e.g., Toxicity Characteristic Leaching Procedure), preparation, cleanup, and analysis are present, as appropriate.
3) Sample-related QC data and QC acceptance criteria (e.g., method blanks, surrogate recoveries, laboratory control sample (LCS) recoveries, duplicate analyses, matrix spike and matrix spike duplicate recoveries, serial dilutions, post-digestion spikes, standard reference materials) are provided and linked to the reported field samples (including the field QC samples such as trip and equipment blanks).
4) Requested spike analytes or compounds (e.g., surrogate, LCS spikes, post-digestion spikes) have been added, as appropriate.
5) Sample holding times (from sampling date to preparation and preparation to analysis) are evaluated.

6) The frequency of QC samples is checked for appropriateness (e.g., one LCS per 20 samples in a preparation batch).
7) Sample results are evaluated by comparing holding times and sample-related QC data to the requirements and guidelines present in national or regional data validation documents, analytical method(s) or contract.

7.5.3 Stage 2B Validation

Stage 2B validation builds on the validation conducted in Stage 2A. Stage 2B validation of the laboratory analytical data package consists of the Stage 2A validation plus the verification and validation checks for the compliance of instrument-related QC. The following additional minimum baseline checks (as relevant) will be performed on the laboratory analytical data package received for a Stage 2B validation:

1) Initial calibration data (e.g., initial calibration standards, initial calibration verification [ICV] standards, initial calibration blanks [ICBs]) are provided for all requested analytes and linked to field samples reported. For each initial calibration, the calibration type used is present along with the initial calibration equation used including any weighting factor(s) applied and the associated correlation coefficients, as appropriate. Recalculations of the standard concentrations using the initial calibration curve are present, along with their associated percent recoveries, as appropriate (e.g., if required by the project, method, or contract). For the ICV standard, the associated percent recovery (or percent difference, as appropriate) is present.
2) Appropriate number and concentration of initial calibration standards are present.
3) Continuing calibration data (e.g., continuing calibration verification [CCV] standards and continuing calibration blanks [CCBs]) are provided for all requested analytes and linked to field samples reported, as appropriate. For the CCV standard(s), the associated percent recoveries (or percent differences, as appropriate) are present.
4) Reported samples are bracketed by CCV standards and CCBs standards as appropriate.
5) Method specific instrument performance checks are present as appropriate (e.g., tunes for mass spectrometry methods, instrument blanks and interference checks for ICP methods).
6) The frequency of instrument QC samples is checked for appropriateness (e.g., gas chromatography-mass spectroscopy [GC-MS] tunes have been run every 12 hours).
7) Sample results are evaluated by comparing instrument-related QC data to the requirements and guidelines present in national or regional data validation documents, analytical method(s) or contract.

Metals and Wet Chemistry analyses are also reviewed under Stage 2B validation using a combination of criteria from the DoD QSM (where provided) and laboratory performance-based in-house acceptance criteria.

VOC data are used to evaluate compliance with the relevant ROD and ACLs for each of the GWTS. As a result, the VOC data are subject to a rigorous 100% EPA Stage 2B data review (EPA, 2009) to verify data are of a known quality in compliance with this QAPP, the *Department of Defense Quality Systems*

Manual for Environmental Laboratories, Final Version 5.1, the published analytical methods, and are capable of supporting project decisions.

Stage 2B review is performed using the automated data review software program ADR.NET. Flagging conventions for the test methods included in the QAPP are incorporated with the ADR program's reference library (Attachment E) to assess compliance with project requirements. The ADR program is used as an electronic validation tool for the following Stage 2B elements:

- Holding Times
- Instrument Performance Checks
- Method Blank Contamination
- Surrogates
- Laboratory Duplicates
- Laboratory Control Samples
- Matrix Spike Samples
- Field Blank Contamination
- Field Duplicates
- Initial and Continuing Calibration Data

Initial and continuing calibration files for each test method may need to be validated manually if the contract library is unable to provide electronic validation files.

The Data Reviewer checks the ADR-generated Non-Conformance Report, identifying items that do not conform to the ADR Project Library requirements, and the results are incorporated into the assessment of the data.

The Data Reviewer proceeds with the review of the ADR files in the ADR Data Review module. The ADR Data Review module identifies outliers and applies validation qualifiers to the data based on the ADR Project Library data review requirements. The ADR Library qualification scheme files are provided as Attachment E.

The Data Reviewer then reviews the ADR output, comparing the ADR findings with the lab reports to ensure the automated validation process is working accurately. The Data Reviewer may manually edit the validation qualifiers based on his or her professional judgment, which will be described in the Validation Summary Report. Flagging conventions used for data qualification are presented in Attachment E.

7.5.4 Stage 3 Validation

Stage 3 validation builds on the validation conducted in Stage 2B. Stage 3 validation of the laboratory analytical data package consists of the Stage 2B validation plus the recalculation of instrument and sample results from the laboratory instrument responses, and comparison of recalculated results to laboratory reported results. The following additional minimum baseline checks (as relevant) will be performed on the laboratory analytical data package received for a Stage 3 validation:

1) Instrument response data (e.g., GC peak areas, ICP corrected intensities) are reported for requested analytes, surrogates, internal standards, and deuterated monitoring compounds for all requested field samples, matrix spikes, matrix spike duplicates, LCS, and method blanks as well as calibration data and instrument QC checks (e.g., tunes, DDT/Endrin breakdowns, interelement correction factors, and Florisil cartridge checks).
2) Reported target analyte instrument responses are associated with appropriate internal standard analyte(s) for each (or selected) analyte(s) (for methods using internal standard for calibration).
3) Fit and appropriateness of the initial calibration curve used or required (e.g., mean calibration factor, regression analysis [linear or non-linear, with or without weighting factors, with or without forcing]) is checked with recalculation of the initial calibration curve for each (or selected) analyte(s) from the instrument response.
4) Comparison of instrument response to the minimum response requirements for each (or selected) analyte(s).
5) Recalculation of each (or selected) opening and closing CCV (and CCB) response from the peak data reported for each (or selected) analyte(s) from the instrument response, as appropriate.
6) A compliance check of recalculated opening and/or closing CCV (and CCB) response to recalculated initial calibration response for each (or selected) analyte(s).
7) Recalculation of percent ratios for each (or selected) tune from the instrument response, as appropriate.
8) A compliance check of recalculated percent ratio for each (or selected) tune from the instrument response.
9) Recalculation of each (or selected) instrument performance check (e.g., DDT/Endrin breakdown for pesticide analysis, instrument blanks, interference checks) from the instrument response.
10) Recalculation and compliance check of retention time windows (for chromatographic methods) for each (or selected) analyte(s) from the laboratory reported retention times.
11) Recalculation of reported results for each reported (or selected) target analyte(s) from the instrument response.
12) Recalculation of each (or selected) reported spike recovery (surrogate recoveries, deuterated monitoring compound recoveries, LCS recoveries, duplicate analyses, MS/MSD recoveries, serial dilutions, post-digestion spikes, standard reference materials etc.) from the instrument response.
13) Each (or selected) sample result(s) and spike recovery(ies) are evaluated by comparing the recalculated numbers to the laboratory reported numbers according to the requirements and guidelines present in national or regional data validation documents, analytical method(s) or contract.

Selection of analytes, spikes, and performance evaluation checks for the Stage 3 validation checks for a laboratory analytical data package being verified and validated generally will depend on many factors including (but not limited to) the type of verification and validation being performed (manual or electronic), requirements and guidelines present in national or regional data validation documents, analytical method(s) or contract, the number of laboratories reporting the data, the number and type of analytical methods reported, the number of analytes reported in each method, and the number of detected analytes.

7.5.5 Stage 4 Validation

10% of the data are subject to Stage 4 data review, which builds on the validation conducted in Stage 3. Stage 4 validation of the laboratory analytical data package consists of the Stage 3 validation plus the evaluation of instrument outputs. It is recommended that the following additional minimum baseline checks (as relevant) be performed on the laboratory analytical data package received for a Stage 4 validation:

1) All required instrument outputs (e.g., chromatograms, mass spectra, atomic emission spectra, instrument background corrections, and interference corrections) for evaluating sample and instrument performance are present.
2) Sample results are evaluated by checking each (or selected) instrument output (e.g., chromatograms, mass spectra, atomic emission spectra data, instrument background corrections, interference corrections) for correct identification and quantitation of analytes (e.g., peak integrations, use of appropriate internal standards for quantitation, elution order of analytes, and interferences).
3) Each (or selected) instrument's output(s) is evaluated for confirmation of non-detected or tentatively identified analytes.

In the event the findings of the Stage 4 validation indicate the potential for other reported results to be impacted by quality related issues, the Stage 4 validation may be expanded to include additional samples.

7.6 Worksheet #37: Data Usability Assessment

The suitability of the environmental data collected from both the Sites 2/12 and OU2 GWTS and the Sites 2/12, OU2, and OUCTP GWMP will be assessed by the Ahtna Project Chemist and the Wood Project Chemist, respectively. Data usability will comprise an evaluation of the quantity, type, and overall quality of the generated data against the project DQOs as presented in Worksheet #11 and the MPC presented in Worksheet #12. The usability of data associated with QC results outside of the established acceptance criteria is dependent on the degree of the exceedance, whether the potential bias is high or low, and whether the uncertainty implied by the exceedance is significant relative to project decisions and DQOs. Data usability will be assessed in accordance with the guidance provided in the DoD QSM Version 5.1 and additional applicable USACE and EPA guidance as well as the professional experience of the decision maker during data validation. The following items will be assessed and conclusions are drawn based on their results:

- **Precision** – Duplicate field and laboratory samples will be evaluated for precision based on relative percent difference (RPD). RPD will be calculated for each detectable result between the two samples. RPDs exceeding MPC in Worksheet #12 will be identified in the Validation Summary Report and any limitations on the use of the data will be noted. RPDs within the MPC will demonstrate the data have acceptable precision and the data are usable.
- **Accuracy** – Laboratory Control Samples (LCS), Laboratory Control Sample Duplicate (LCSD), MS/MSD sample results will be evaluated by comparing spike recovery results with MPC in Worksheet #12.
- **Sensitivity** – Data sensitivity will be verified by comparing method blank results with MPC in Worksheet #12 and cross checking analyte data with limits of quantitation (LOQs) and ACLs presented in Worksheet #15a.
- **Bias** – Laboratory surrogate compound recovery will be evaluated for bias by comparing results with MPC in Worksheet #12.
- **Contamination** – Field blank, trip blank and method blank data will be used to determine whether there are contamination issues based upon MPC in Worksheet#12.
- **Representativeness** – Sampling procedures will be implemented in accordance with SOPs to eliminate or minimize sources of error. Compliance with SOPs will be confirmed through QC field audits. Analytical procedures will be implemented in accordance with laboratory SOPs, QC acceptance limits, and the laboratory Quality Assurance Manual. Laboratories used for sample analysis will maintain DoD ELAP certification and undergo annual audits by the independent accrediting bodies responsible for the DoD ELAP certification.
- **Completeness** – The completeness of the sample event will be determined based upon the number of field samples collected compared to the number of samples planned and the number of unqualified laboratory results compared to the total number of results.[20] This information will be compared to MPC in Worksheet #12.

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[20] Results qualified as estimated due to detected quantities between the LOQ and LOD will not be counted in the analytical completeness quantity assessment.

- **Comparability** – The data from each sampling event are comparable to past and future events as long as the same or similar sampling and analytical SOPs located in Attachment A are utilized.
- **Reconciliation** – Each of the DQOs presented in Worksheet #11 will be examined to determine whether the objectives were met. This examination will include a combined overall assessment of the results of each analysis pertinent to an objective. Each analysis will be first evaluated separately in terms of the major impacts observed from the data validation, DQIs, and MPC assessments. Based on the results of these assessments, the quality of the data will be determined. Based on the quality, data usability for each analysis will be determined. Based on the combined data usability from all analyses for an objective, it will be determined whether the DQO was met and whether action limits were exceeded.

In the event the data quantity or quality prove to be inadequate to meet project objectives, re-analysis or re-sampling may be required. Replacement samples may be collected when existing data are insufficient or inadequate to support project objectives. The decision to take replacement samples will be made in coordination with the project team and may include USACE, Ahtna or Wood Project Managers, and the Ahtna Program Chemist or Wood Project Chemist.

Usability of the data will be presented in the Validation Summary Report, included with each Quarterly Monitoring Report. Copies of the associated data validation reports will be presented as an attachment to the Validation Summary Report. The Validation Summary Report will contain the following information:

- Basic summary of validation results, including a summary of data qualified with validation flags as listed in Attachment E
- Summary of deviations from the QAPP
- Summary of rejected data that resulted in a data gap
- Summary of points that went into the reconciliation of each objective
- Comments on recovery issues with the MS/MSDs
- Comments on limitations on the data usability
- Comments on corrective action needed and/or taken
- Conclusions and recommendations

8.0 References[21]

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[21] At the end of references included in the Fort Ord Administrative Record are the Administrative Record Numbers (AR#s) (e.g. BW-1234). To find the referenced document, this number may be typed into the online search tool at: http://www.fortordcleanup.com/documents/search/. Please note the referenced documents were available in the Fort Ord Administrative Record at the time this document was issued; however, some may have been superseded by more current versions and were subsequently withdrawn. TBD: to be determined.

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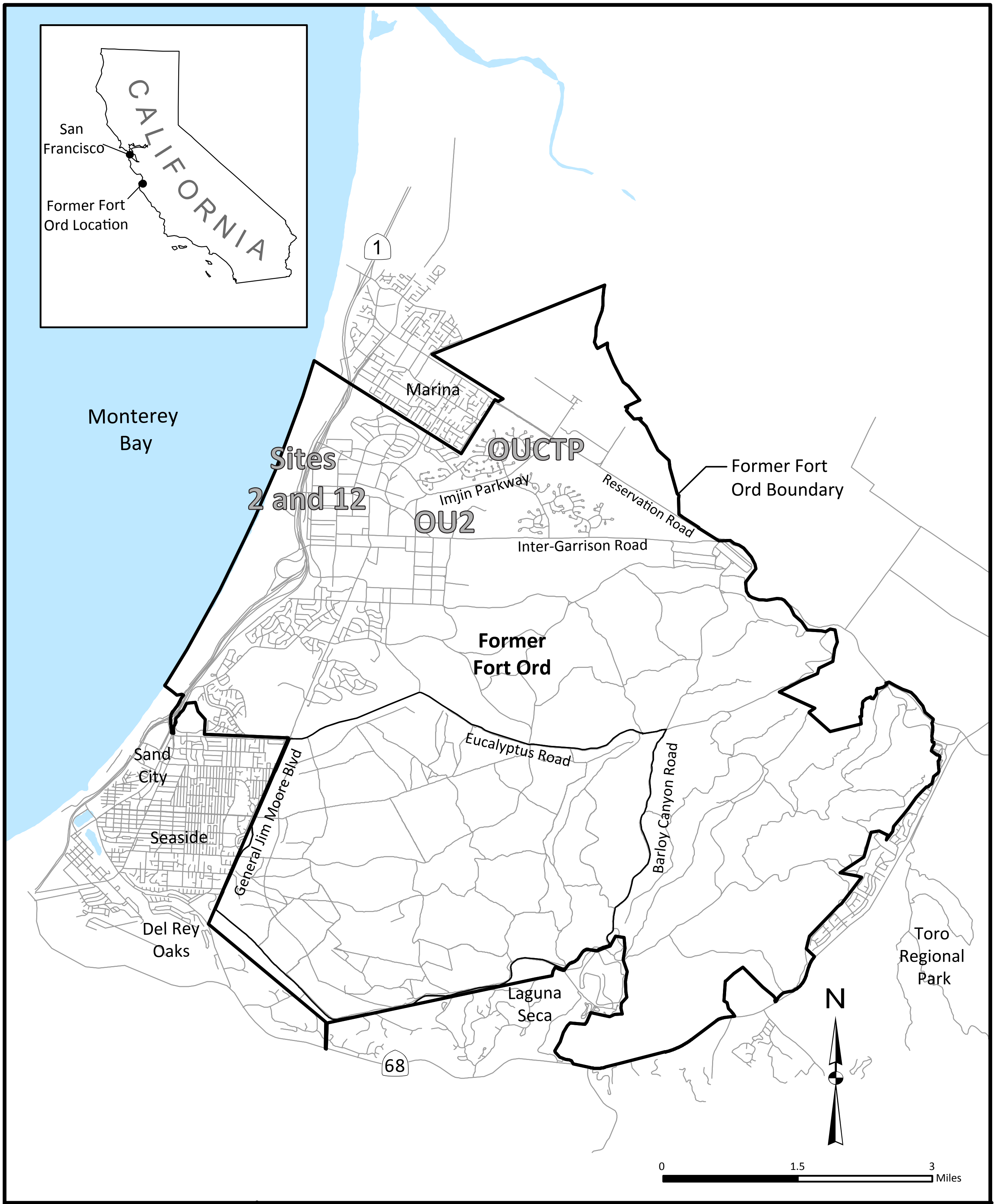
FIGURES



Ahtna

Former Fort Ord Location Map

Quality Assurance Project Plan, Former Fort Ord, California, Volume 1, Appendix A
Revision 7, Groundwater Remedies and Monitoring at Operable Unit 2,
Sites 2 and 12, and Operable Unit Carbon Tetrachloride Plume

Figure:

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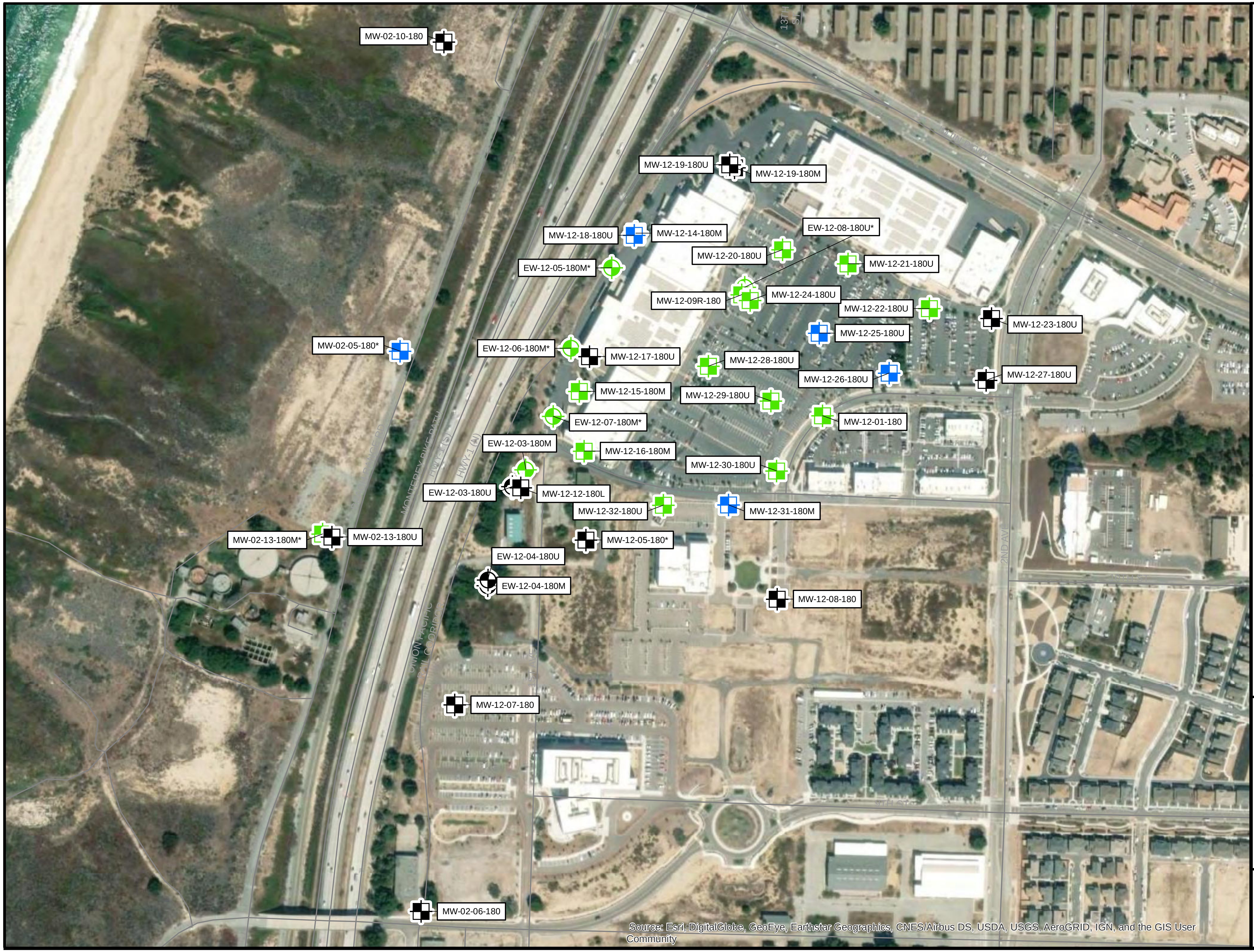

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

— Roads

Sites 2/12 Wells 2019-2Q

Well Type and Sample Schedule

- Extraction Well - Quarterly VOCs
- Monitoring Well - Quarterly VOCs
- Monitoring Well - Annual VOCs
- Extraction Well - Water Levels
- Monitoring Well - Water Levels

*Annual chloride sample collected

N

0 100 200 400 Feet

Sites 2/12 Groundwater Monitoring Program Sampling Locations

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 7
Groundwater Remedies and Monitoring
at Operable Unit 2, Sites 2 and 12,
and Operable Unit Carbon Tetrachloride Plume

Ahtna

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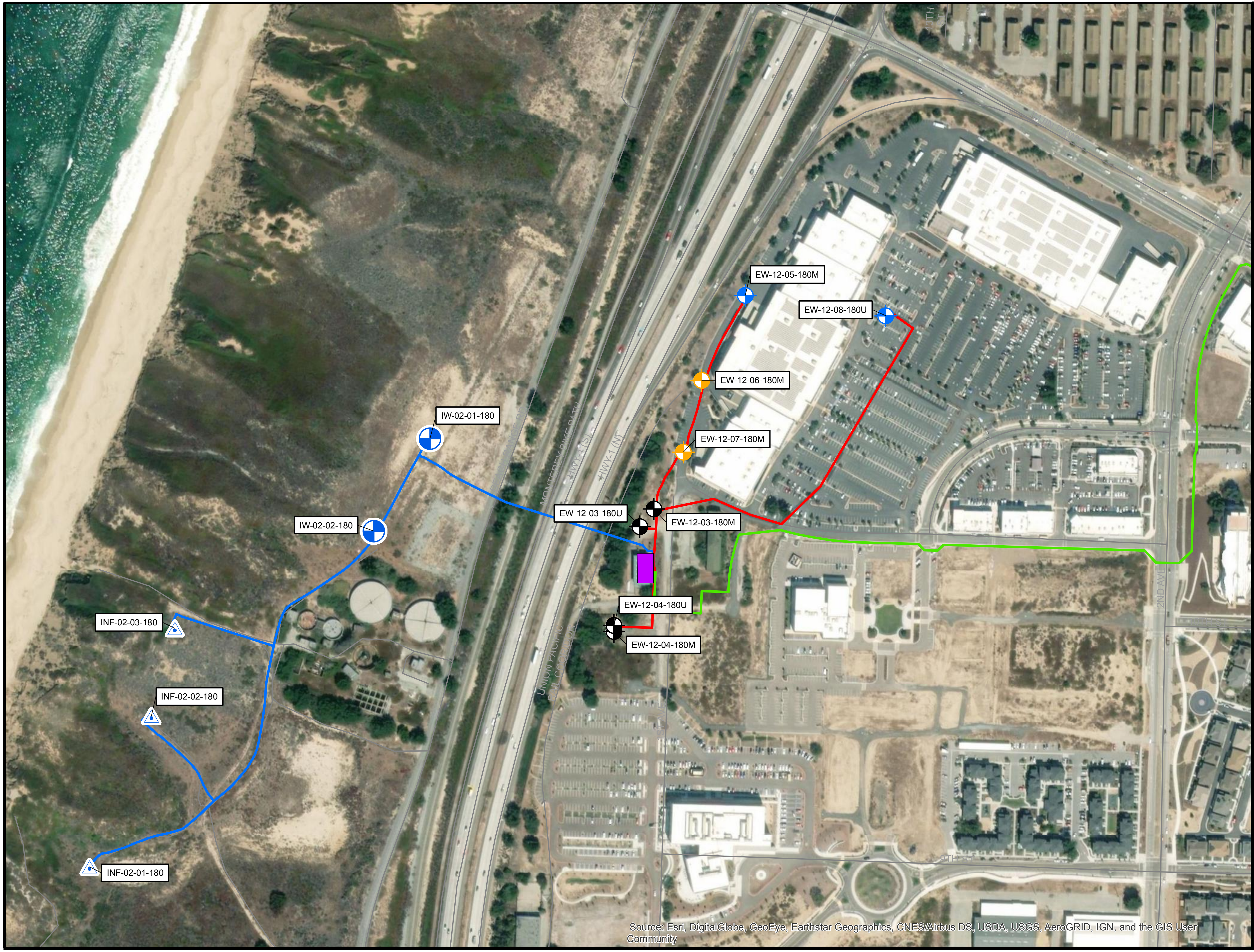

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Sites 2/12 Groundwater Remedy Map

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 7
Groundwater Remedies and Monitoring
at Operable Unit 2, Sites 2 and 12,
and Operable Unit Carbon Tetrachloride Plume

Ahtna

Figure:
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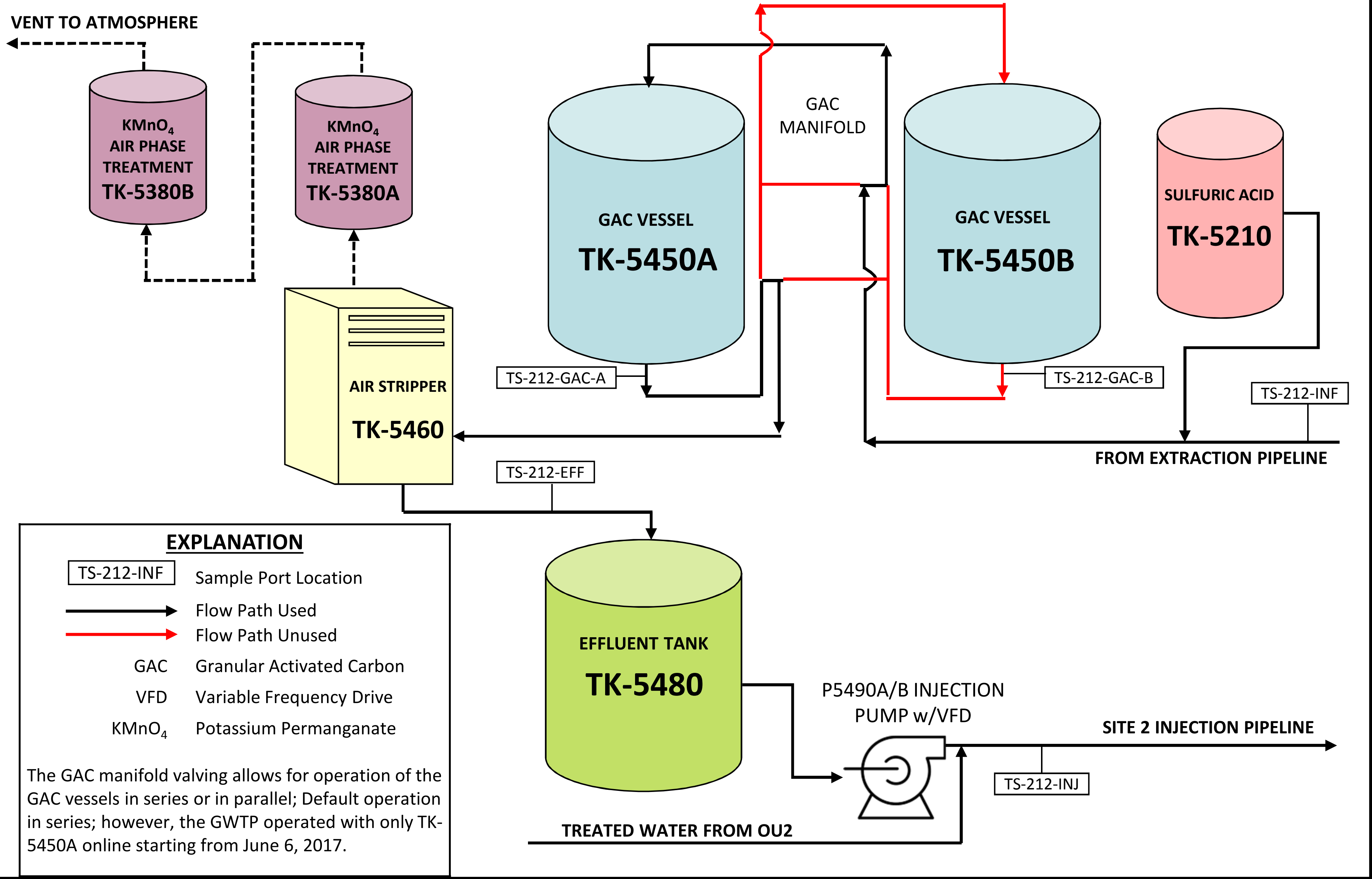

EXPLANATION

TS-212-INF	Sample Port Location
→	Flow Path Used
→	Flow Path Unused
GAC	Granular Activated Carbon
VFD	Variable Frequency Drive
$KMnO_4$	Potassium Permanganate

The GAC manifold valving allows for operation of the GAC vessels in series or in parallel; Default operation in series; however, the GWTP operated with only TK-5450A online starting from June 6, 2017.

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Sites 2/12 Groundwater Treatment Plant Schematic

Quality Assurance Project Plan, Former Fort Ord, California, Volume I, Appendix A, Revision 7
Groundwater Remedies and Monitoring at Operable Unit 2, Sites 2 and 12, and
Operable Unit Carbon Tetrachloride Plume

Figure:

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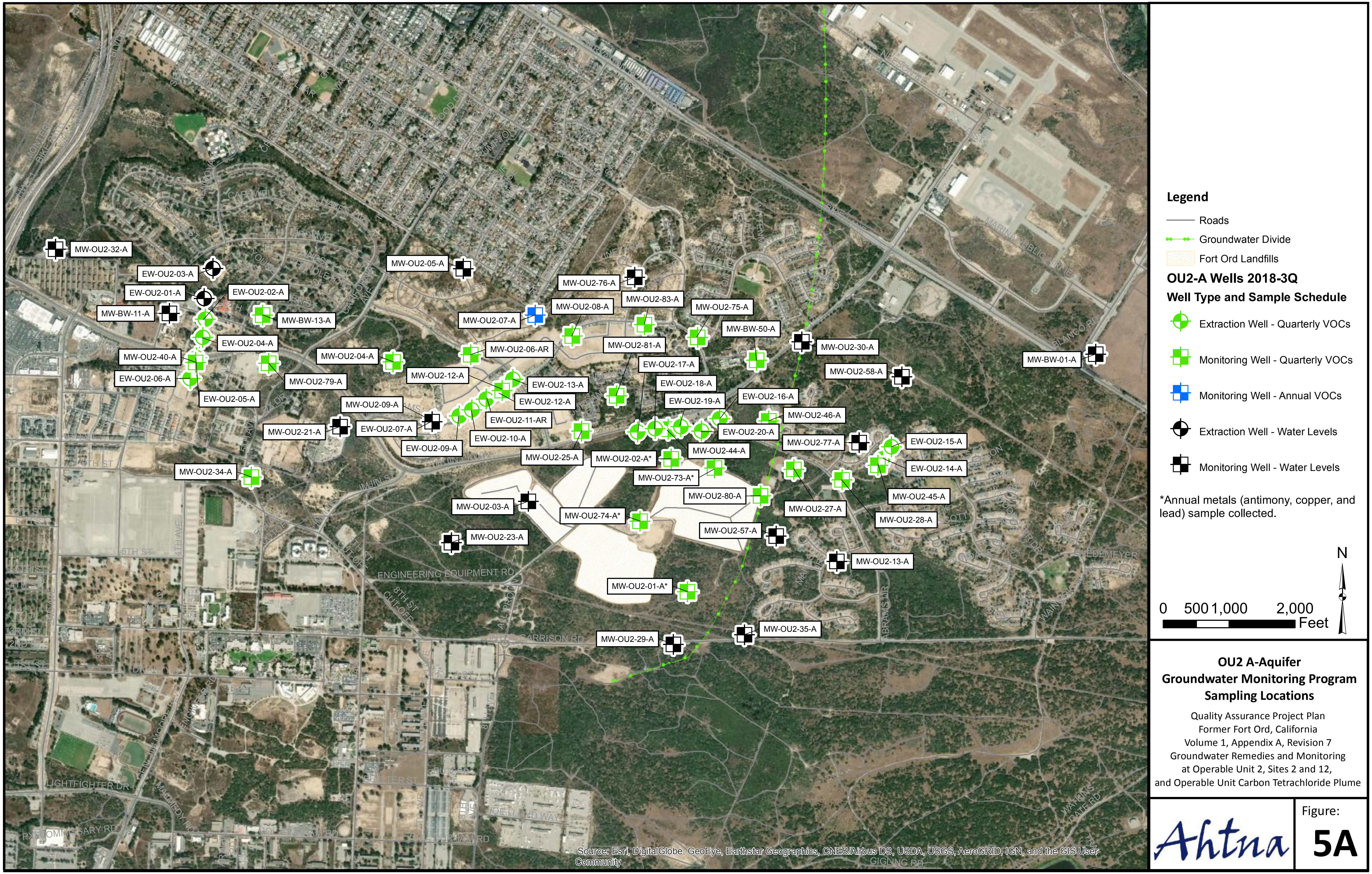

OU2 A-Aquifer
Groundwater Monitoring Program
Sampling Locations

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 7
Groundwater Remedies and Monitoring
at Operable Unit 2, Sites 2 and 12,
and Operable Unit Carbon Tetrachloride Plume

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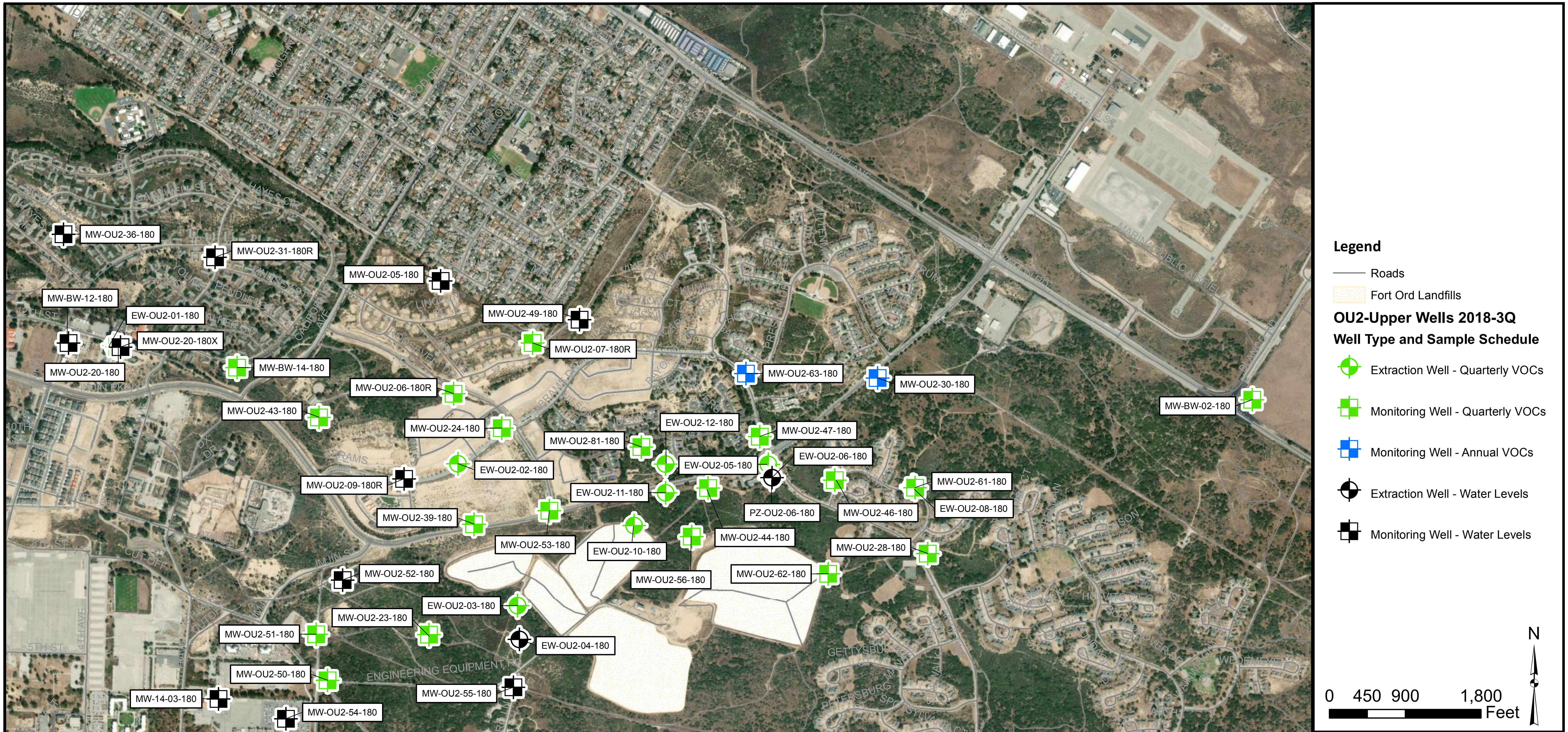

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OU2 Upper 180-Foot Aquifer Groundwater Monitoring Program Sampling Locations

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 7
Groundwater Remedies and Monitoring
at Operable Unit 2, Sites 2 and 12,
and Operable Unit Carbon Tetrachloride Plume

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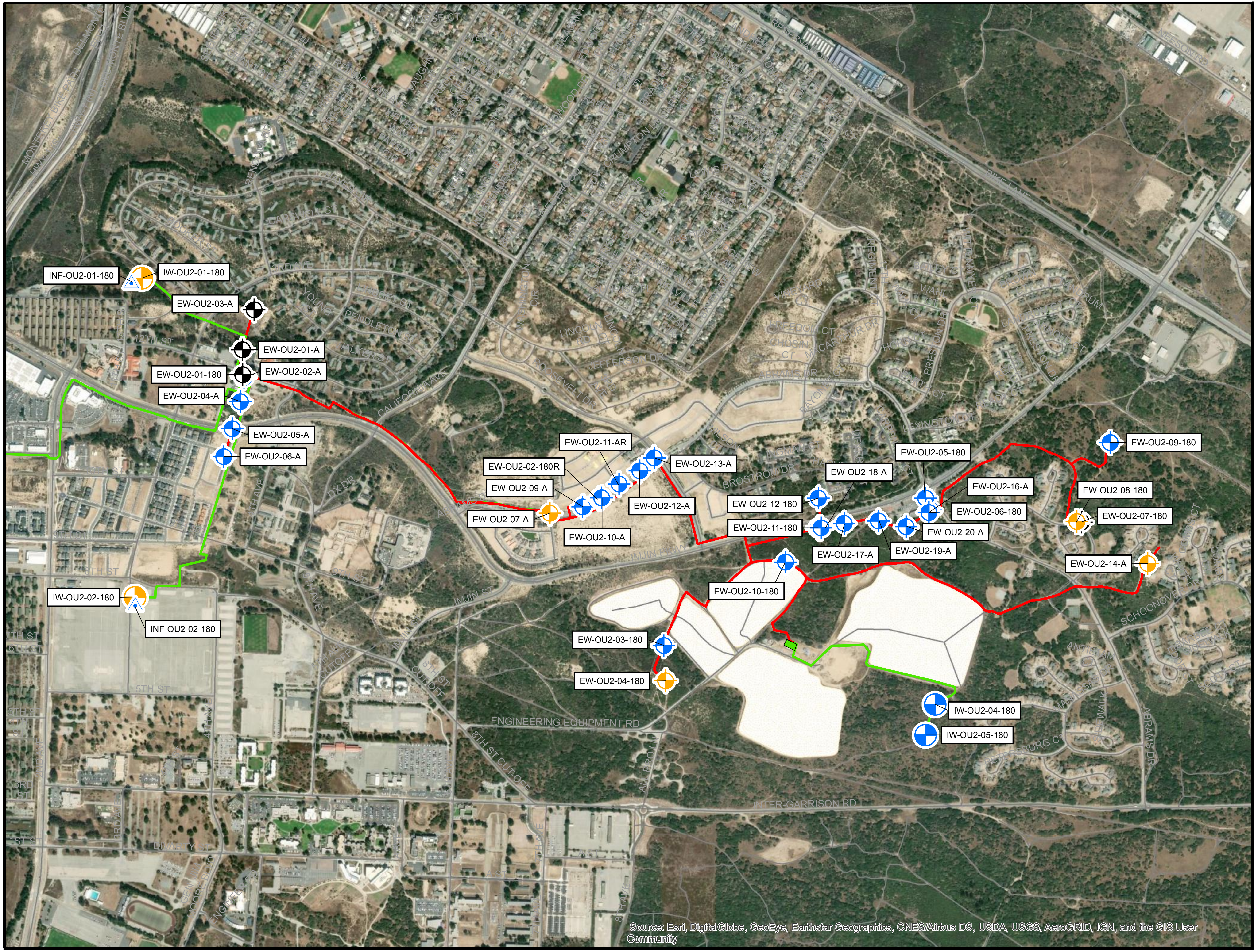

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

— Roads
▨ Fort Ord Landfills
🟩 OU2 GWTP

Extraction Well Status

⊕ Extraction Well - Operated
⊕ Extraction Well - Not Operated
⊕ Extraction Well - No Pump

Groundwater Pipeline

— Groundwater Extraction
— OU2 Treated Water Discharge

◐ Injection Well - Not Used
◐ Injection Well - Operated
△ Infiltration Gallery - Operated

OU2 and OUCTP
Upper 180-Foot Aquifer
Groundwater Remedies Map

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 7
Groundwater Remedies and Monitoring
at Operable Unit 2, Sites 2 and 12,
and Operable Unit Carbon Tetrachloride Plume

Ahtna

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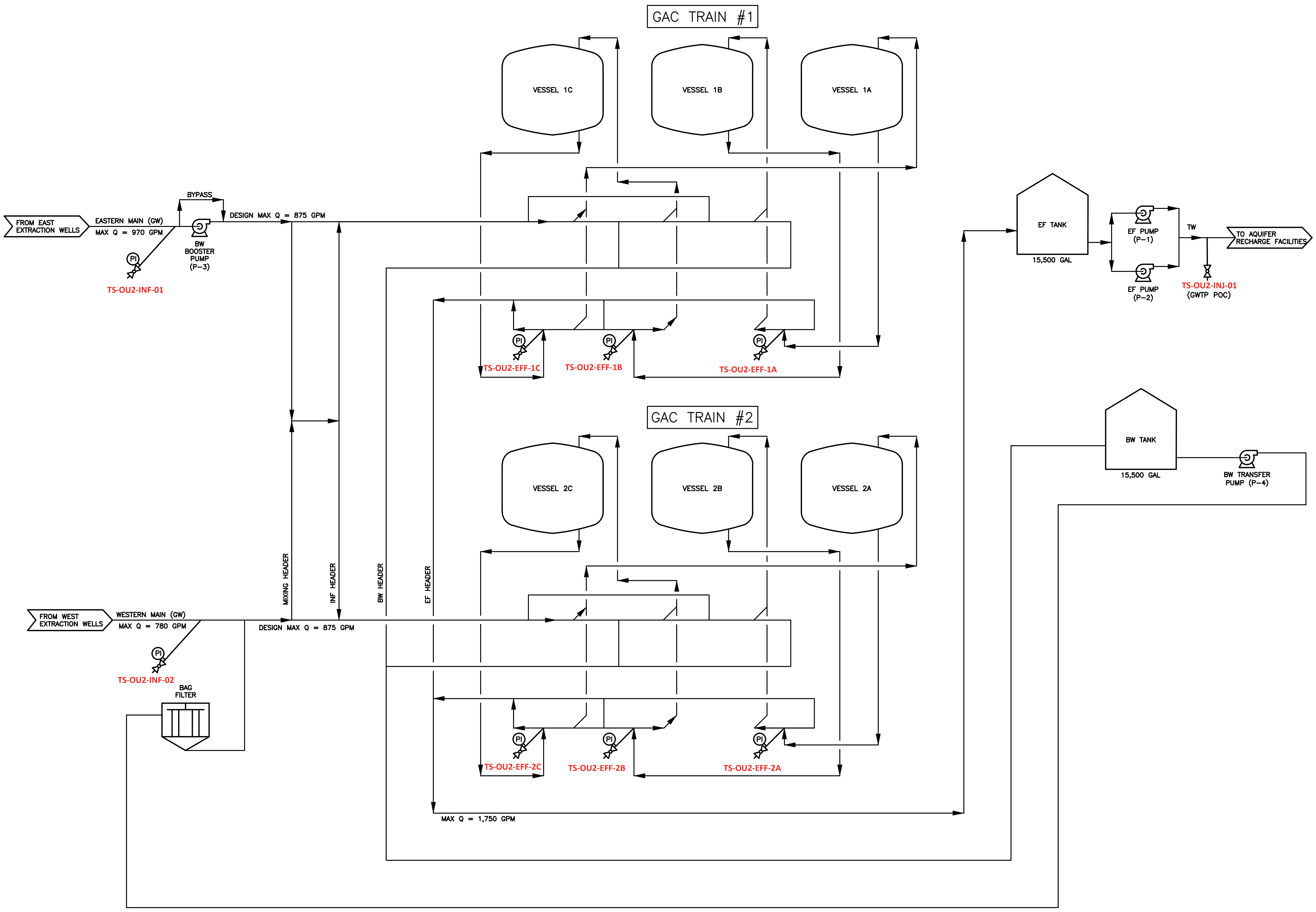

Legend

ABBREVIATIONS

BW	BACKWASH
EF	EFFLUENT
GAC	GRANULAR ACTIVATED C
GAL	GALLONS
GPM	GALLONS PER MINUTE
GW	GROUNDWATER (UNTREA
GWTP	GROUNDWATER TREATME
MAX	MAXIMUM
PI	PRESSURE INDICATOR
POC	POINT OF COMPLIANCE
Q	FLOW RATE
SP	SAMPLE PORT
TW	TREATED WATER

NOTES

1. VALVES ARE NOT INDICATED.
2. FLOW ARROWS INDICATE NORI OPERATION, WITH VESSEL SE(A–B–C IN EACH GAC TRAIN.

Locations in red font are sample locations

Note: The lead GAC vessel effluent will be sampled at the time of the sampling event

OU2 Groundwater Treatment Plant Schematic

Quality Assurance Project Plan
Former Fort Ord, California
Volume I, Appendix A
Revision 7, Groundwater Remedies and Monitoring at Operable Unit 2, Sites 2 and 12, and Operable Unit Carbon Tetrachloride Plume

Ahtna
RORE ITSI

Figure

7

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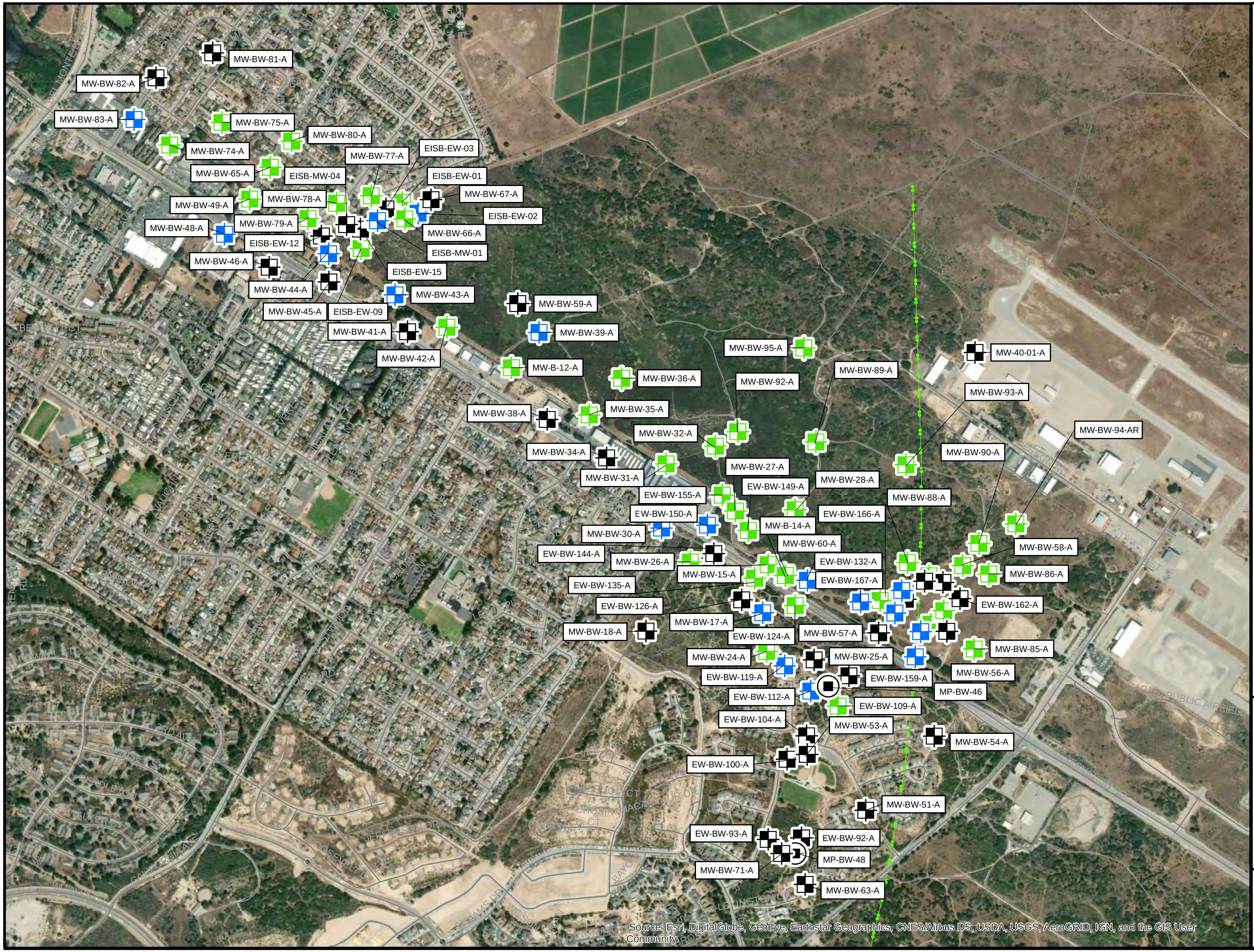

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

— Roads

•-•-• Groundwater Divide

OUCTP-A Wells 2019-2Q

Well Type and Sample Schedule

🟩 Monitoring Well - Quarterly VOCs

● Multi-Port Well - Quarterly VOCs

🟦 Monitoring Well - Annual VOCs

⬛ Monitoring Well - Water Levels

● Multi-Port Well - Water Levels

0 300 600 1,200 Feet

N

OUCTP A-Aquifer Groundwater Monitoring Program Sampling Locations

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 7
Groundwater Remedies and Monitoring
at Operable Unit 2, Sites 2 and 12,
and Operable Unit Carbon Tetrachloride Plume

Ahtna

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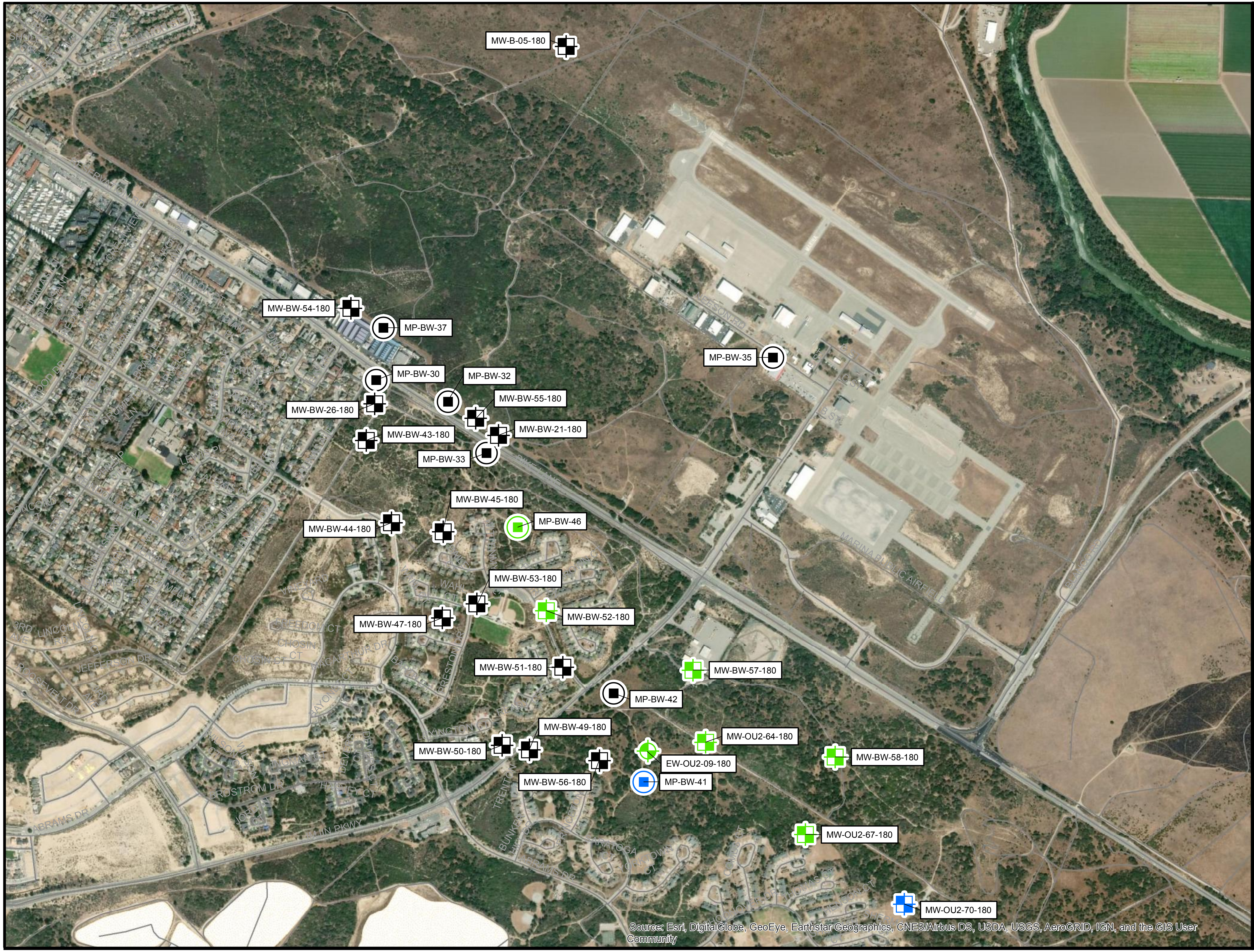

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OUCTP Upper 180-Foot Aquifer Groundwater Monitoring Program Sampling Locations

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 7
Groundwater Remedies and Monitoring
at Operable Unit 2, Sites 2 and 12,
and Operable Unit Carbon Tetrachloride Plume

Ahtna

Figure:
8B

Legend

Roads

Fort Ord Landfills

OUCTP-Lower Wells 2018-3Q

Well Type and Sample Schedule

- Extraction Well - Quarterly VOCs
- Monitoring Well - Quarterly VOCs
- Multi-Port Well - Quarterly VOCs
- Water Supply Well - Quarterly VOCs
- Monitoring Well - Annual VOCs
- Multi-Port Well - Annual VOCs
- Monitoring Well - Water Levels
- Multi-Port Well - Water Levels

N

0 500 1,000 2,000 Feet

OUCTP Lower 180-Foot Aquifer Groundwater Monitoring Program Sampling Locations

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 7
Groundwater Remedies and Monitoring
at Operable Unit 2, Sites 2 and 12,
and Operable Unit Carbon Tetrachloride Plume

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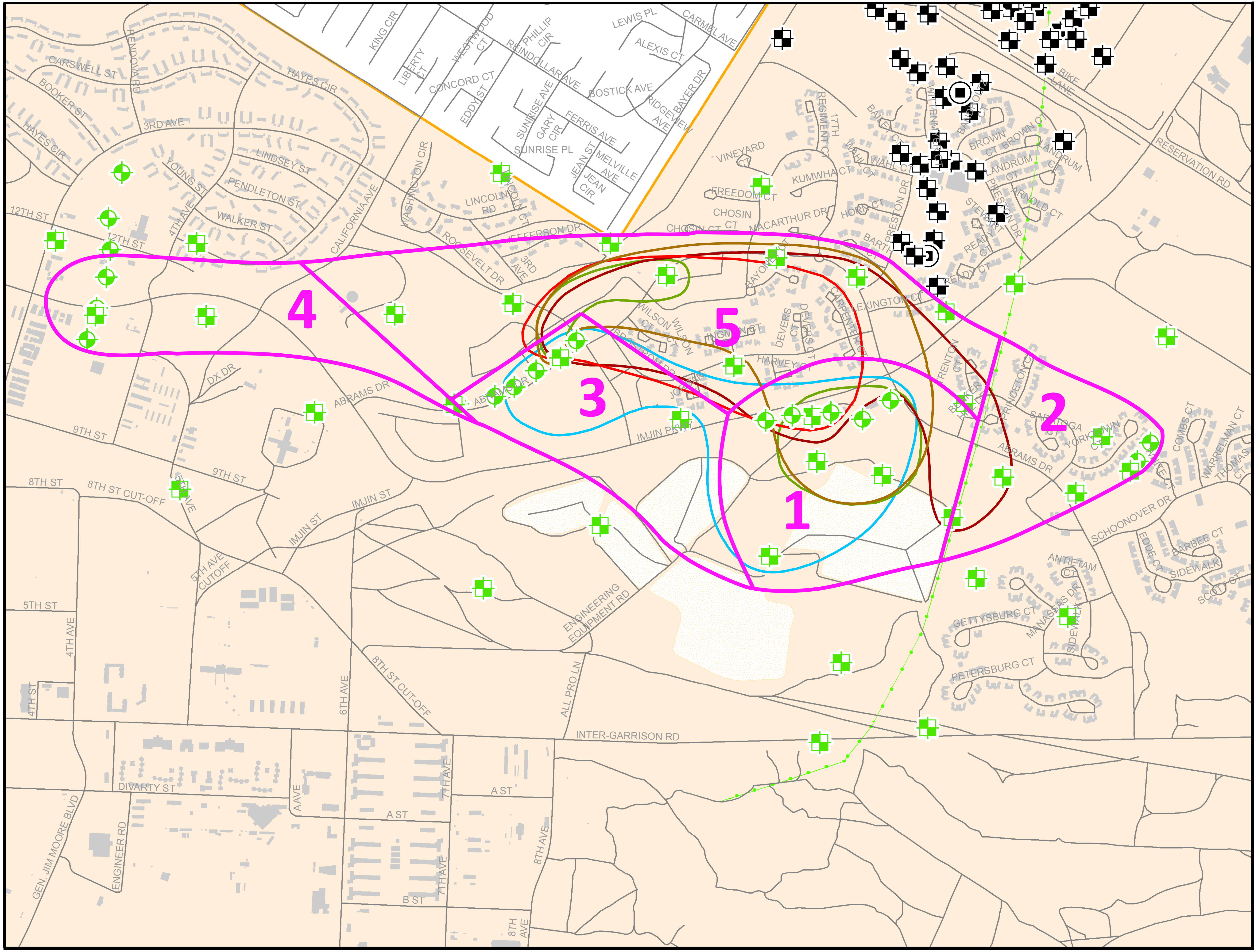

Legend

- ▬ Buildings
- — Roads
- Groundwater Divide
- 🟧 Former Fort Ord Boundary
- Fort Ord Landfills

OUCTP A-Aquifer Well Type

- OUCTP-A Multi-Port Well
- OUCTP-A Monitoring Well

OU2 A-Aquifer Well Type

- OU2-A Extraction Well
- OU2-A Monitoring Well

OU2 COC ACL Exceedances 2018-2Q

- 1,1-DCA (5 ug/L)
- 1,2-DCA (0.5 ug/L)
- PCE (3 ug/L)
- TCE (5 ug/L)
- VC (0.1 ug/L)
- 1 Hydraulic Zone

OU2 A-Aquifer Hydraulic Zone Map

Quality Assurance Project Plan
Former Fort Ord, California
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Groundwater Remedies and Monitoring
at Operable Unit 2, Sites 2 and 12,
and Operable Unit Carbon Tetrachloride Plume

Ahtna

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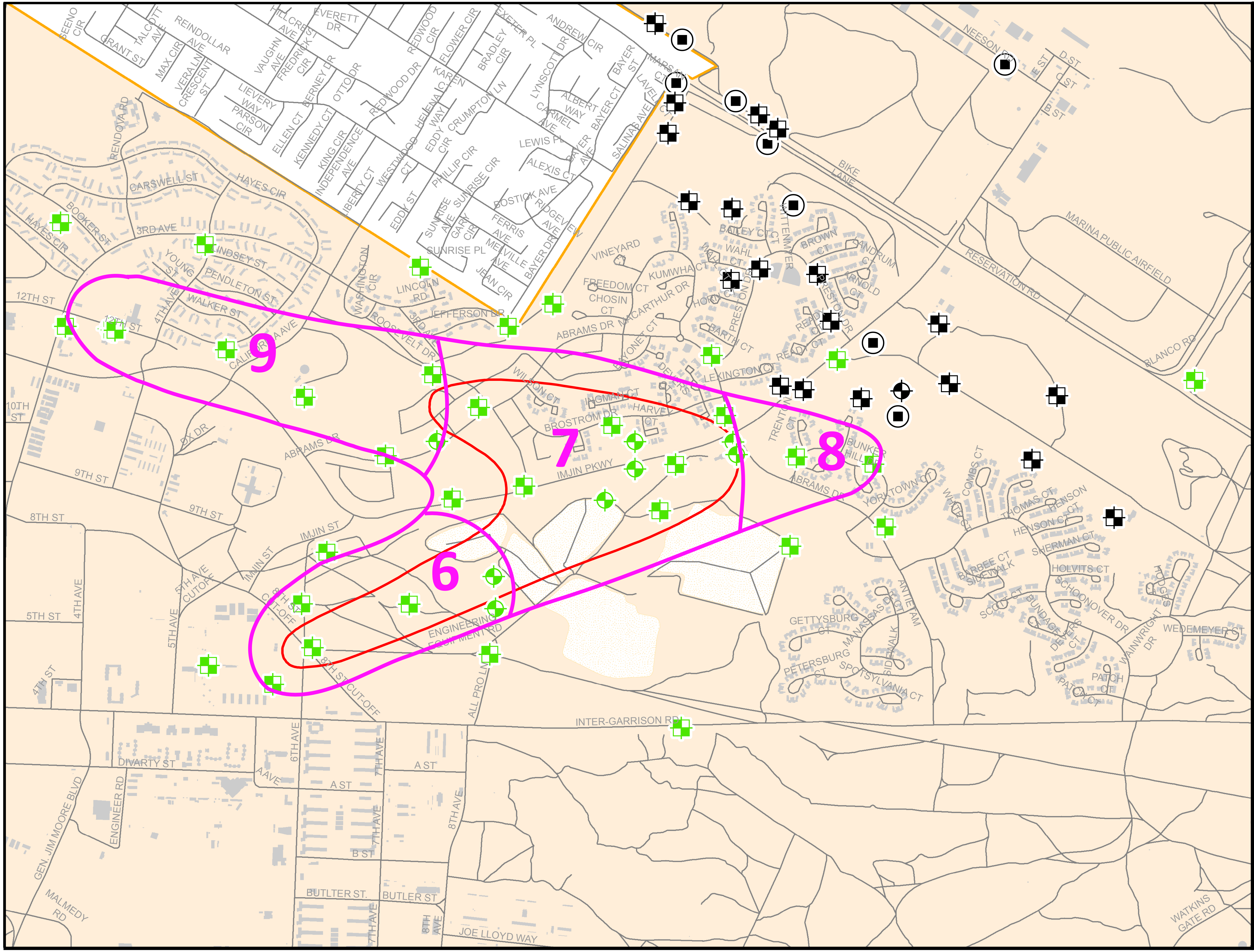
9



Legend

OUCTP Upper Well Type

⊕ OUCTP-U Extraction Well

◙ OUCTP-U Multi-Port Well

▣ OUCTP-U Monitoring Well

OU2 Upper Well Type

⊕ OU2-U Extraction Well

▣ OU2-U Monitoring Well

OU2 COC ACL Exceedance 2018-2Q

— TCE (5 ug/L)

▨ Buildings

— Roads

▨ Fort Ord Landfills

▭ Former Fort Ord Boundary

① Hydraulic Zone

N

0 375 750 1,500
Feet

OU2 Upper 180-Foot Aquifer Hydraulic Zone Map

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 7
Groundwater Remedies and Monitoring
at Operable Unit 2, Sites 2 and 12,
and Operable Unit Carbon Tetrachloride Plume

Ahtna

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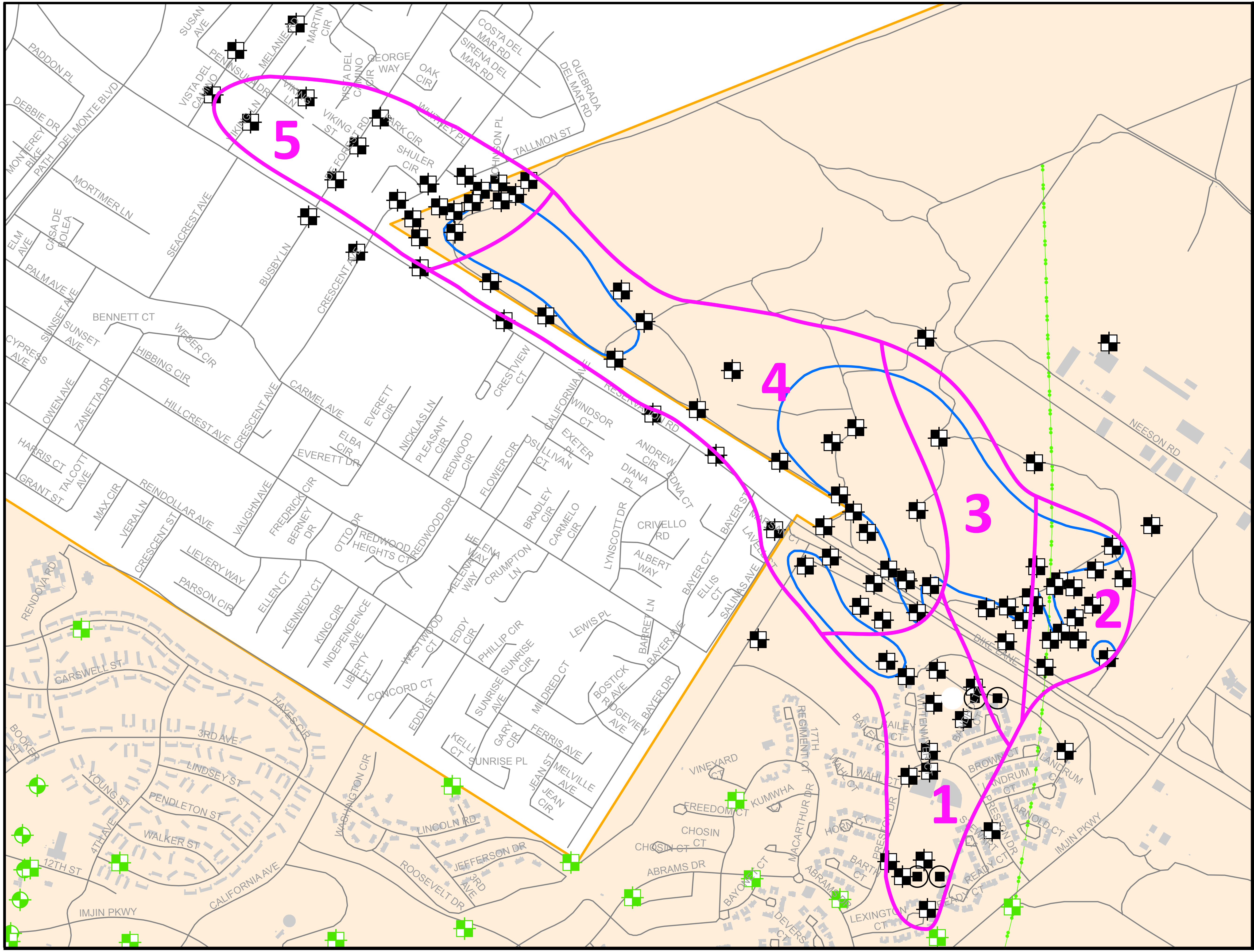


Legend

- ⊕ OU2-A Extraction Well
- ▣ OU2-A Monitoring Well

A-Aquifer Well Type

- ◉ OUCTP-A Multi-Port Well
- ▣ OUCTP-A Monitoring Well

ACL Exceedance 2018-2Q

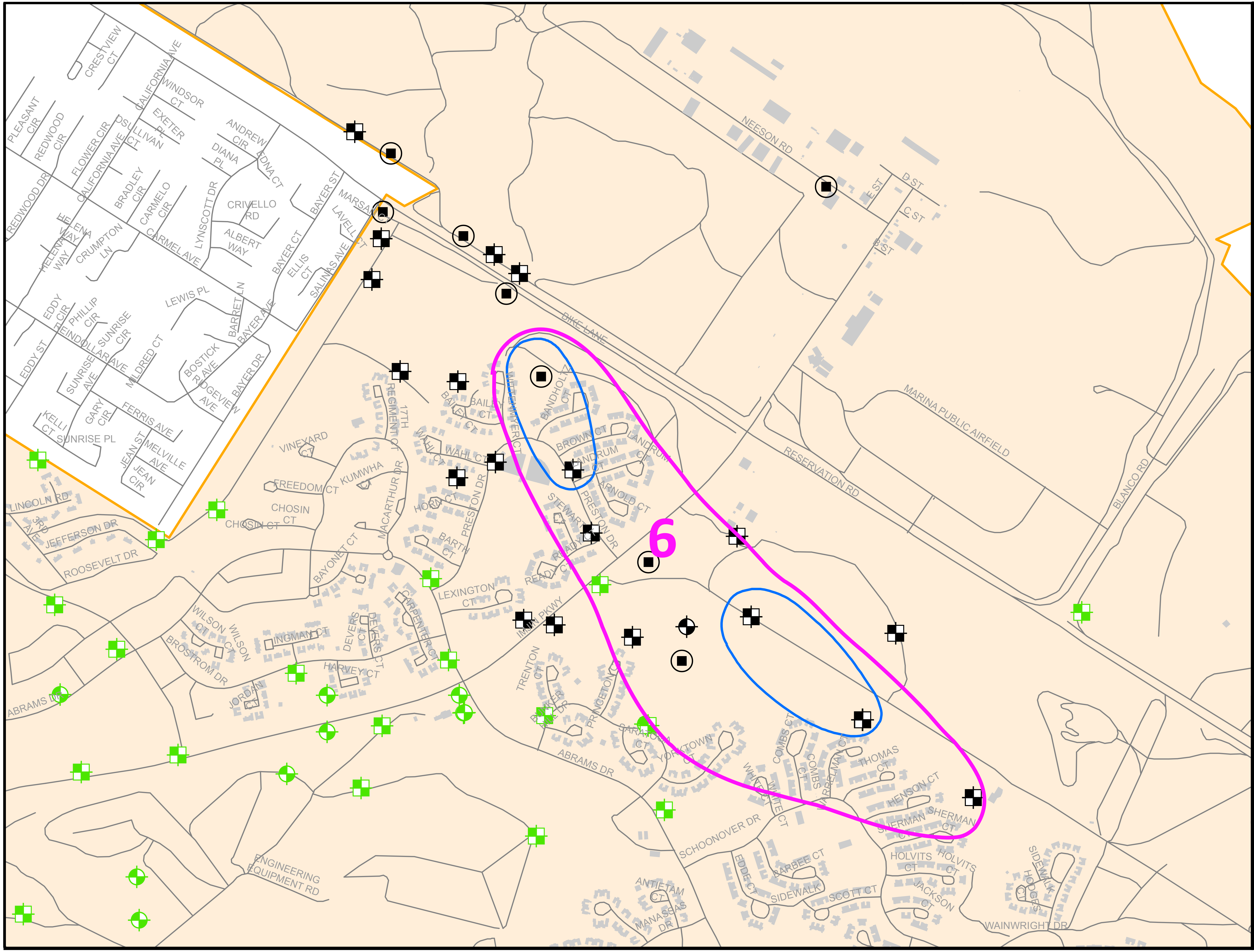
- — CT (0.5 ug/L)
- ▨ Buildings
- — Roads
- ··· Groundwater Divide
- ☐ Former Fort Ord Boundary
- ① Hydraulic Zone

OUCTP A-Aquifer
Hydraulic Zone Map

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 7
Groundwater Remedies and Monitoring
at Operable Unit 2, Sites 2 and 12,
and Operable Unit Carbon Tetrachloride Plume

Ahtna

Figure:
11



Legend

⌖ OU2-U Extraction Well

⊞ OU2-U Monitoring Well

⊕ OUCTP-U Extraction Well

⊡ OUCTP-U Multi-Port Well

⊞ OUCTP-U Monitoring Well

ACL Exceedance 2018-2Q

— CT (0.5 ug/L)

▨ Buildings

— Roads

☐ Former Fort Ord Boundary

① Hydraulic Zone

0 300 600 1,200 Feet

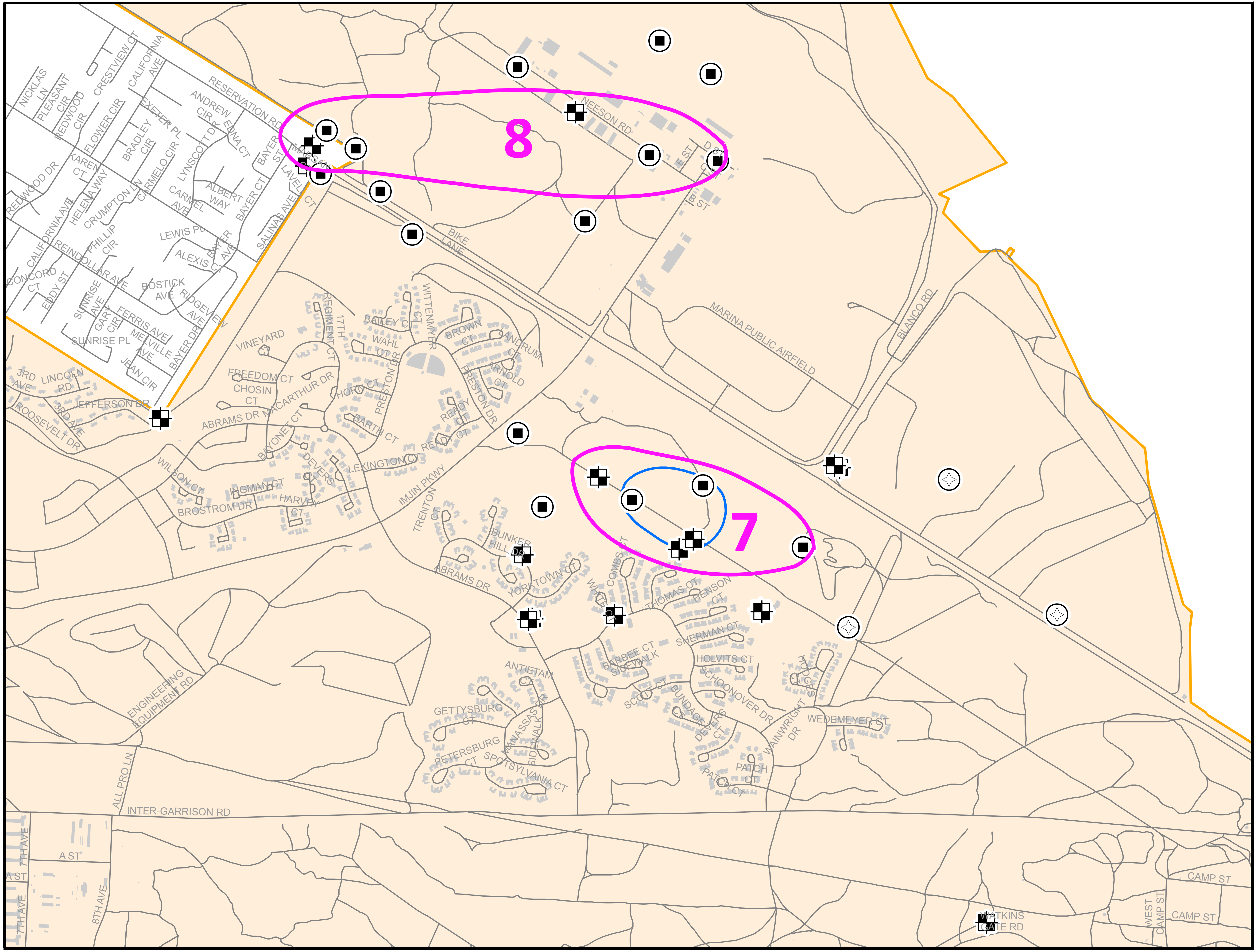
N

OUCTP Upper 180-Foot Aquifer Hydraulic Zone Map

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 7
Groundwater Remedies and Monitoring
at Operable Unit 2, Sites 2 and 12,
and Operable Unit Carbon Tetrachloride Plume

Ahtna

Figure:
12



Legend

- OUCTP-L Extraction Well
- OUCTP-L Water Supply Well
- OUCTP-L Multi-Port Well
- OUCTP-L Monitoring Well

ACL Exceedance 2018-2Q

- CT (0.5 ug/L)
- ▨ Buildings
- Roads
- Former Fort Ord Boundary
- 1 Hydraulic Zone

N

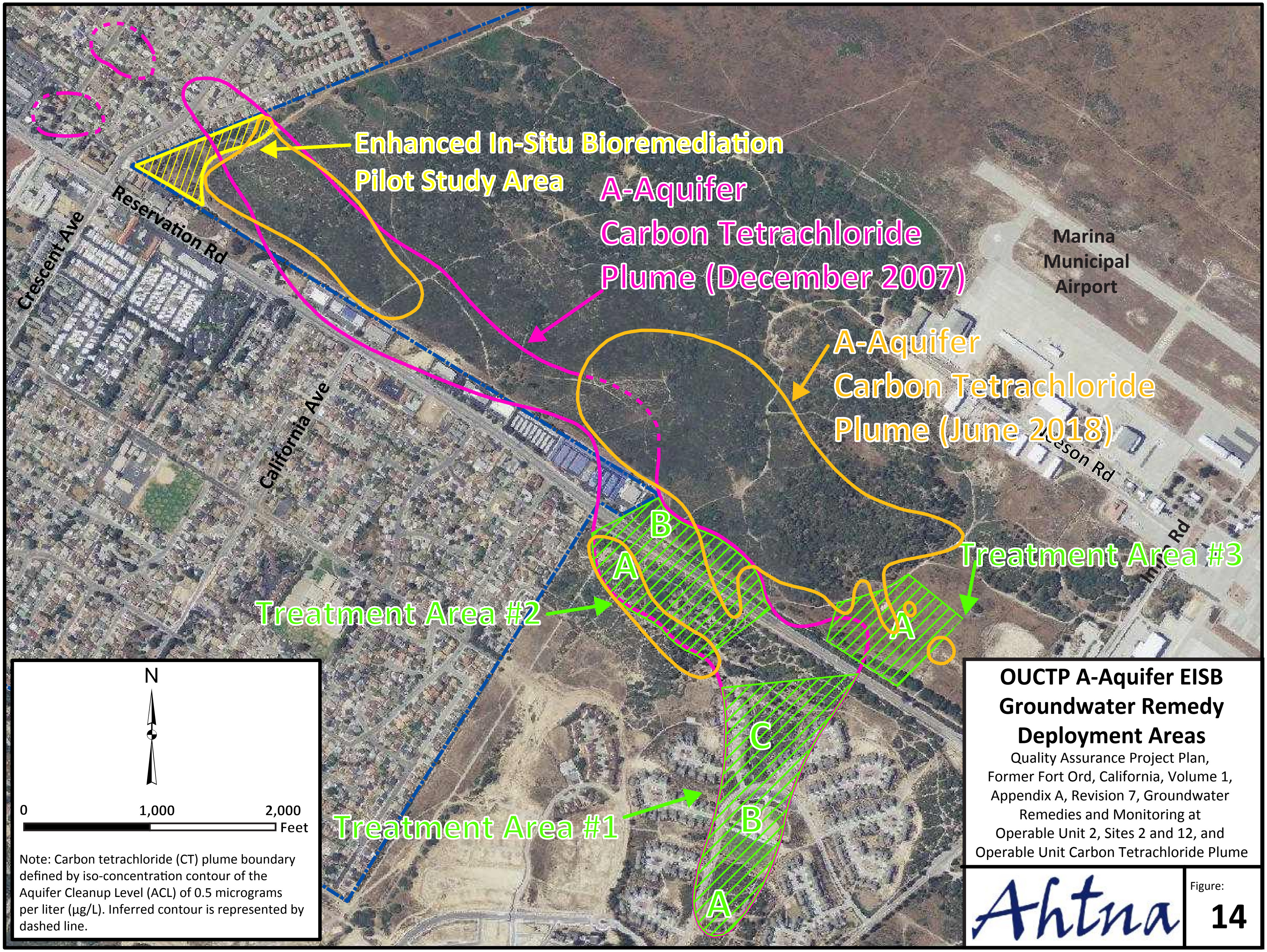
0 375 750 1,500 Feet

OUCTP Lower 180-Foot Aquifer Hydraulic Zone Map

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 7
Groundwater Remedies and Monitoring
at Operable Unit 2, Sites 2 and 12,
and Operable Unit Carbon Tetrachloride Plume

Ahtna

Figure:
13



Note: Carbon tetrachloride (CT) plume boundary defined by iso-concentration contour of the Aquifer Cleanup Level (ACL) of 0.5 micrograms per liter (µg/L). Inferred contour is represented by dashed line.

OUCTP A-Aquifer EISB Groundwater Remedy Deployment Areas

Quality Assurance Project Plan, Former Fort Ord, California, Volume 1, Appendix A, Revision 7, Groundwater Remedies and Monitoring at Operable Unit 2, Sites 2 and 12, and Operable Unit Carbon Tetrachloride Plume

Ahtna

Figure:
14

TABLE

Table 1: Summary of Existing Monitoring Wells and Samples Collected Annually

Site	Aquifer	Total Number[1] of Wells Per Aquifer	Number of Army-Owned Wells	Total Number of Sample Ports Currently Sampled	Number of Well/Ports Sampled Quarterly	Number of Wells/Ports Sampled Annually	Number of Wells Not Sampled (water level only)	Number of Samples Collected Annually[2]
Sites 2 and 12	A	0	0	0	0	0	0	0
	Upper 180	38	38	24	19	5	14	89
	Lower 180	1	1	0	0	0	1	0
	Subtotal	**39**	**39**	**24**	**19**	**5**	**15**	**89**
Operable Unit 2	A	59	59	40	39	1	19	173
	Upper 180	45	45	31	29	2	14	130
	Lower 180	0	0	0	0	0	0	0
	Subtotal	**104**	**104**	**71**	**68**	**3**	**33**	**303**
Operable Unit Carbon Tetrachloride Plume	A	95	95	62	43	19	33	210
	Upper 180	37	37	9	7	2	28	33
	Lower 180	95	89	24	21	3	71	96
	Subtotal	**227**	**221**	**95**	**71**	**24**	**132**	**339**
Total Number of Samples Collected Annually								**730**

Notes:

[1] Number of wells in the groundwater monitoring program (not including wells not measured for depth to water and to be decommissioned at a later date).

[2] Includes duplicate samples collected during groundwater monitoring at a frequency of 10 percent (%) per quarterly event.

ATTACHMENTS

ATTACHMENT A

Standard Operating Procedures (SOPs)

Sampling SOPs

1. Westbay MOSDAX Sampler Probe – Model 2531 Operations Manual
2. Passive Diffusion Bag (PDB) Sampling Protocol
3. HydraSleeve Field Manual
4. Supply and Irrigation Well Sampling Protocol
5. OU2 and Sites 2/12 GWTSs and OUCTP EISB Extraction Well Sample Handling and Custody Requirements
6. Low Flow Groundwater Quality Parameter Collection
7. Downhole Meter Groundwater Quality Parameter Collection

OPERATIONS MANUAL

Westbay MOSDAX Sampler Probe - Model 2531

Schlumberger
WATER SERVICES

NOTICE

Operation of Westbay System equipment should only be undertaken by qualified instrument technicians who have been trained by Westbay authorized personnel.

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DO NOT OPEN THE SAMPLER

All warranties expressed or implied will be void if, after examination by Westbay Instruments Inc. personnel, it is established that any of the instrument housings have been opened without prior authorization from Westbay Instruments Inc.

DO NOT LET THE SAMPLER FREEZE

Extreme care should be taken to avoid freezing the MOSDAX Sampler probe. Permanent transducer damage may result from freezing.

Manual Revision: 1.13 20 October 2006

Issued for Serial No.: ____________

Date: ____________

Signature: ____________

Contents

1. DESCRIPTION

1.1 MOSDAX Sampler Probe, Model 2531

The MOSDAX Sampler is a downhole probe designed to collect fluid pressure information and fluid samples from Westbay System monitoring wells. Each MOSDAX pressure sensor is calibrated over its full pressure range for nonlinearity and temperature variation. MOSDAX Sampler probes are available in a variety of pressure ranges to permit operation to various depths. The shoe and valve motors can be operated from the surface. The power for the shoe and valve motors is supplied from the surface.

1.2 MOSDAX Automated Groundwater Interface (MAGI), Model 2536

The MOSDAX Sampler can be operated directly by the keypad on the MOSDAX Automated Groundwater Interface (MAGI), or by a Hand Held Controller (HHC) connected to the MAGI, or with a computer running Microsoft Windows (2000 or higher) and Westbay software connected to the MAGI. The MAGI translates the signals between the computer or HHC and the MOSDAX Sampler. The MAGI requires 12 volt DC power to operate.

Older versions of MOSDAX sampling equipment may incorporate a Model 2522 MOSDAX PC Interface (MPCI) and HHC rather than a MAGI. For such systems, reference to the MAGI in this document can be considered as reference to the MPCI and HHC.

1.3 Cable Reels

The manual cable reel can operate all Westbay probes and tools to a depth of 300m (1,000 ft) on a single-conductor cable. The manual reel is hand operated with an internal brake to control the speed of descent of the probe in the well. The two-pin cable connects the MAGI to the reel and the signals pass through a slipring located in the hub of the reel into the control cable. For maintenance information, see the appropriate cable reel manual.

Motorized cable reels are available for deeper applications.

1.4 Sample Containers

Sample containers can be used with the MOSDAX Sampler. The nonvented stainless steel sample containers maintain samples under formation pressure while the sampler and container are brought to the surface.

2. PRESSURE PROFILING

2.1 Items Required

- MOSDAX Sampler Probe, Model 2531
- MAGI, Model 2536 with:
  - one two-pin data cable
  - one three-pin power cable
  - hand held controller with cable and user's guide (optional)
  - computer running Windows 2000 or higher with one nine-pin computer cable and MProfile software (optional)
- MOSDAX-compatible winch with cable
- Sheave with counter and tripod
- 12 VDC, 2 Amp power source (Battery pack, car/truck battery, or transformer)
- Water level measuring tape
- MProfile User's Guide for computer or the Handheld Controller Operations Manual
- Westbay Casing Log showing depths to ports and couplings in hole to be tested.

2.2 Surface Checks

1. Remove the MOSDAX Sampler from its storage case. Inspect the probe housing and body for any damage. Please contact Westbay for advice on any cover tube damage.
2. Assemble the tripod and counter over the well. Run the cable over the counter.
3. Connect the probe to the cable. Before attaching, inspect the O-ring at the top of the probe and lubricate with silicon. The O-ring should be clean and intact. Tighten the nut hand tight only.
4. Connect the two-pin cable from the MPCI to the cable reel. With the MPCI OFF connect the three-pin cable from the MPCI to the 12 v power supply.
5. Connect the 9 pin cable from computer or HHC to the MPCI and turn the MPCI ON.
6. Perform the following surface checks to ensure that the location arm and the shoe mechanisms are operating normally: Release the location arm. The location arm should extend smoothly. The number of revolutions used to release the location arm is displayed and should be 15 to 16 revolutions. If a smaller number of revolutions is reported, retract the arm and repeat. Place the probe in a piece of Westbay casing or coupling. Activate the shoe. The shoe should extend and hold the probe firmly in the coupling or casing. The display should indicate 16 to 19 revolutions. A reading of 23 revolutions indicates the probe is activated in open air. Retract the backing shoe.

7. Check that the face plate for sampling and the plastic plunger are installed on the sampler.
8. The probe is now ready to be lowered down the well.

2.3 Pressure Measurement Procedures

1. Obtain the completed Westbay Casing Log.
2. With the location arm retracted, lower the probe into the Westbay casing to immediately below the lowest measurement port coupling to be monitored. If magnetic collars have been installed on the well, the Collar Detect Command can be used to detect the collars. The Collar Detect Command is cancelled by pressing any key.
3. Release the location arm. The display should update and beep after the arm is released.
4. Raise the probe about 0.5 m (1.5 ft) above this measurement port. If the probe is accidentally lifted above the next higher coupling, it will be necessary to retract the location arm and lower the probe to below the measurement port and release the arm.
5. Lower the probe gently until the location arm rests in the measurement port.
6. Record the pressure and temperature inside the Westbay casing.
7. Optional: If a water level tape is available, measure and record the depth to water in the Westbay casing.
8. Activate the shoe. The pressure on the display should change to the formation pressure.
9. When the reading has stabilized, record the formation pressure.
10. Once the pressure has been recorded, retract the shoe.
11. Record the pressure of the fluid in the Westbay casing. This reading should be similar to that recorded in Step 6. If a large difference is noted between the readings, record the water level inside the Westbay casing again using the water level tape.
12. The three pressure readings plus the time and water level constitute a complete set of readings at a measurement port coupling.
13. Continue up the Westbay casing to obtain the pressure data from other measurement ports.
14. Take one last set of pressure and temperature readings at the surface. These readings should be similar to those recorded in Step 2.

CAUTION: **If a water level tape was used, remove the water level tape from the Westbay casing before removing the sampler probe from the well to prevent them from becoming jammed.**

3. FLUID SAMPLING

3.1 Items Required

- MOSDAX Sampler, Model 2531
- MAGI, Model 2536 with:
  - one two-pin data cable
  - one three-pin power cable
  - hand held controller with cable and user's guide (optional)
  - computer running Windows 2000 or higher with one nine-pin computer cable and MProfile software (optional)
- MOSDAX-compatible winch with cable
- Sample containers and connecting tubes
- Westbay Casing Log
- Groundwater Sampling Field Data Sheet
- 12 VDC, 2 amp power source (battery pack, car/truck, or transformer)
- Counter and tripod
- Westbay Sampling Kit including vacuum pump

3.2 Surface Checks and Preparation

1. Set up the MOSDAX Sampler probe following Steps 1 through 8 of Section 2.2.
2. Attach the sample containers.
3. Release the location arm. Locate the probe in the vacuum coupling.
4. Activate the shoe in the vacuum coupling.
5. Close the sampler valve. The motor should run about 5 seconds. The display should indicate one revolution.
6. Use the vacuum pump to apply a vacuum through the vacuum coupling. The vacuum should remain constant. If the vacuum is not maintained, inspect for leaks at the face seal of the probe, the connection to the pump and at the probe sampling valve.
7. Once a vacuum has been maintained, open the sampler valve. Apply a vacuum again to check that all connections are sealed.
8. Close the sampler valve. A vacuum has now been applied to the sample bottles.
9. Retract the shoe.

3.3 Drillhole Sampling

1. Check recent pressure logs of the hole and ensure that the head inside the Westbay casing is lower than the head outside the measurement port to be sampled.
2. After completing the surface checks, follow Steps 1 to 5 of Section 2.3 to locate the sampler at the measurement port in the monitoring zone to be sampled.
3. Record the pressure reading.
4. Activate the probe and record the formation pressure.
5. Open the sampler valve. The pressure should drop and then slowly increase as the bottles fill. When the pressure in the bottle equals the zone pressure from Step 4, the bottle is full. Wait a maximum of two minutes per sample bottle even if the pressures are not equal.
6. Close the sampler valve and retract the shoe.
7. Record the pressure reading. A reading the same as in Step 3 indicates that the sample is OK.
8. Reel the sampler to the surface and remove it from the Westbay casing.
9. **Do not open the sampler valve as damage to the probe or injury to the operator could occur.**
10. Remove the cap from the bottom sample bottle and open the valve on the bottle to release the pressure and to transfer the sample.
11. Open the sampler valve to allow the sample to flow from the bottles. Once the pressure in the sampler and bottles has decreased to atmospheric, the bottles may be disconnected to speed the process.
12. Take particular care in handling pressurized samples.

3.4 Rinsing Instructions

Rinse the sampler around the face seal and the bottom connector. With the sampler valve open, flush the interior of the sampler from the bottom connector. Rinse the sample bottles and connectors.

Note: Project specific procedures for decontaminating the sampler and sample bottles are the responsibility of the project manager and are not covered in this manual.

4. Care and Maintenance

The MOSDAX Sampler System must be routinely maintained for optimum performance. The procedures outlined here are required to keep the instrument operating properly. For any additional information or advice, please contact Westbay Instruments Inc.

4.1 MAGI

The MAGI should be cleaned to remove dirt and dust and inspected for damage or wear. If any part requires replacement, contact Westbay for information.

4.2 Cable Reels and Control Cable

The cable reels should be kept clean and protected from damage. The cable and cable head should be inspected for kinks and corrosion. Rehead the cable if necessary. For more information concerning cable reels and the control cable, refer to the appropriate reel manual.

4.3 MOSDAX Sampler Probe

1. Never allow the probe to freeze or the pressure transducer may be damaged.
2. Clean and inspect the probe for dents and scratches on the cover tube. Clean the threads with a nylon brush, such as a toothbrush. DO NOT use a wire brush. Protect the O-rings from damage and dirt.

4.3.1 Face Seal

Inspect the face seal and replace if damaged or worn.

1. Remove the two screws holding the face plate to the probe body and lift the face plate off.
2. Remove the face seal and plunger. Set the location arm assembly aside. Clean the plunger and probe body.
3. When reinstalling the face plate hold the face seal, plunger and location arm assembly in place. Replace the two screws the hold the face plate on the probe.

4.3.2 Location Arm

Release the location arm. Check that the arm moves smoothly and freely and check for damage and sharp edges due to wear. Replace the location arm if necessary.

1. Release the location arm. Remove the two screws and face plate (Section 4.3.1).
2. Remove the location arm with its spring and pivot pin. Clean and inspect all parts and replace if needed.
3. Insert the spring and pivot in the location arm and place the assembly in the probe body. Place the face plate over the face seal and location arm and tighten the two screws.

SECTION 4.3.2 SUPPLEMENT

WESTBAY Probe Location Arm replacement

a) It is easier when the arm is first extended to the "out" position (Fig. A). Do this before powering down and disconnecting the probe.

b) Remove the face seal slowly and stabilize the arm as it is under tension from the spring (Section 4.3.2.2) and may suddenly pop out. Observe the position and orientation of the parts as they are removed (Fig. B).

c) Insert the hook of bent leg of the spring into the tiny hole on the neck of the new arm and align the spring coil opening alongside the larger hole in the arm with the spring leg positioned directly against the arm and over the pivot facing out (Fig. C-1). The metal pivot pin goes through the hole in the arm and through the spring coil (Fig. C-2). The straight leg of the spring leads under the pivot into the smaller side slot on the side of the main arm aperture, parallel with the probe. Place the assembly into its space in the probe body (Fig. C-3). <u>The arm assembly has to be held in place while replacing the face seal</u> to counter the force of the slightly compacted spring (Fig.C-4).

d) Replace the face seal by sliding it toward the top of the probe and sliding the top edge into the slot while at the same time allowing the arm to protrude through the face seal. The arm should remain in the extended position while screwing down the face seal.

e) Check to see that the arm can be freely, manually pushed in and that it pops back out when released. Attach the probe to the cable and mechanically retract the arm using the MAGI commands.

Parsons, 11/21/07

Figure **A -** Arm is extended out at start of replacement operation.

Figure **B** - Disassembled face seal and location arm.

Figure **C-1 -** Orientation of spring relative to arm.

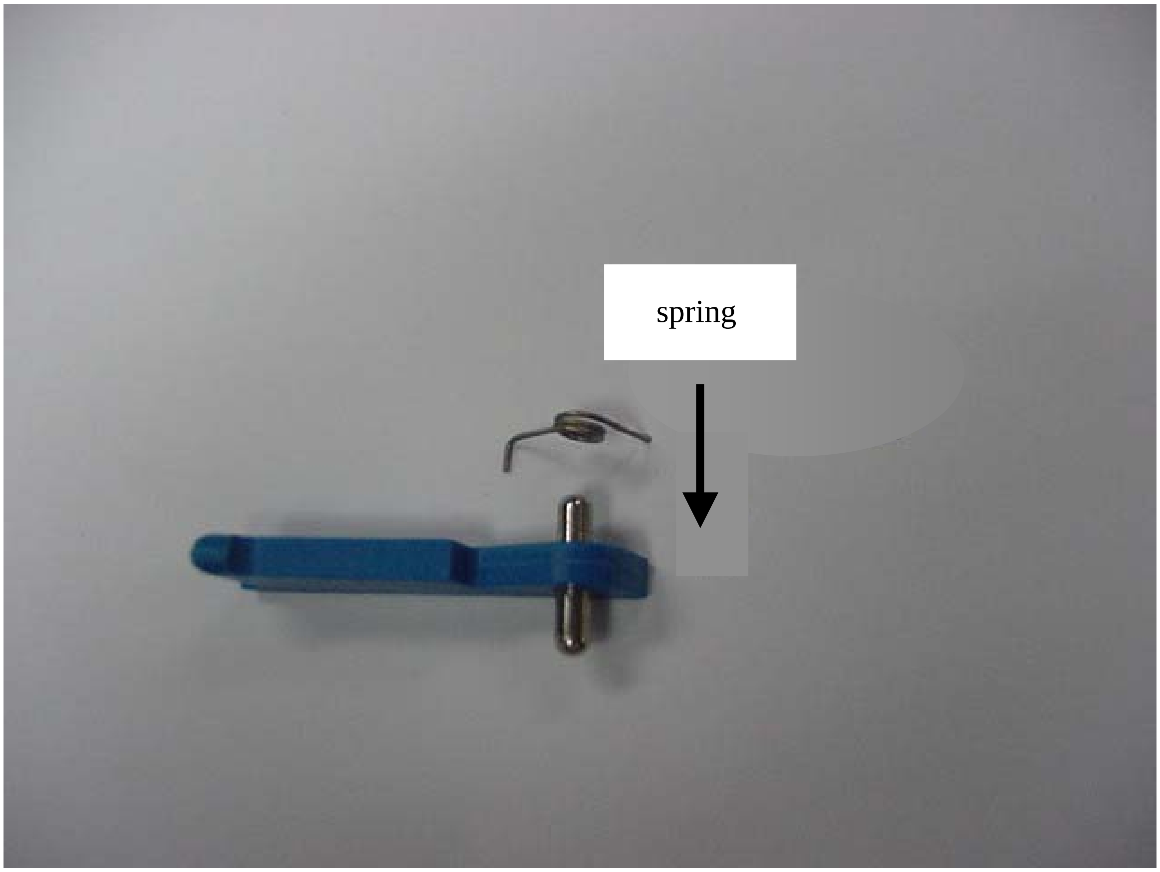


Figure **C-2 -** Position of spring and pivot in the arm.

Figure **C-3 -** Placement of arm assembly.

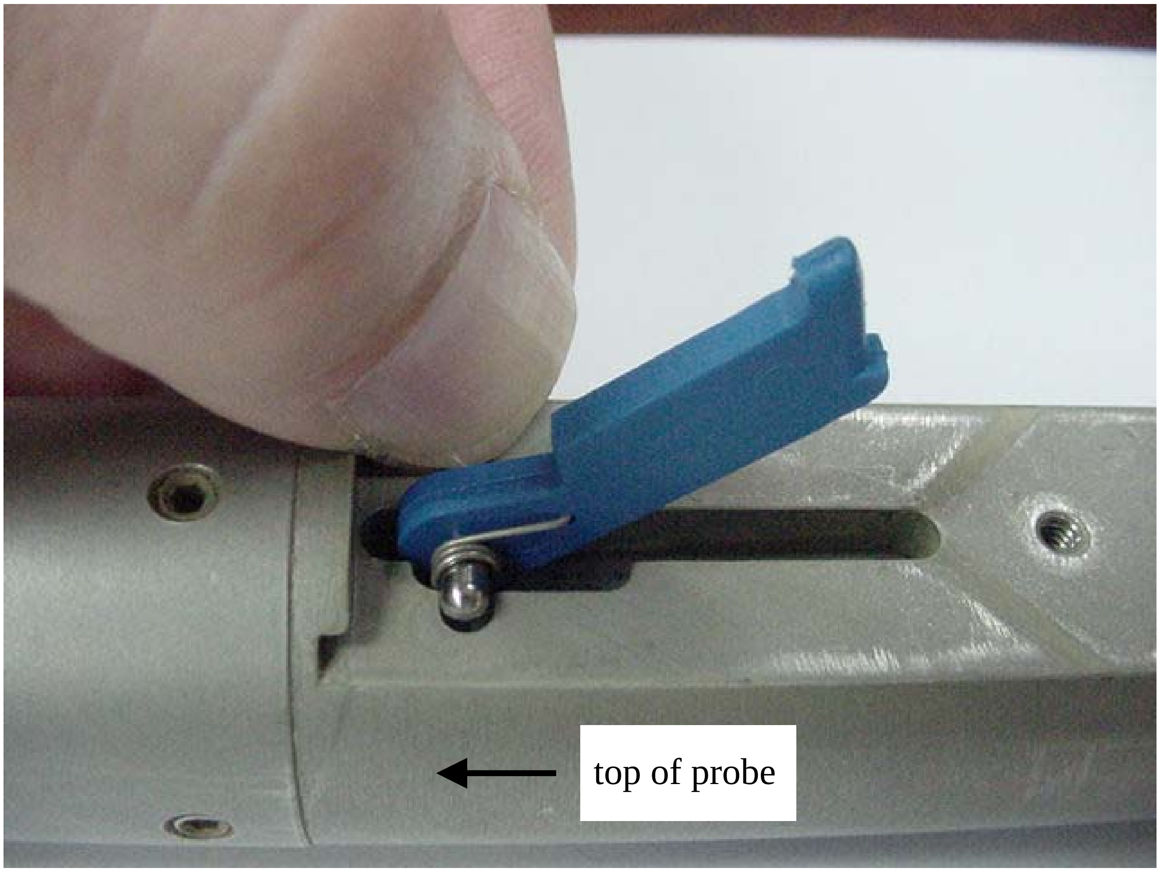
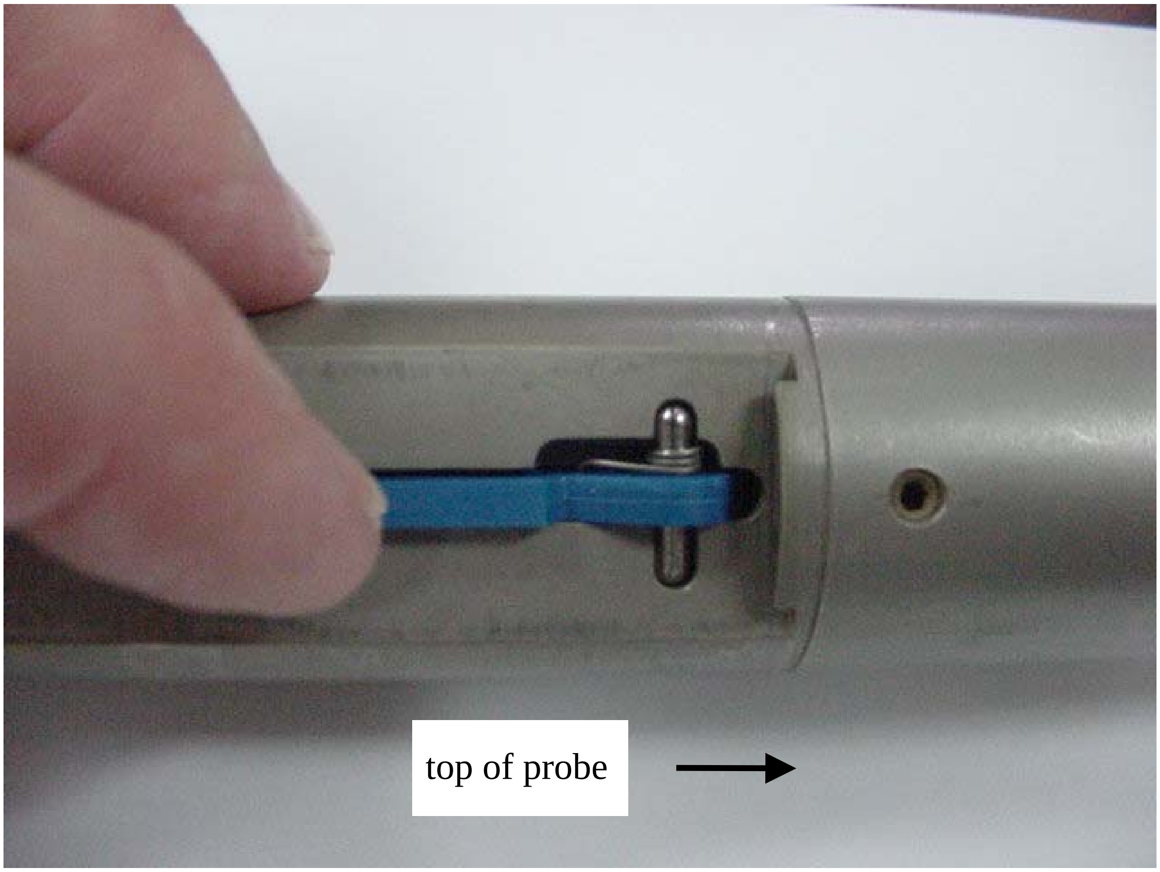


Figure **C-4** - Top view of arm and spring placement.



Check that the arm is moving freely and the face seal insert and plunger are held securely in place.

4.3.3 Shoe Replacement

Activate the shoe and inspect for damage or wear. The shoe should rotate freely about the pivot pin. When the shoe is retracted it should retract quickly and smoothly back into the probe. The shoe may be replaced in the following manner:

1. Release the location arm and extend the shoe to expose the pivot pin.
2. Unscrew the shoe pivot pin from the lever arm and remove the shoe.
3. Place a new shoe in the lever arm and install the shoe pivot pin.

4.3.4 Actuator Nut

The actuator nut needs to be routinely cleaned to remove particles of grit which can interfere with its movement. Remove the actuator nut in the following manner:

1. Remove the two set screws that hold in the lever arm pivot pin. Using the Allen key, push the lever pivot pin out of the probe body.
2. Remove the set screws on the side of the probe body that holds the plastic support block.
3. Remove the screw closest to the top of the probe.
4. Lift out the lever arm, guide plate, shoe, spring and plastic support block as one unit.
5. Use the Clean Nut Command to remove the actuator nut from the actuator screw. Turn off the MPCI and remove the nut from the probe.
6. Clean the actuator nut with the cleaning tap. Use the Clean Nut Command and clean the actuator screw with a nylon brush. DO NOT use a wire brush.
7. Apply a thin coating of silicone lubricant to the actuator screw. Place the actuator nut in the probe body against the actuator screw and retract the arm to thread the nut onto the actuator screw. Allow the nut to travel along the full length of the screw. YOU MAY HAVE TO REPEAT THIS OPERATION.
8. Install the single unit from Step 4 in the probe body. Install the lever arm pin through the probe body, lever arm, and spring. Lock the pin in position with two set screws.
9. Install the top screw into the guide plate and install the set screws to secure the support block.

5. CALIBRATION

The Westbay System permits frequent or periodic calibration of the transducers used for pressure measurement. Contact Westbay for details.

6. SPARE PARTS LIST

Item	Part No. or Size	Qty
Face Seal Insert	200302	5
Plunger	(see Note 1)	5
Location Arm	252112	5
Shoe	252313	5
Pin 3 (Location Arm)	252320	2
Spring 2 (Location Arm)	252319	2
Pin 1 (Shoe)	252316	2
Spring 1 (Shoe Lever)	252318	2
Pan Head Screw	# 4-40 x 1/4 - inch	2
Pan Head Screw	# 6-32 x 3/16 - inch	2
Pan Head Screw	# 6-32 x 1/2 - inch	2
Hex Socket Head Screw	# 8-32 x 1/8 - inch	4
Hex Socket Head Screw	# 10-32 x 3/16 - inch	4
Hex Socket Set Screw	# 8-32 x 5/16 - inch	2
Allen Key	5/64 - inch	1
Allen Key	3/32 - inch	1
Actuator Nut Tap	208001	1
Cablehead Parts:		
O-ring	# 111 B	2
Termination Sleeve	251805	1
Termination Insert	251806	1
Feedthru Connector	251814	1
Bushing 1	251812	1
Bushing 2	251813	1
O-Ring	# 108 V	1
O-Ring	# 010 V	1
O-Ring	# 004 V	1
Boot	JF0602CF	1
Contact	JF0603CF	1
Cable Heading Tool	208100	1

1. Plunger appropriate to type of measurement port to be accessed.

Schlumberger
WATER SERVICES

Groundwater Sampling

Field Data Sheet

Project: ____________________

Monitoring Well No.: ____________________

Sampling Zone No(s).: ____________________

Date: ____________________

Start Time: __________ Atm. Rdg: __________

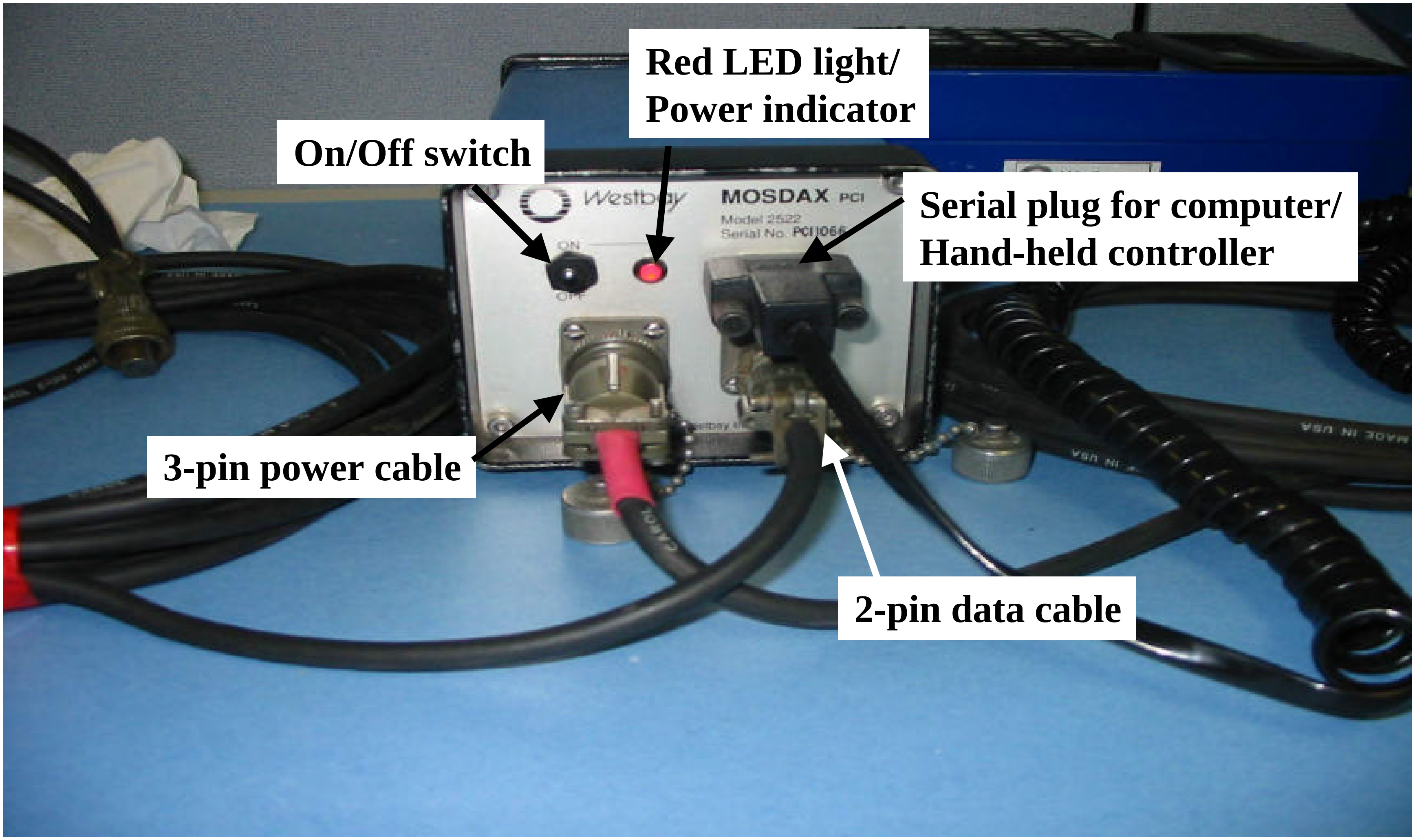
End Time: __________ Atm. Rdg: __________

Operators: ____________________

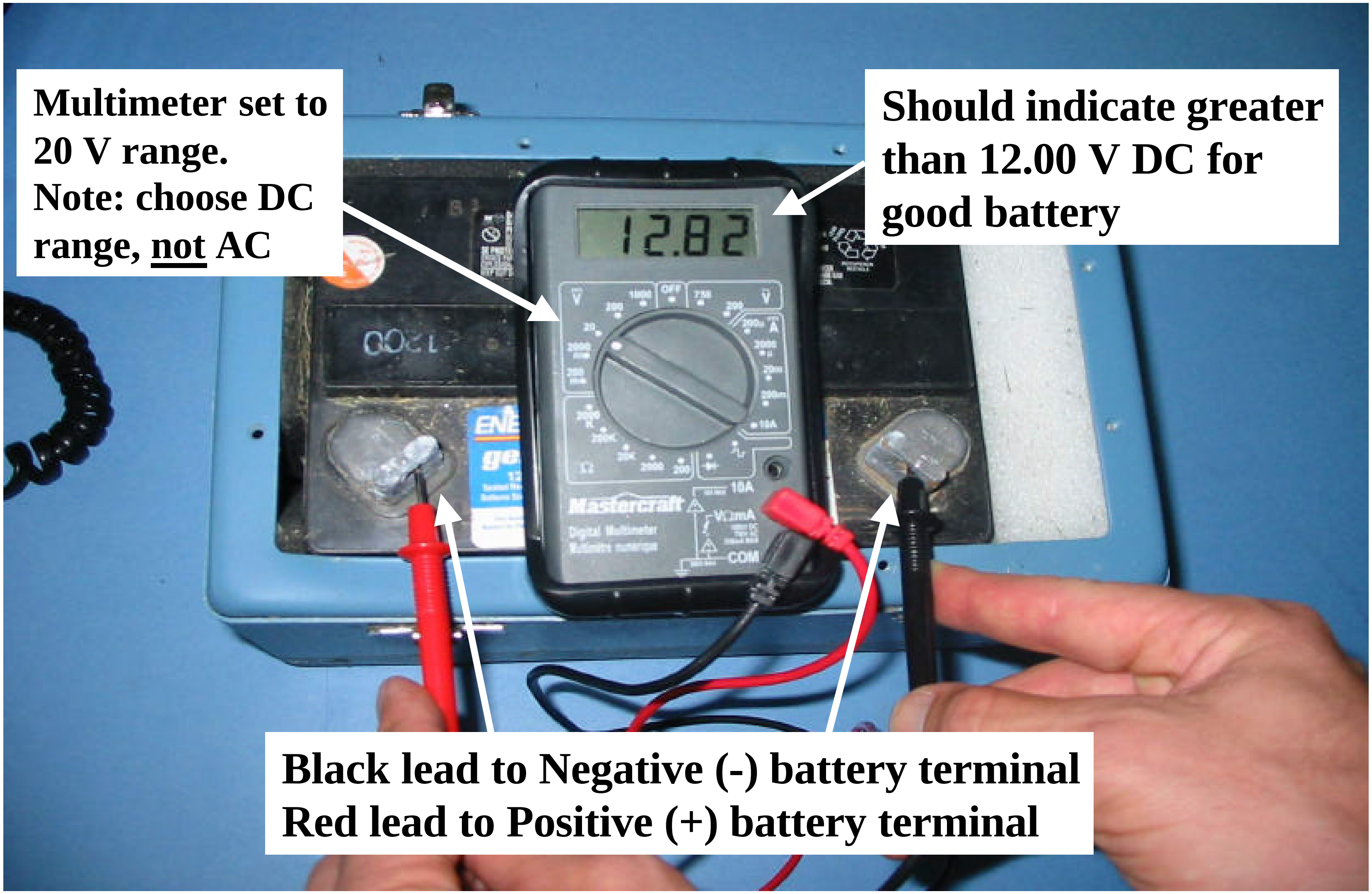
Port No.	Run No.	Surface Function Tests (probe in flushing collar)						Position Sampler			Sample Collection Checks (probe located at sampling zone in Westbay casing)								Comments (volume recovered)
		Shoe Out	Close Valve	Check Vacuum	Open Valve	Apply Vacuum	Close Valve	Locate Port	Arm Out	Land Probe	Pressure in Westbay ( )	Shoe Out	Zone Pressure ( )	Open Valve	Zone Pressure ( )	Close Valve	Shoe In	Pressure in Westbay ( )	

Additional Comments: (pH, turbidity, S.C., etc.)

Pic.1 Computer Interface Units, old and new:
MPCI model 2522 (left) and MAGI model 2536 (right)



Pic.2 MPCI unit showing typical set-up configuration

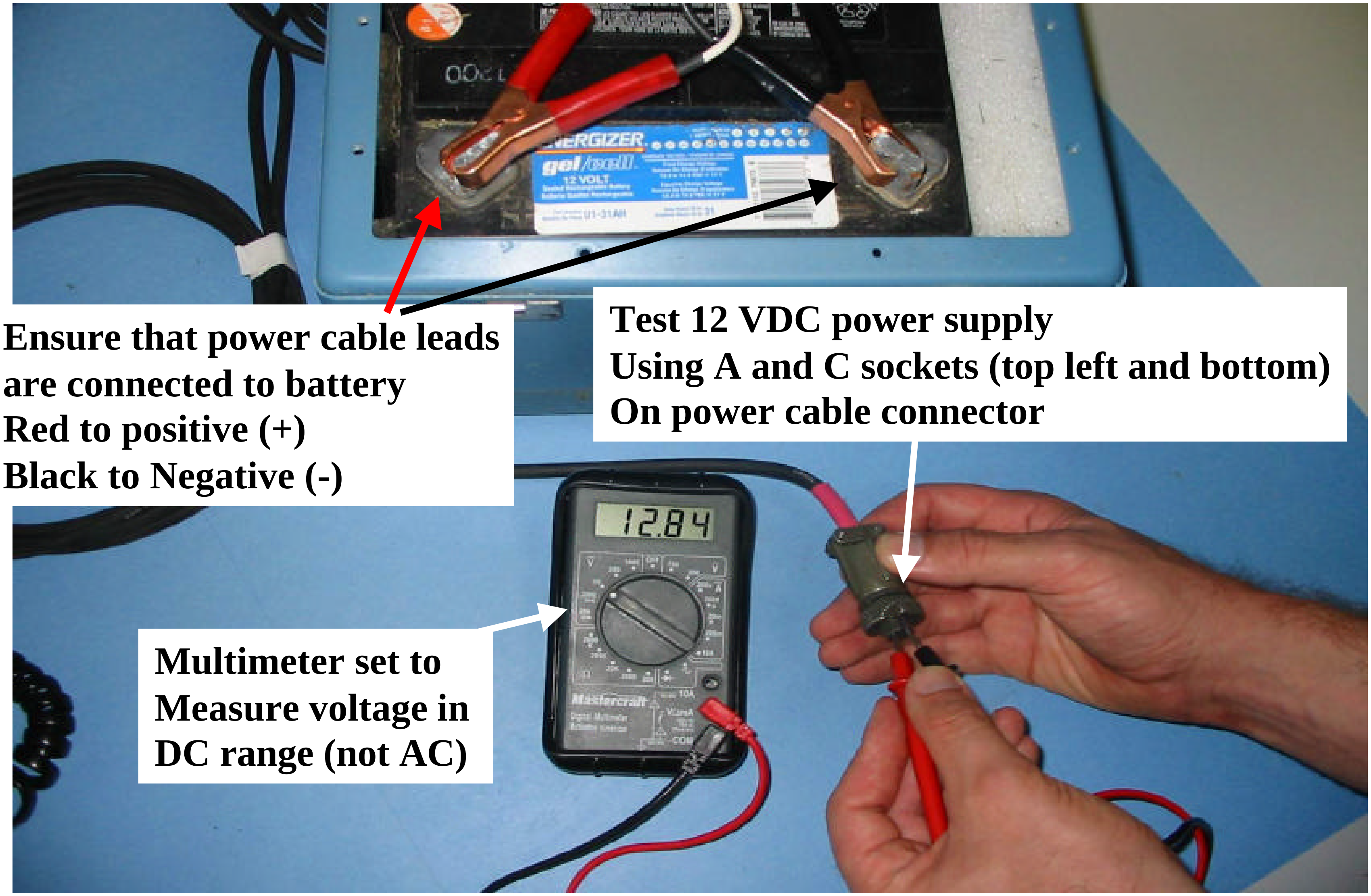


**Multimeter set to 20 V range.
Note: choose DC range, not AC**

Should indicate greater than 12.00 V DC for good battery

**Black lead to Negative (-) battery terminal
Red lead to Positive (+) battery terminal**

Pic.3 Testing 12 VDC Power Supply using Multimeter

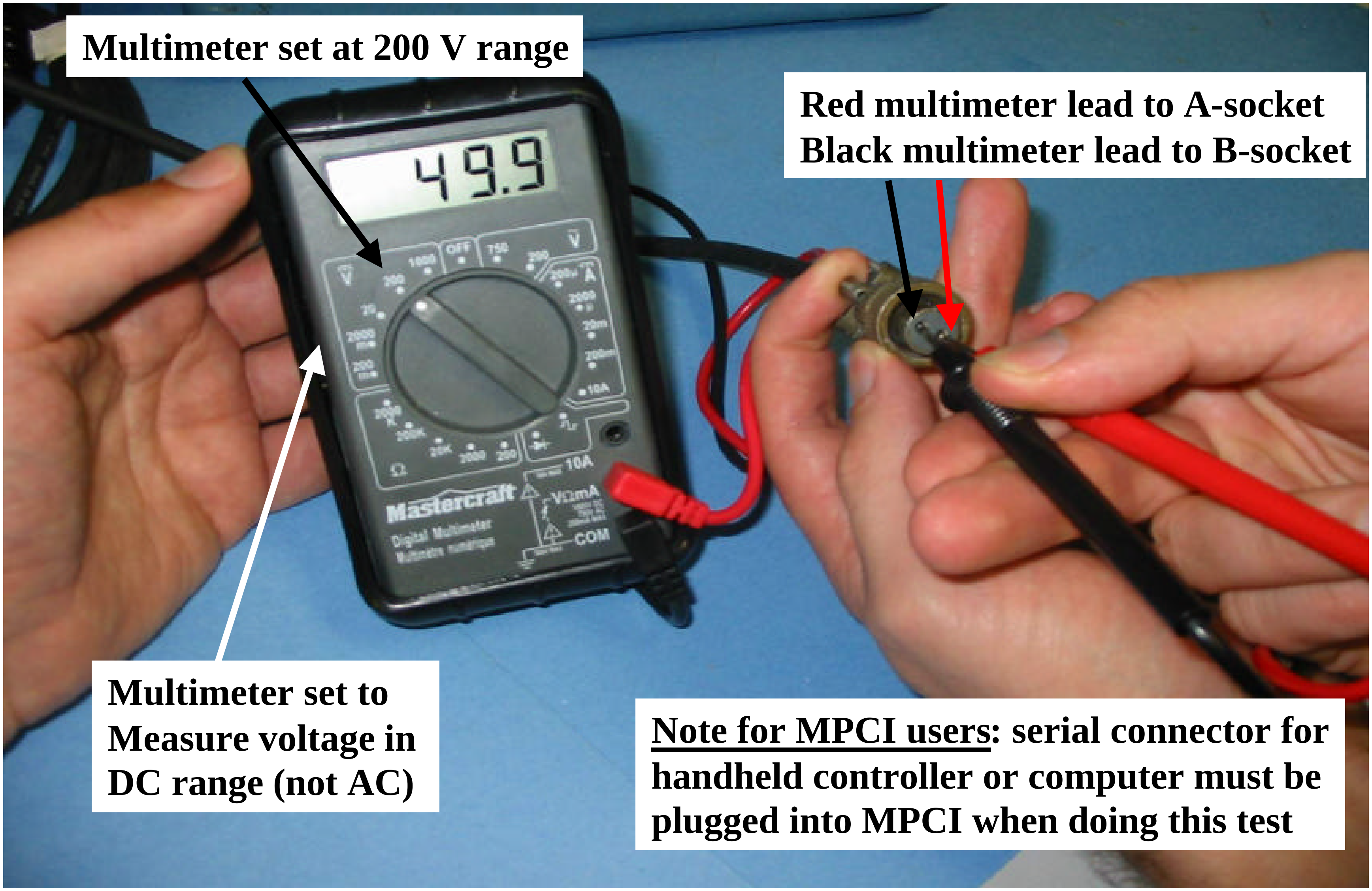


Ensure that power cable leads
are connected to battery
Red to positive (+)
Black to Negative (-)

Test 12 VDC power supply
Using A and C sockets (top left and bottom)
On power cable connector

Multimeter set to
Measure voltage in
DC range (not AC)

Pic.4 Testing Power Cable Voltage
(should indicate greater than 12.00 V DC for good battery and cable)



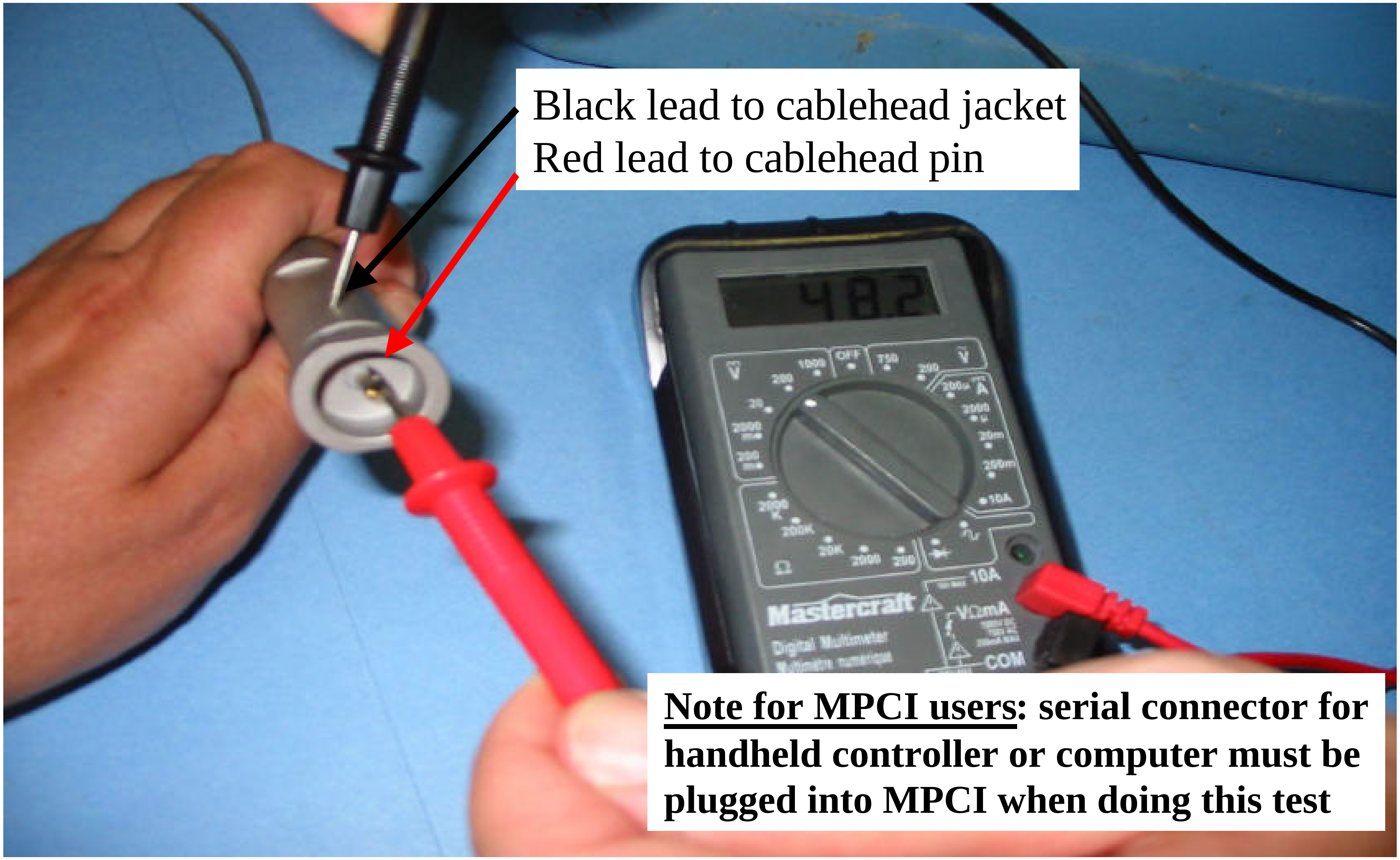
Multimeter set at 200 V range

Red multimeter lead to A-socket
Black multimeter lead to B-socket

Multimeter set to Measure voltage in DC range (not AC)

<u>Note for MPCI users</u>: serial connector for handheld controller or computer must be plugged into MPCI when doing this test

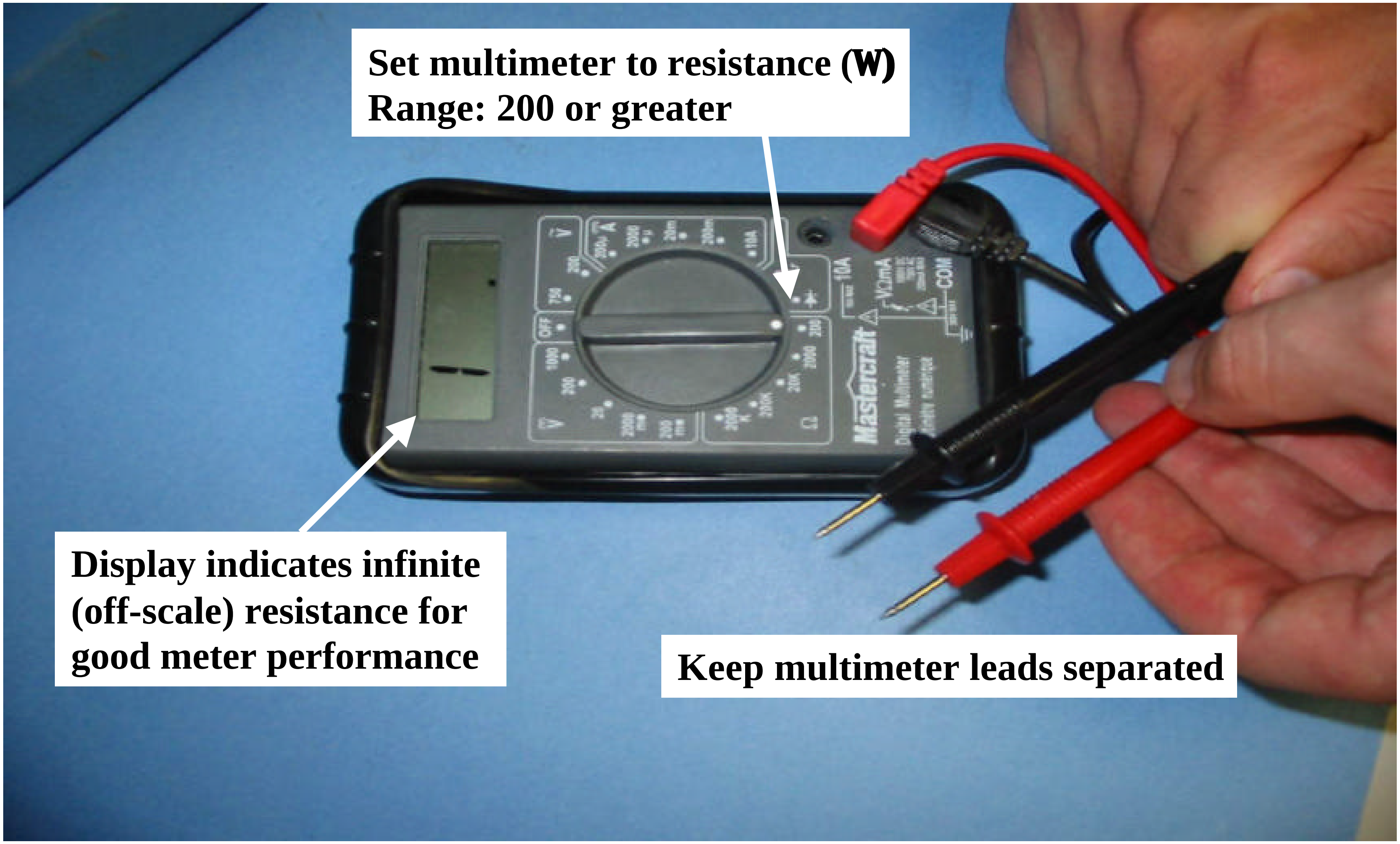
Pic.5 Testing Power output from MPCI or MAGI using data cable (should be greater than 48 V) *Note: MPCI/MAGI must have power 'on' and be connected to power supply.*



Black lead to cablehead jacket
Red lead to cablehead pin

<u>Note for MPCI users</u>: serial connector for handheld controller or computer must be plugged into MPCI when doing this test

Pic.6 Checking power output at cablehead (should be greater than 48 V)
Note: MPCI/MAGI must have power 'on' and be connected to power supply.

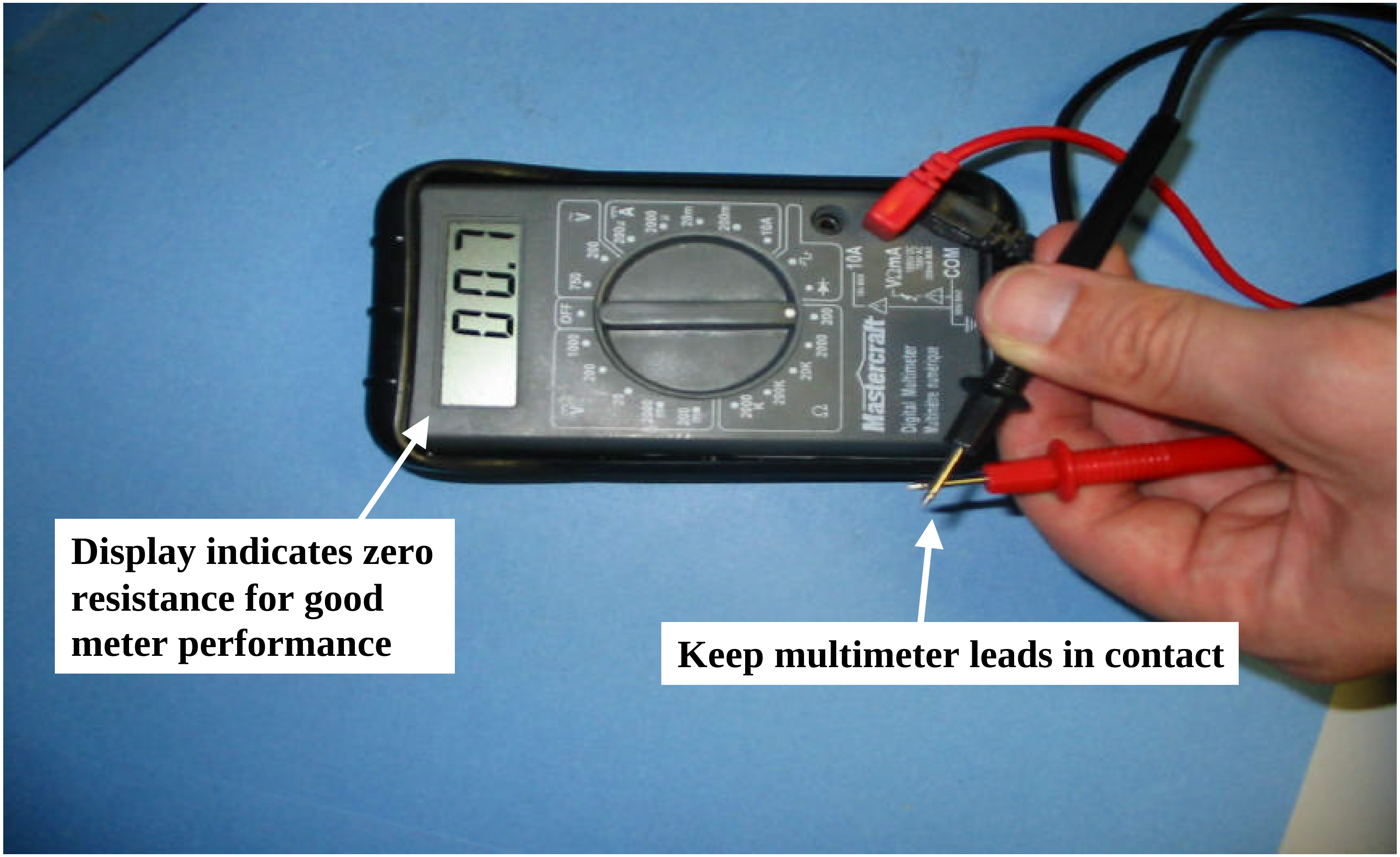


Set multimeter to resistance (W)
Range: 200 or greater

Display indicates infinite (off-scale) resistance for good meter performance

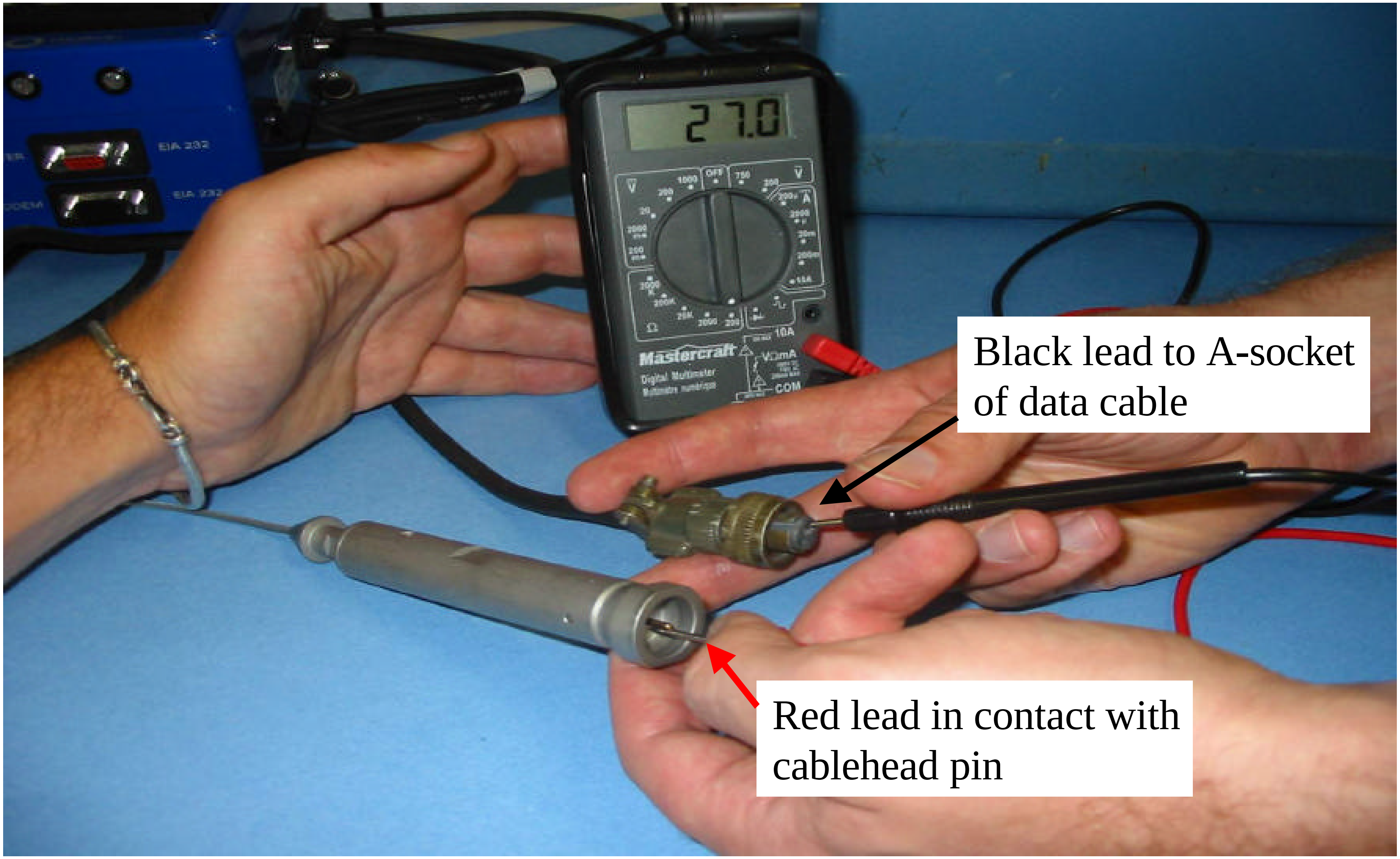
Keep multimeter leads separated

Pic.7 Test multimeter “open” resistence


Display indicates zero resistance for good meter performance

Keep multimeter leads in contact

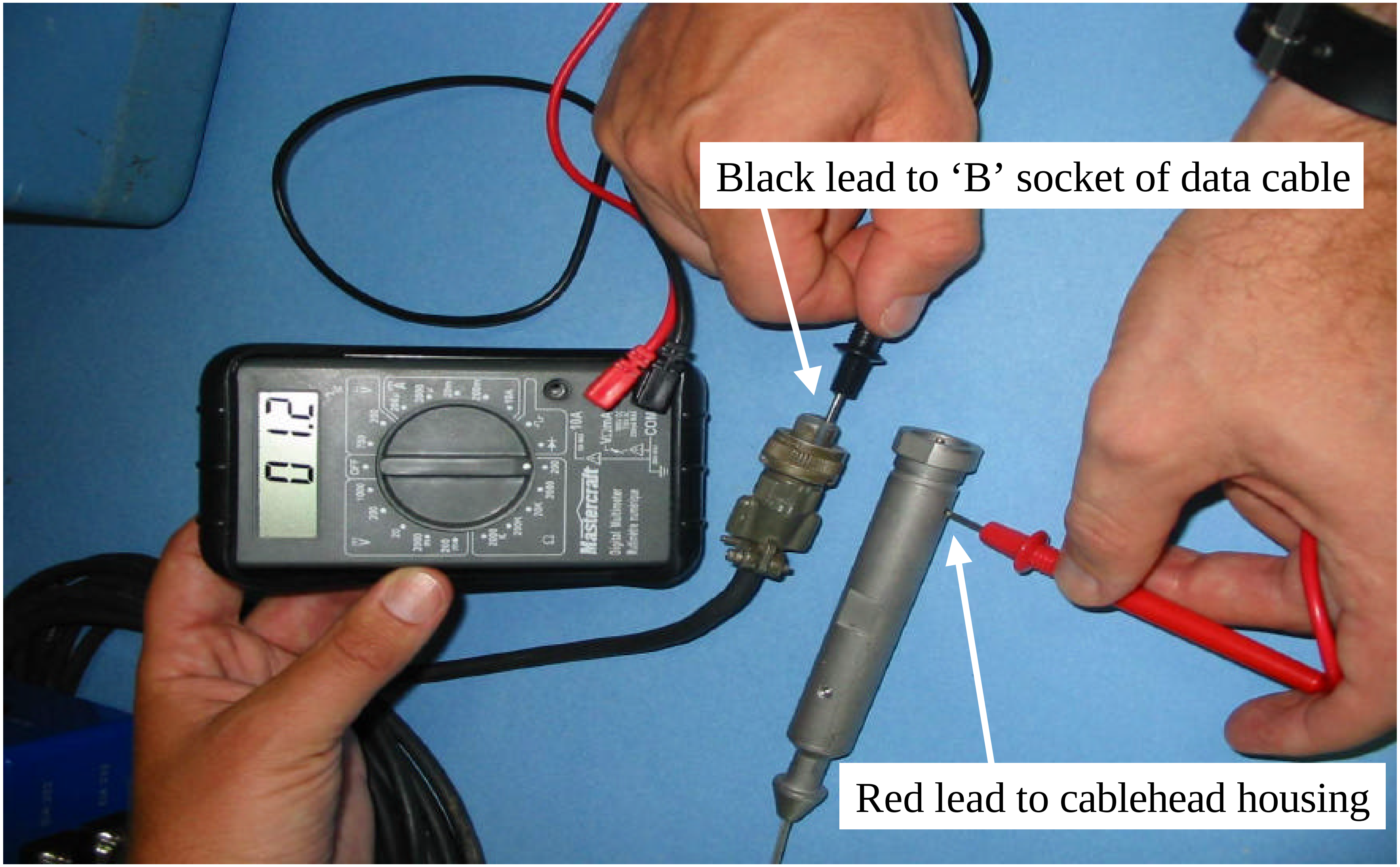
Pic.8 Test multimeter “closed” resistence



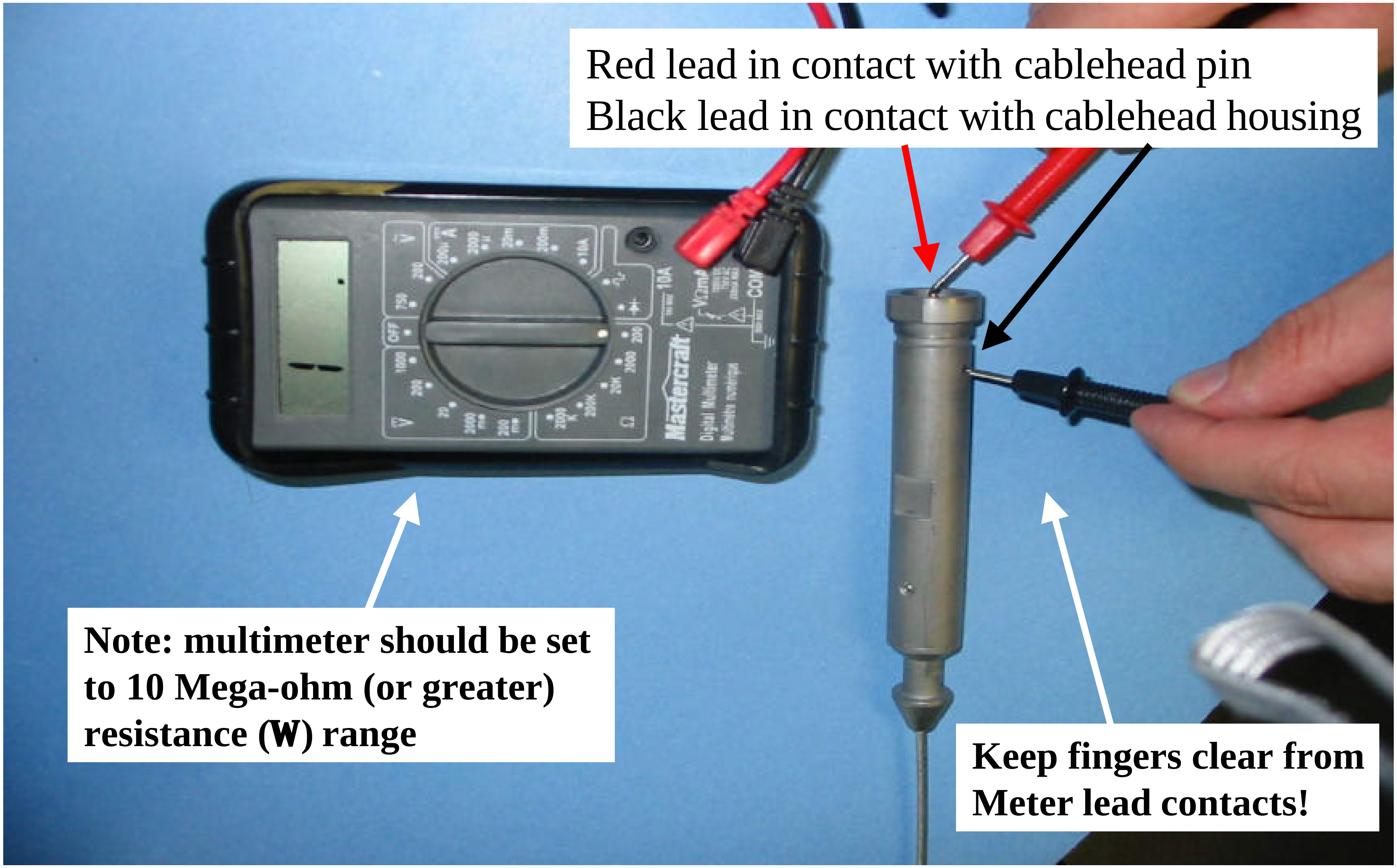
Black lead to A-socket of data cable

Red lead in contact with cablehead pin

Pic.9 Test wireline ‘A-A’ resistance (approx. 27 W/1000 ft)



Pic.10 Test wireline 'B-B' resistance (should be less than 'A-A')

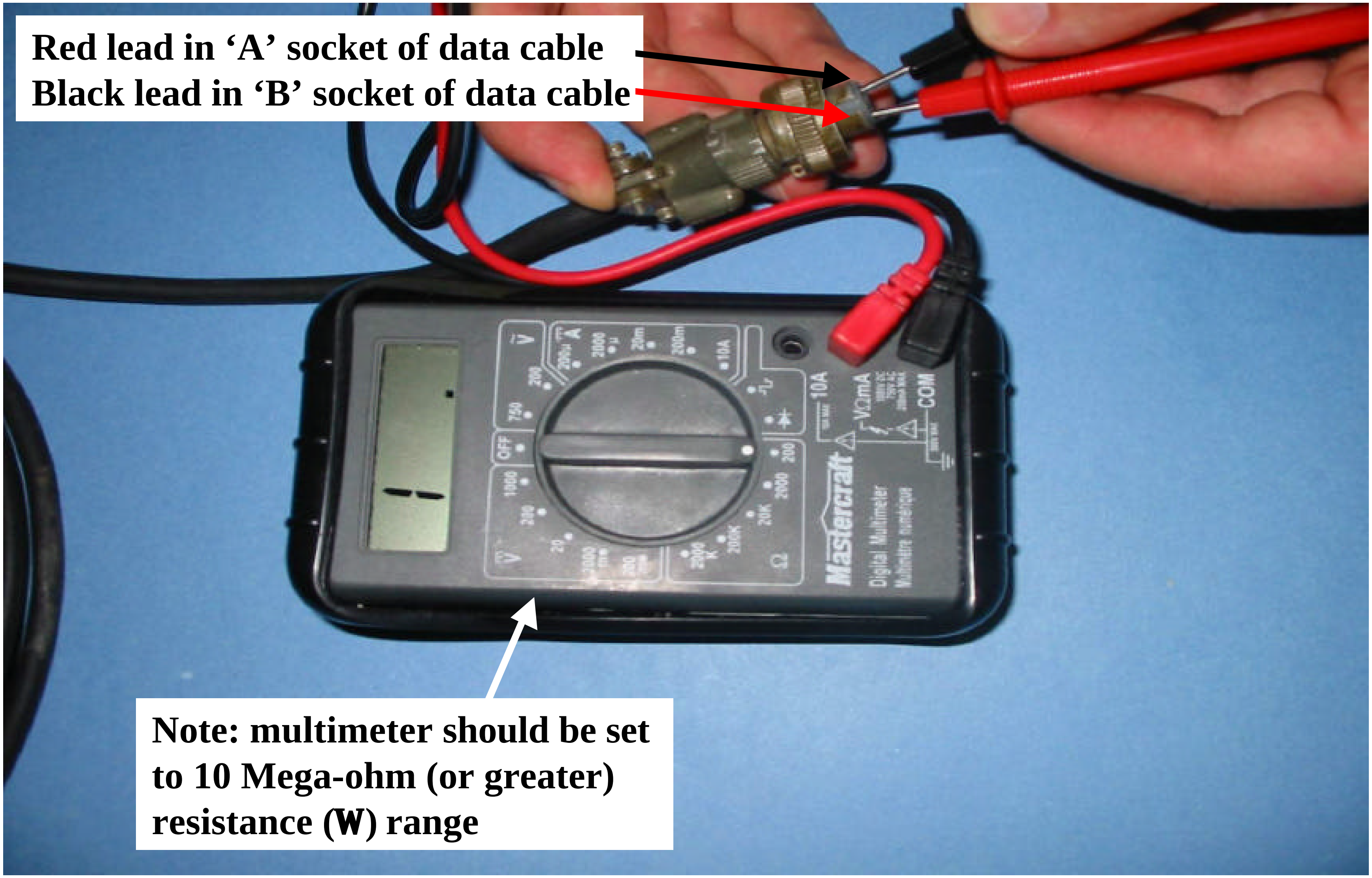


Red lead in contact with cablehead pin
Black lead in contact with cablehead housing

Note: multimeter should be set to 10 Mega-ohm (or greater) resistance (W) range

Keep fingers clear from Meter lead contacts!

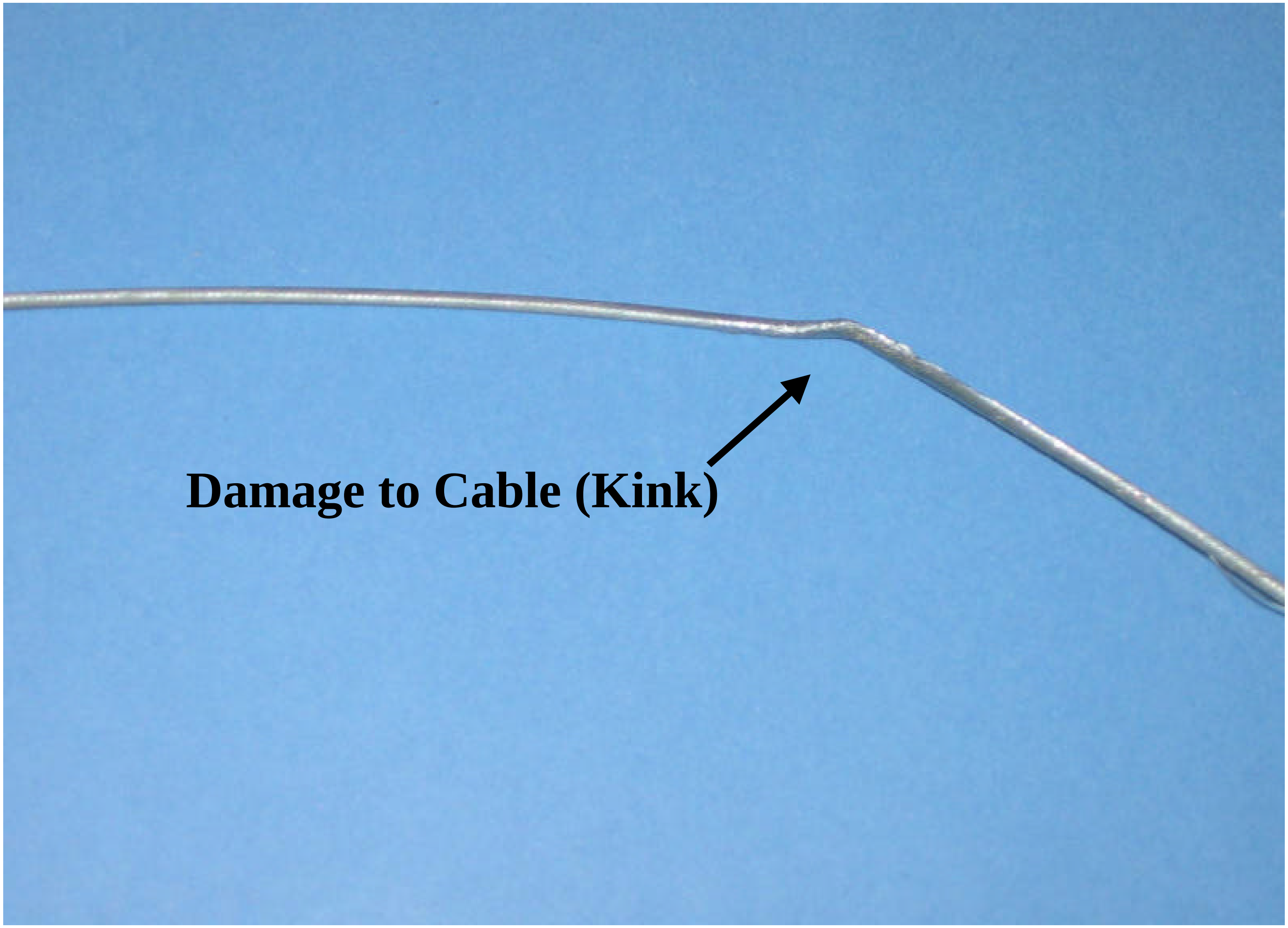
Pic.11 Test wireline ‘A-B’ resistance at cablehead (should be off-scale)



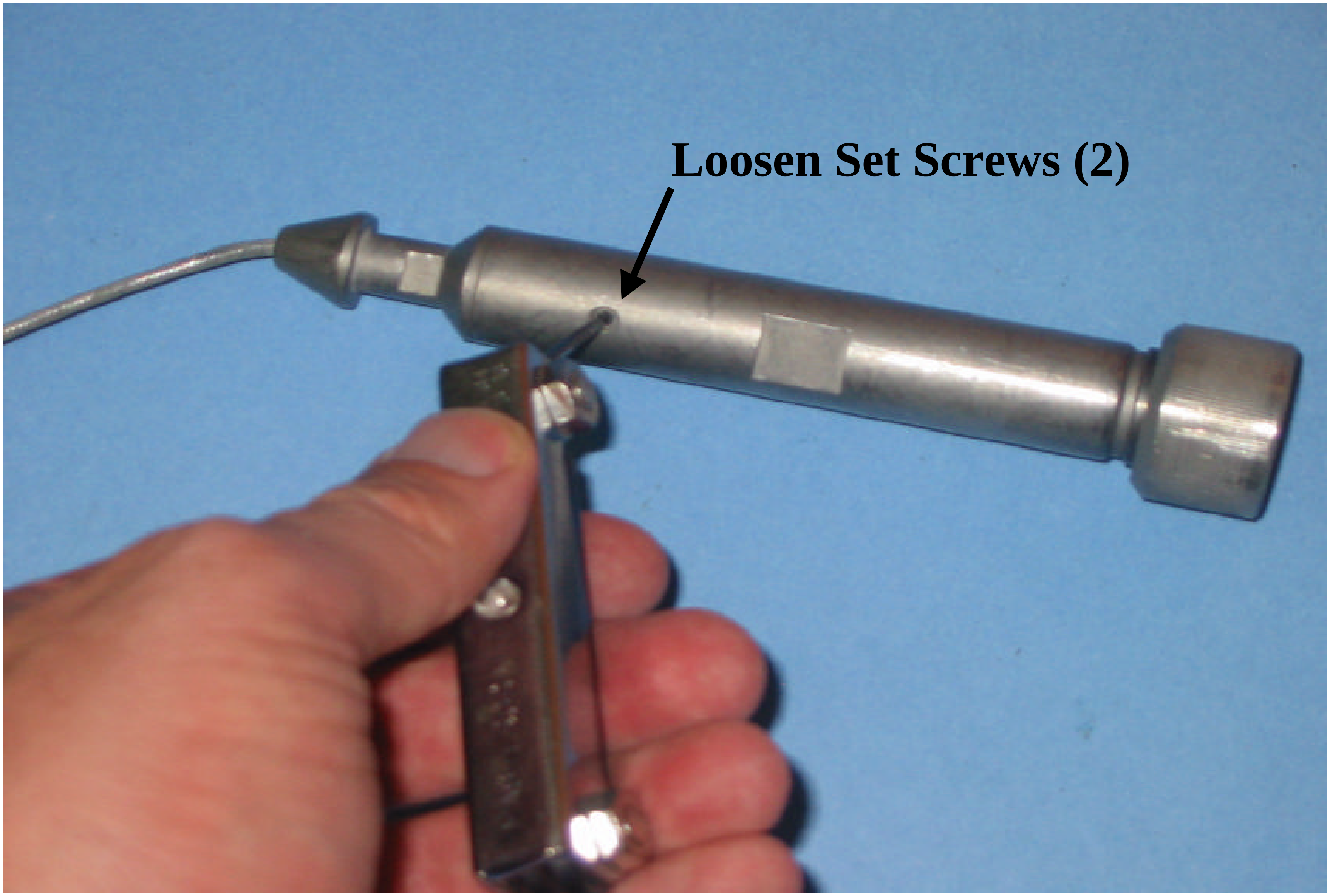
Red lead in ‘A’ socket of data cable
Black lead in ‘B’ socket of data cable

Note: multimeter should be set to 10 Mega-ohm (or greater) resistance (W) range

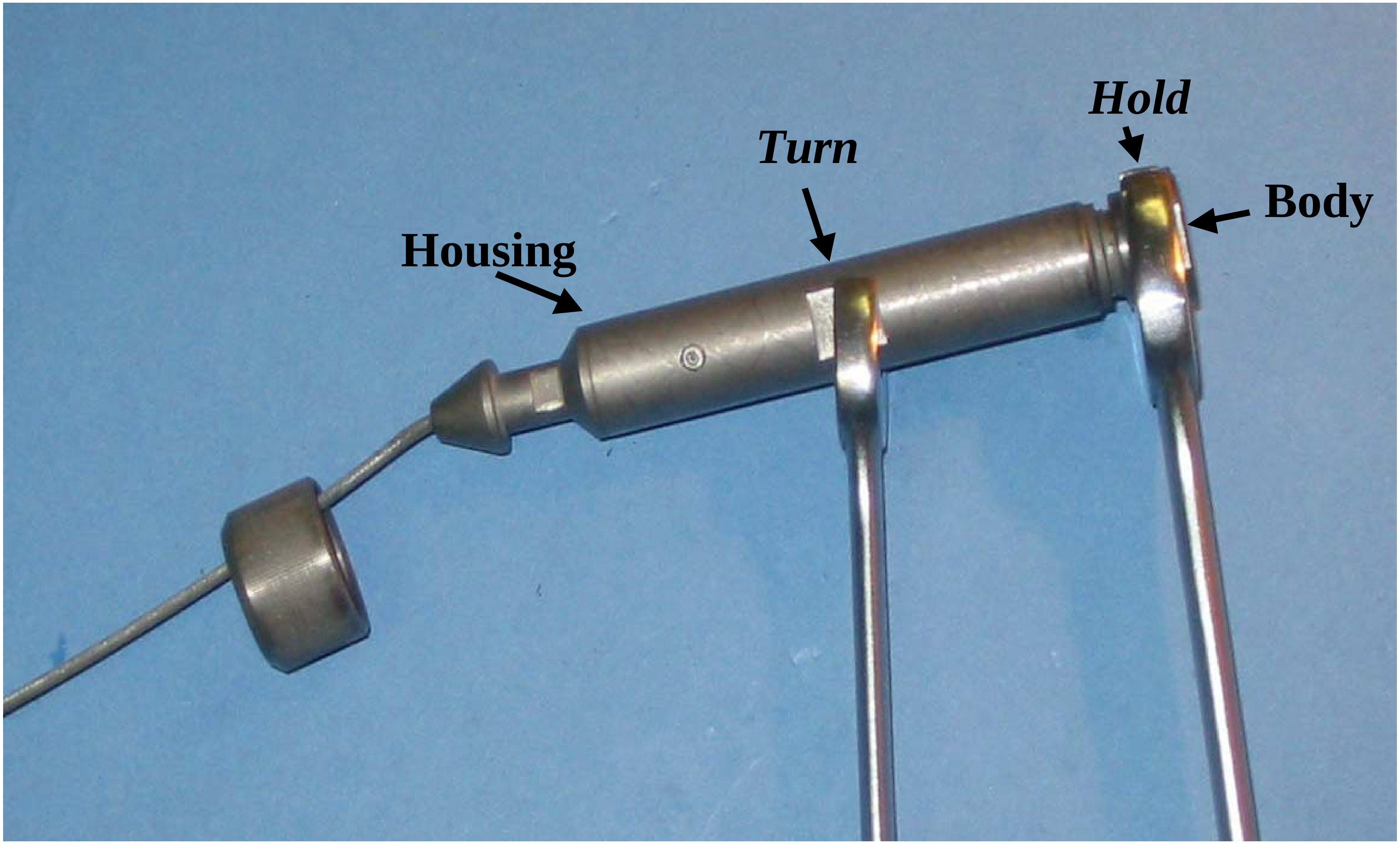
Pic.11 Test wireline ‘A-B’ resistance at data cable (should be off-scale)



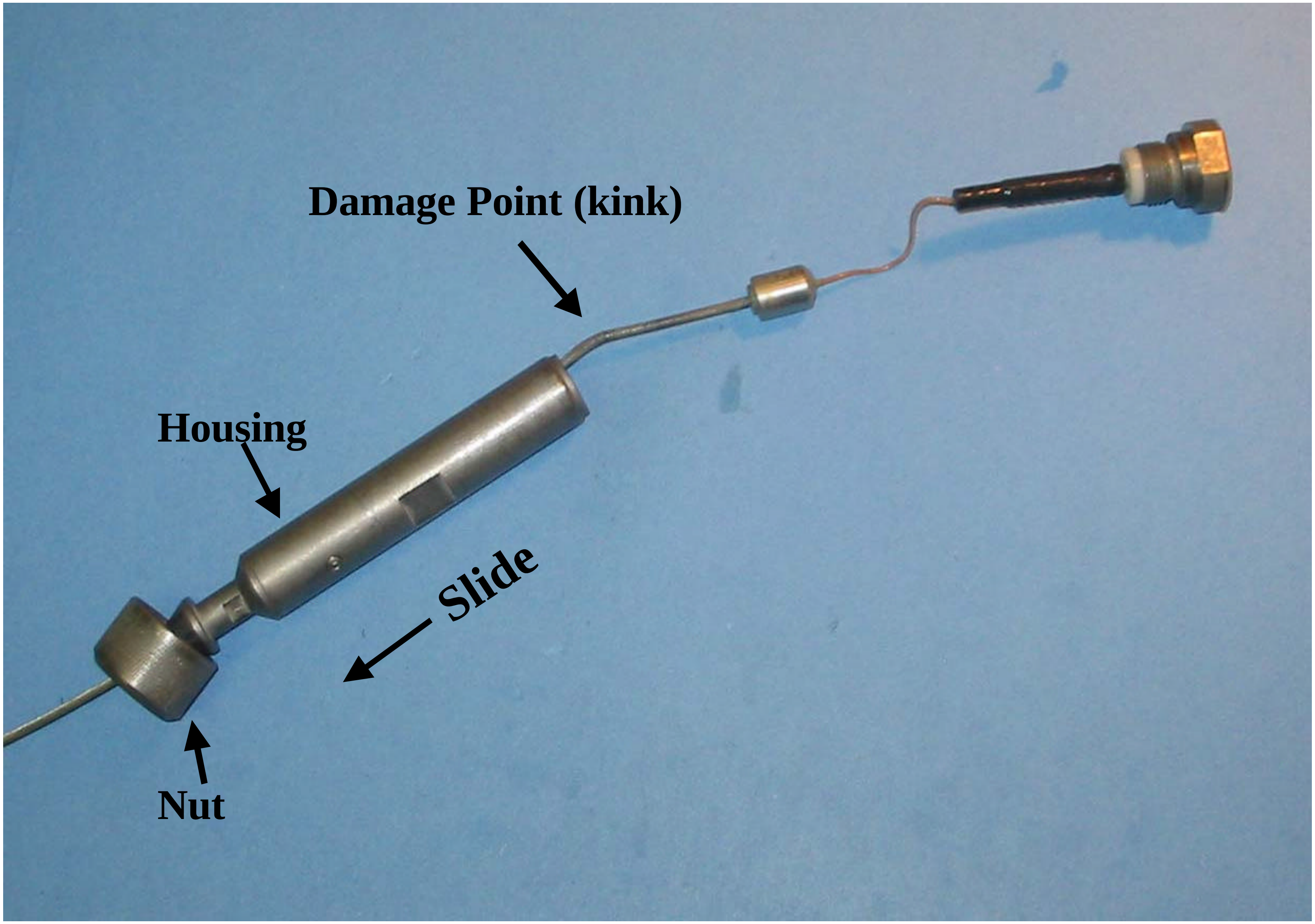
Pic.1 Identification of Cable Damage



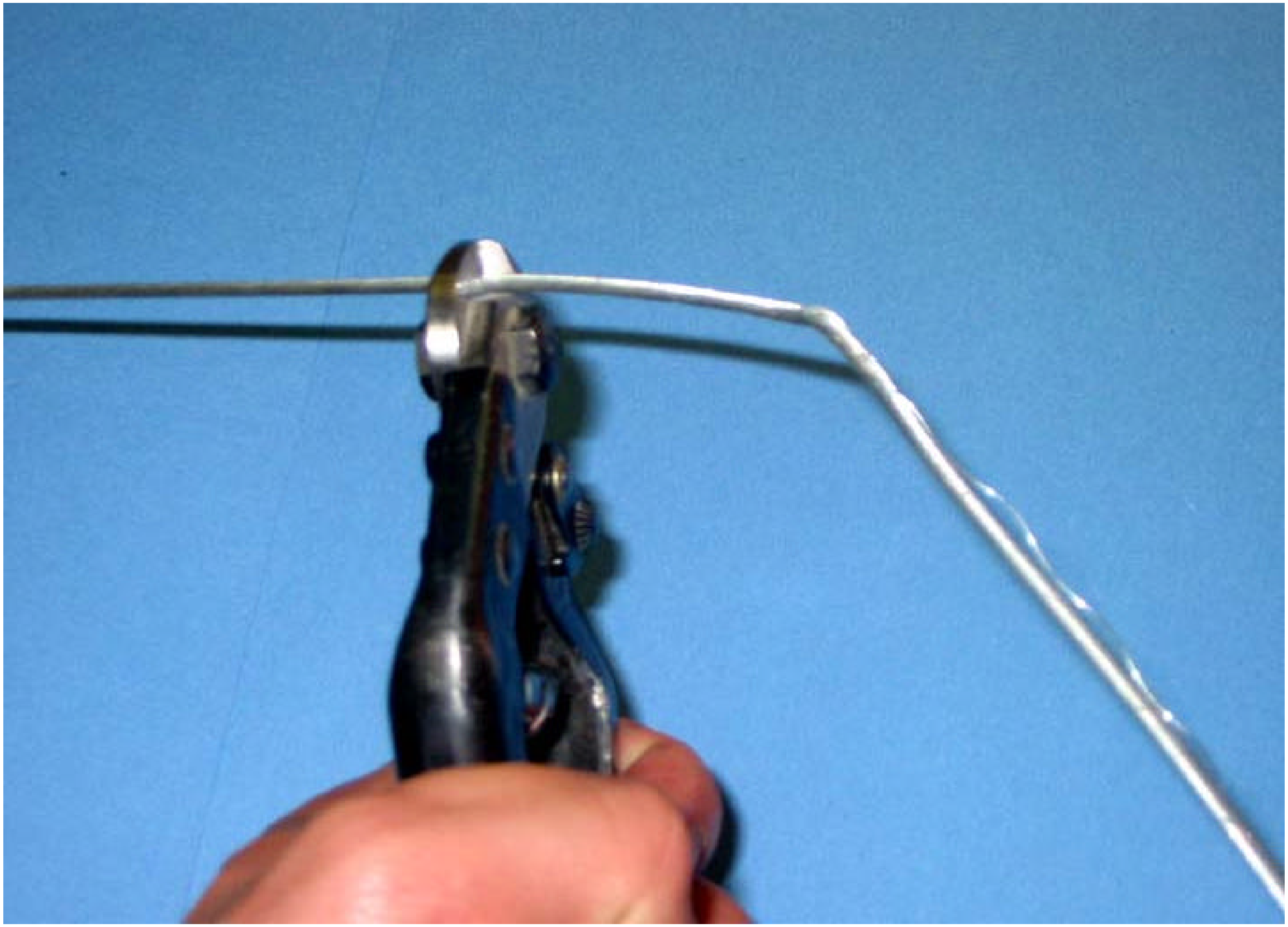
Pic.2 **Cablehead Disassembly (1): Loosen set Screws**



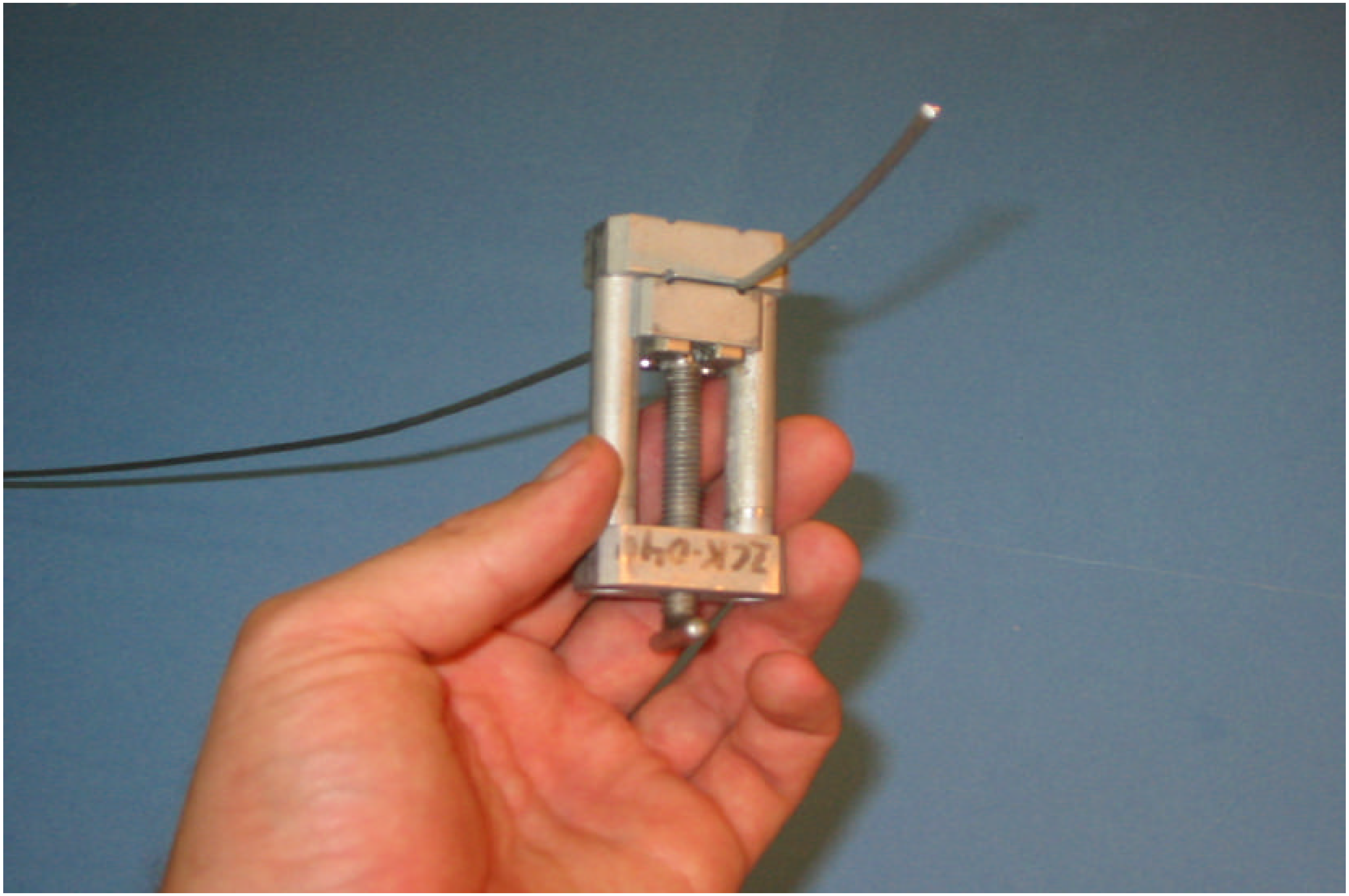
Pic.3 Cablehead Disassembly(2): Unscrew Housing From Body



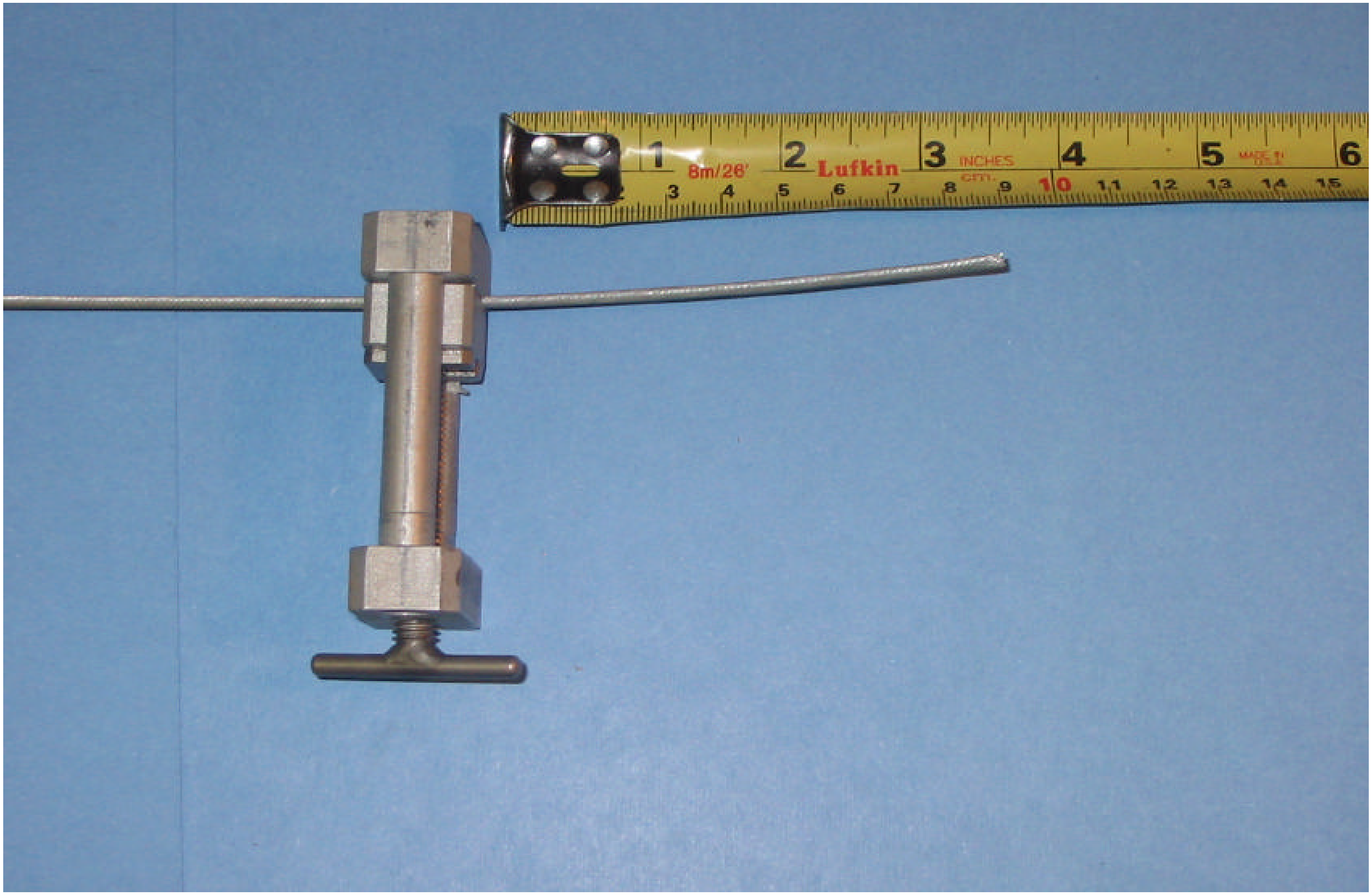
Pic.4 **Cablehead Disassembly(3):**
Slide Housing and Cablehead Nut Past Damage Point



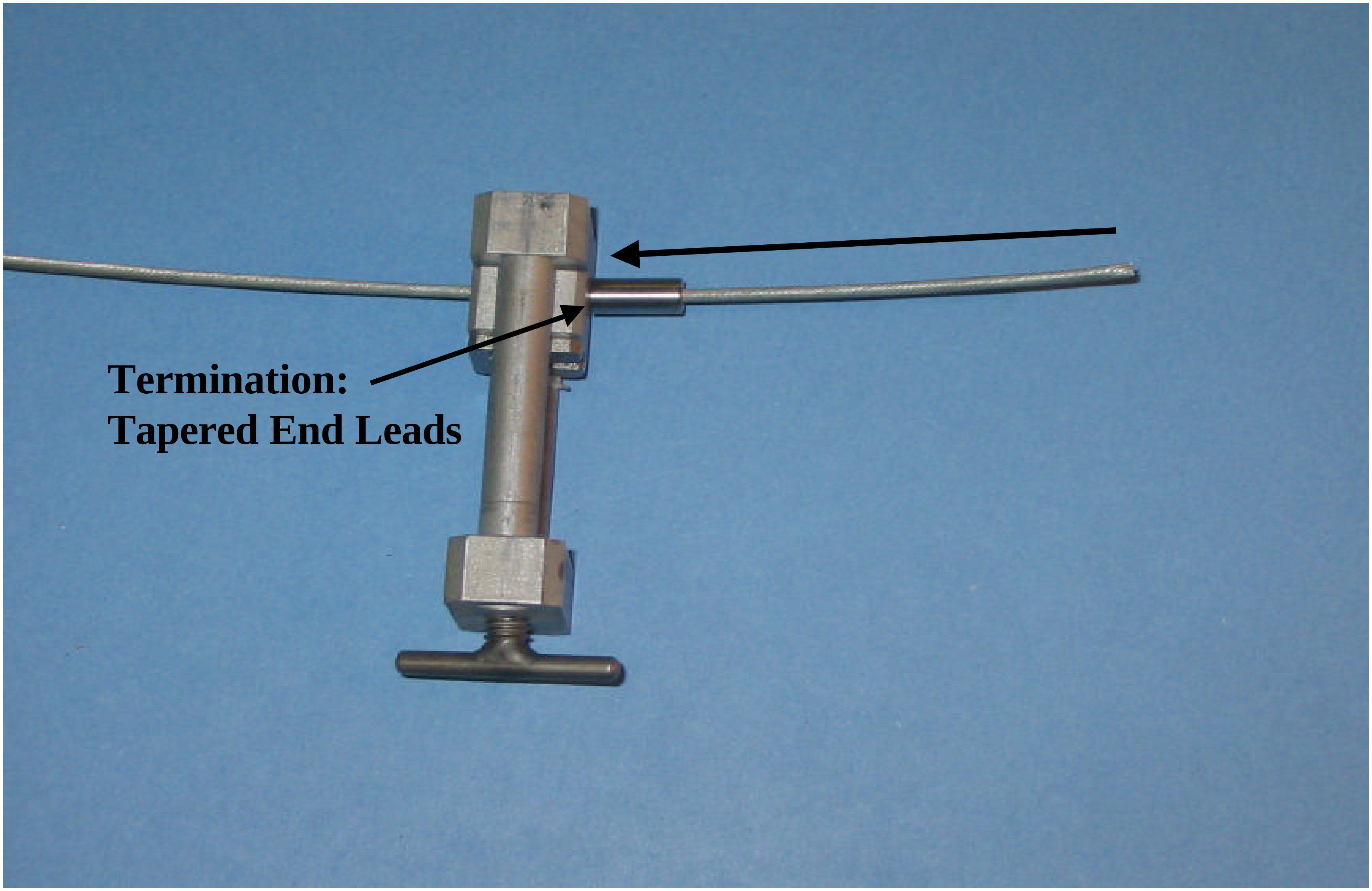
Pic.5 Cut Cable above Damage Point



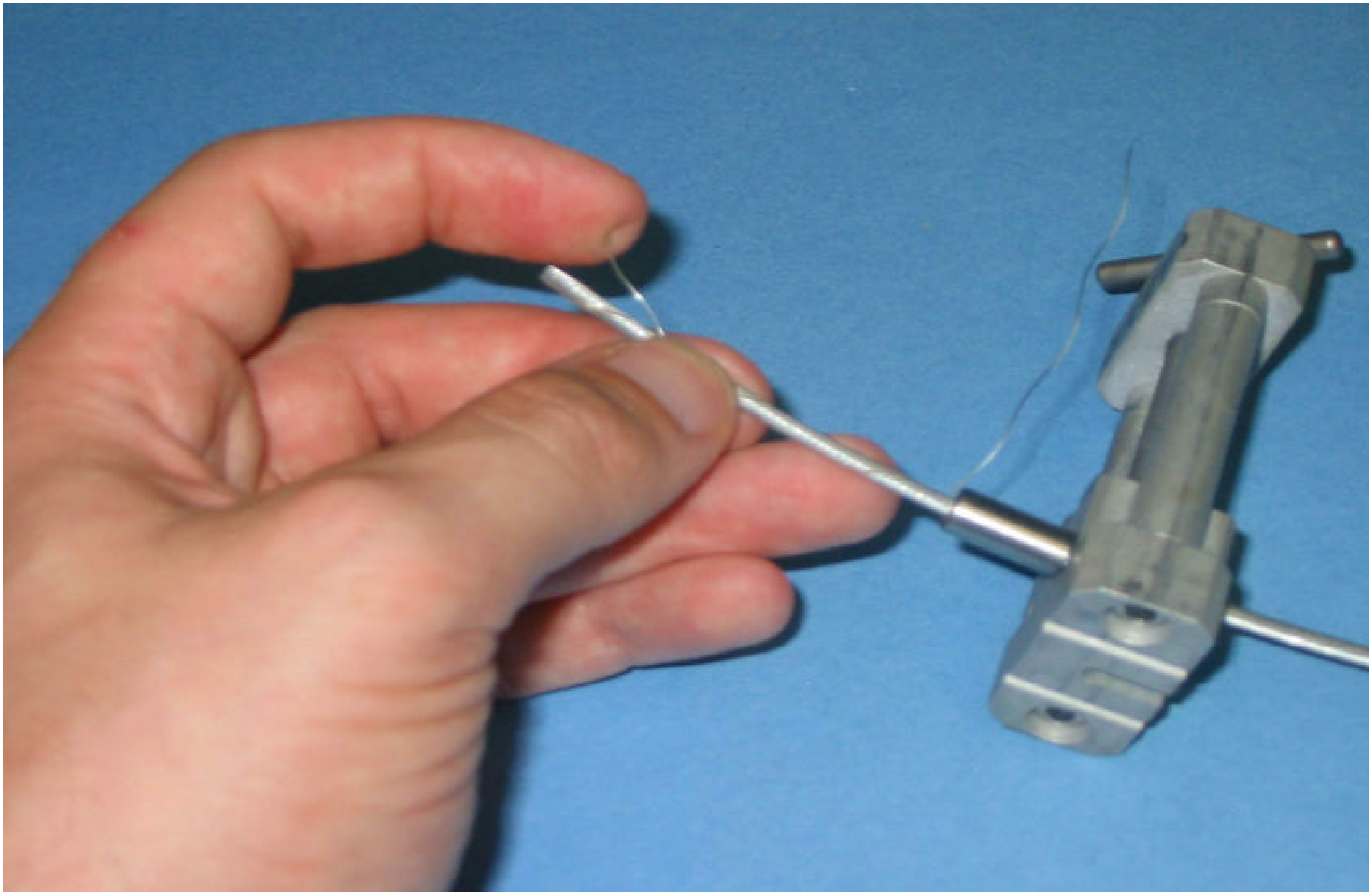
Pic.6a Clamp Cable in Termination Jig



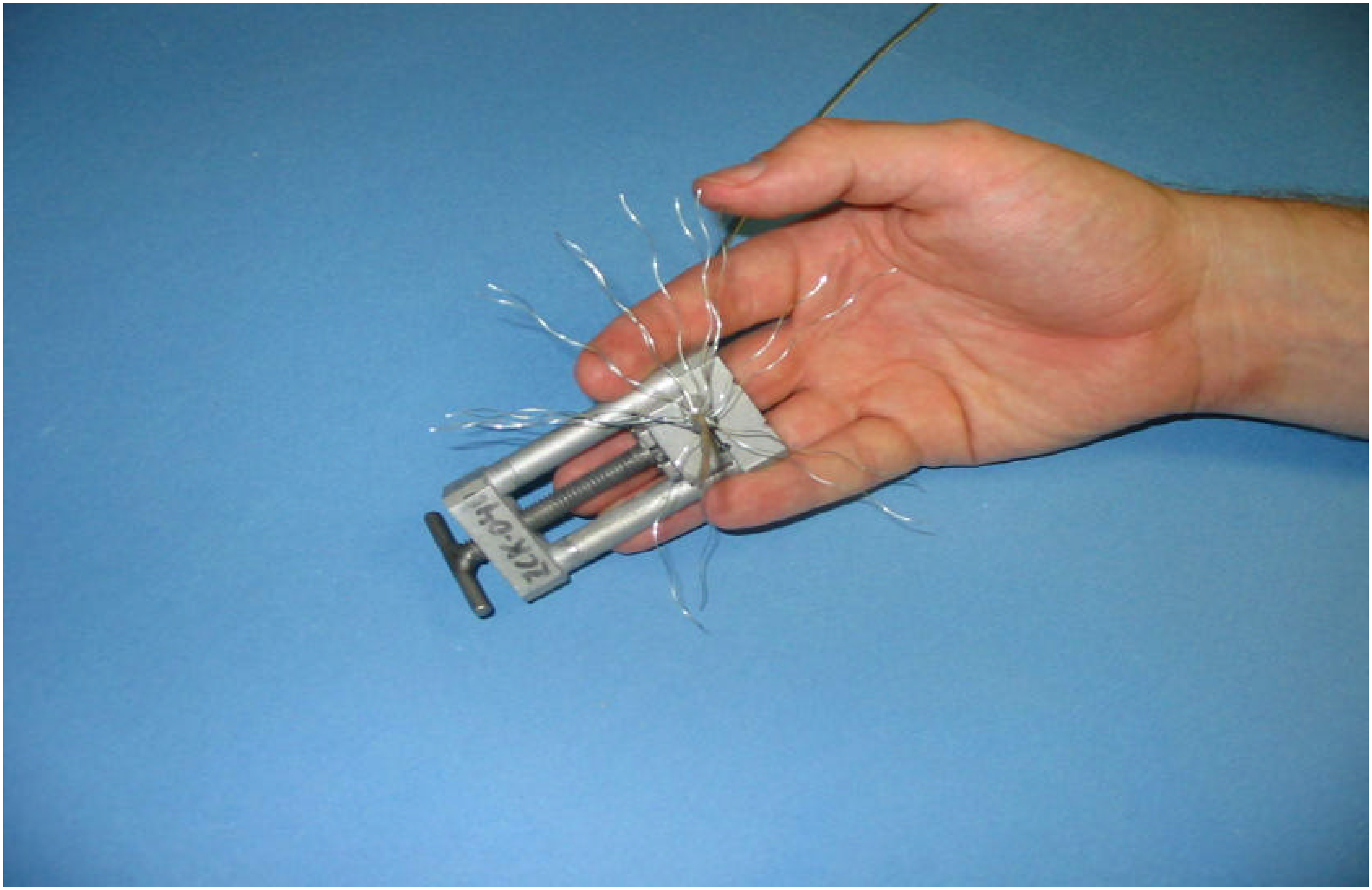
Pic.6b Leave 3.5 inches Cable Exposed



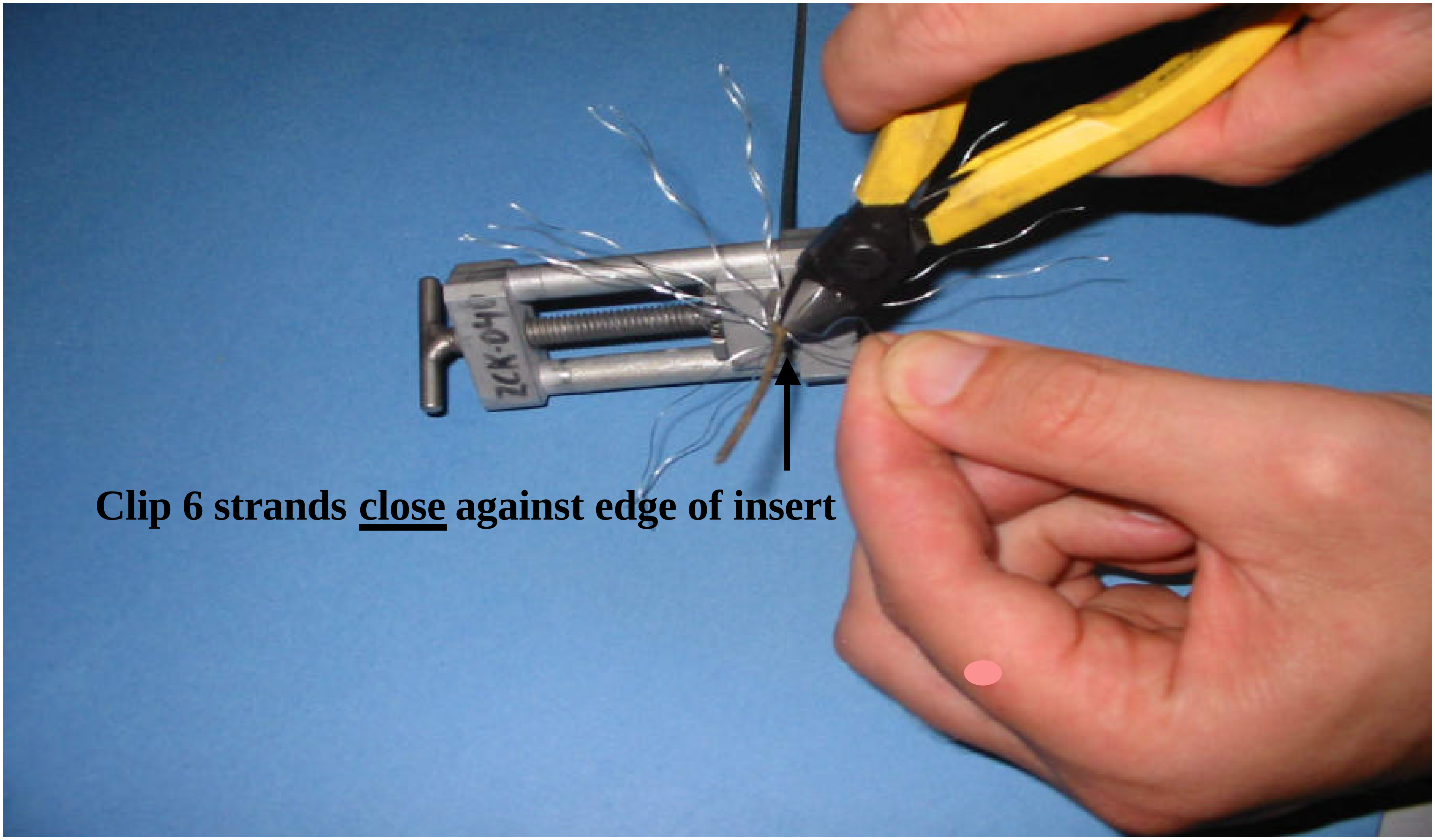
Pic.6c Slide Termination Insert Over Cable



Pic.7a Unwind Outer-layer Strands (start)

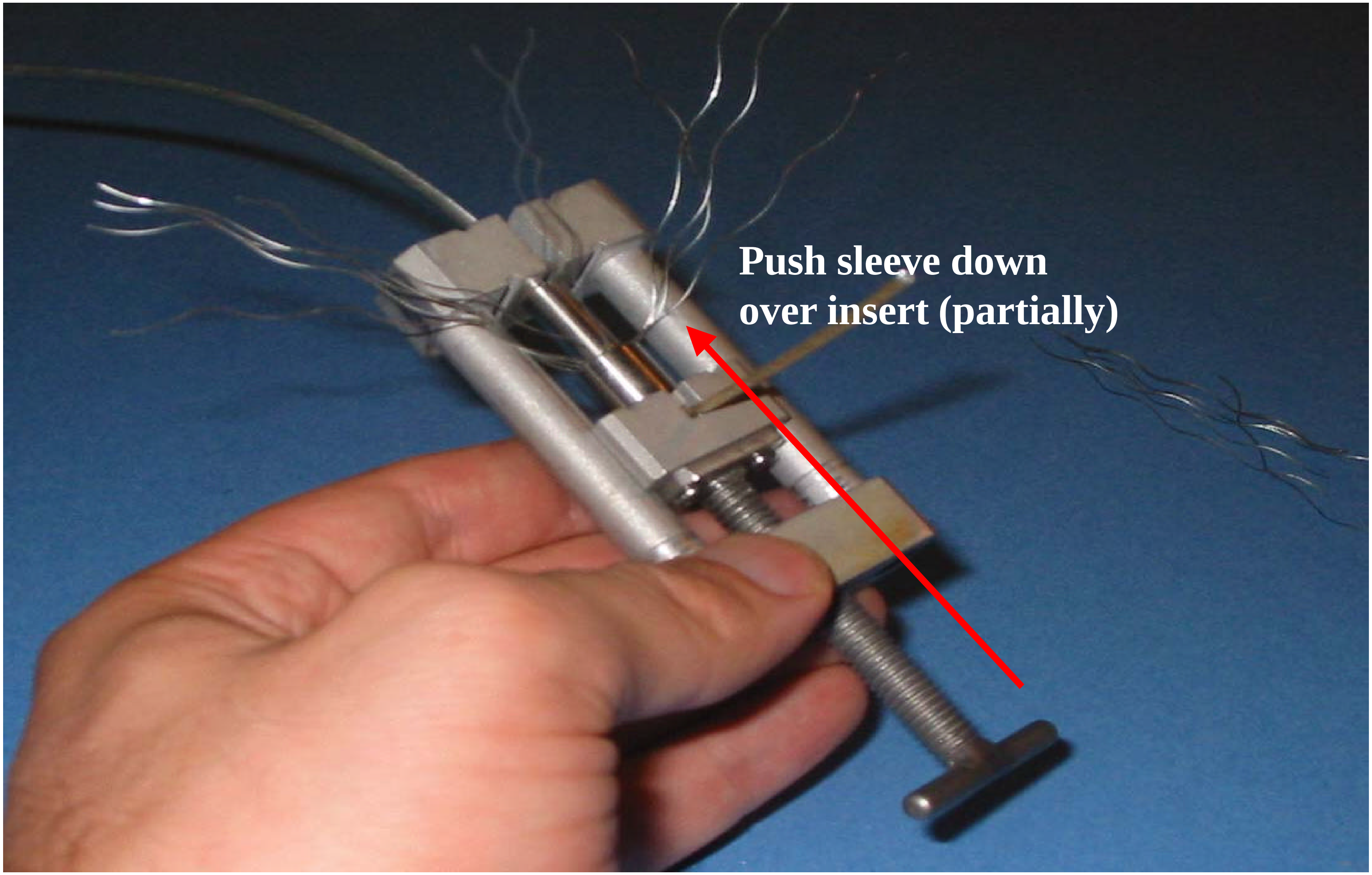


Pic.7b Unwind Outer Layer Strands (finish)

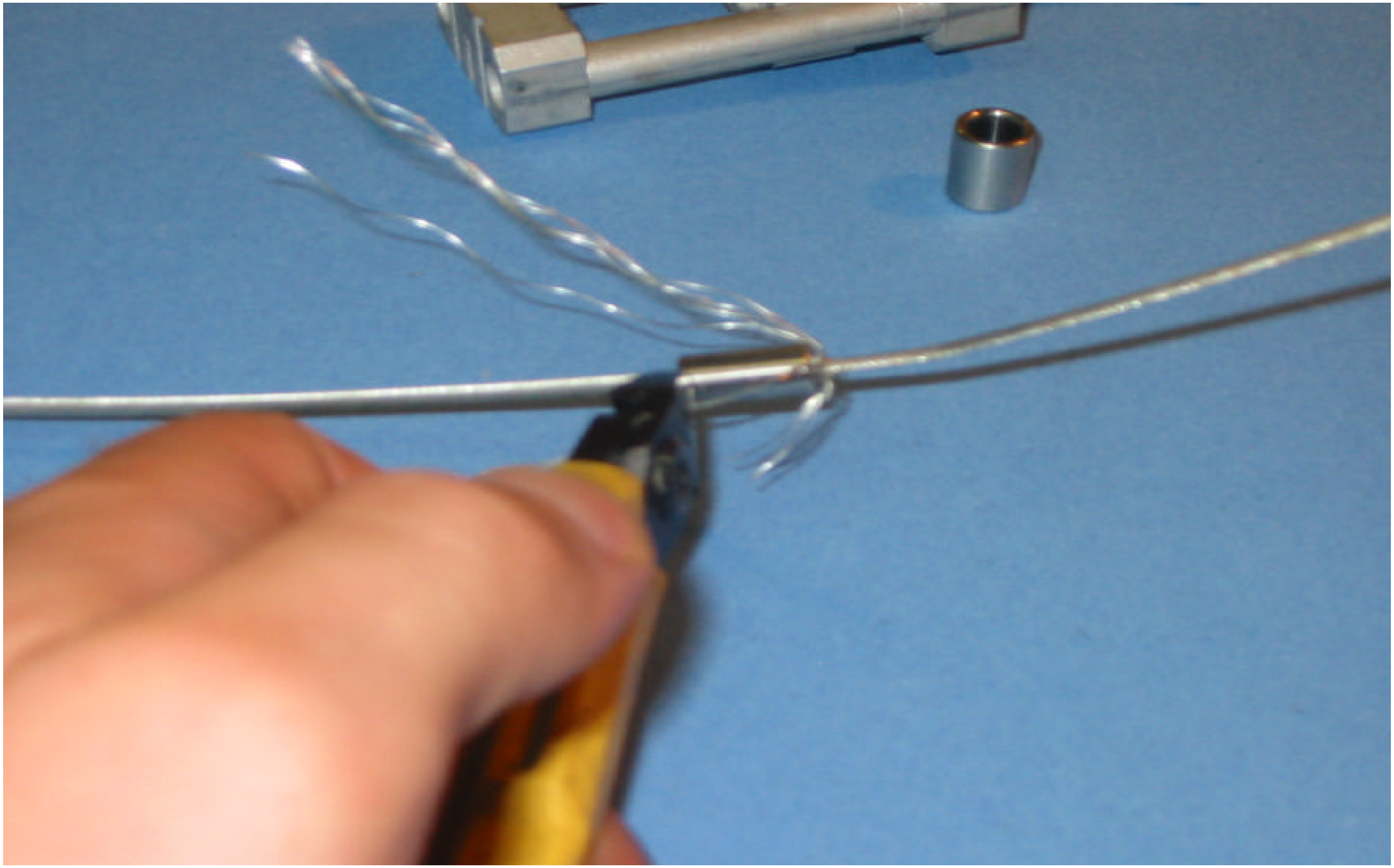


Clip 6 strands close against edge of insert

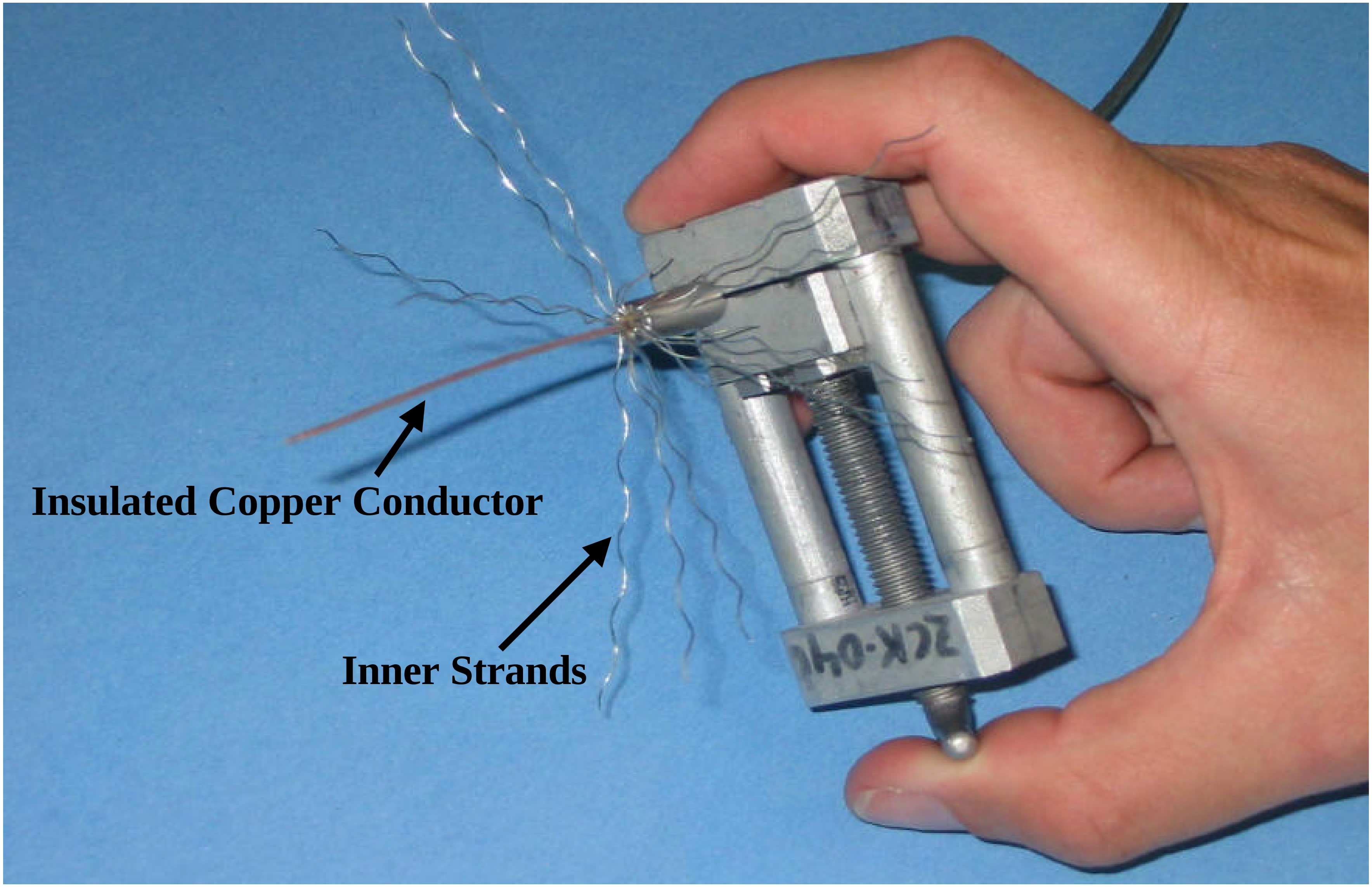
Pic.8 Clipping Outer Wire Strands (6 strands out of 18)


Push sleeve down
over insert (partially)

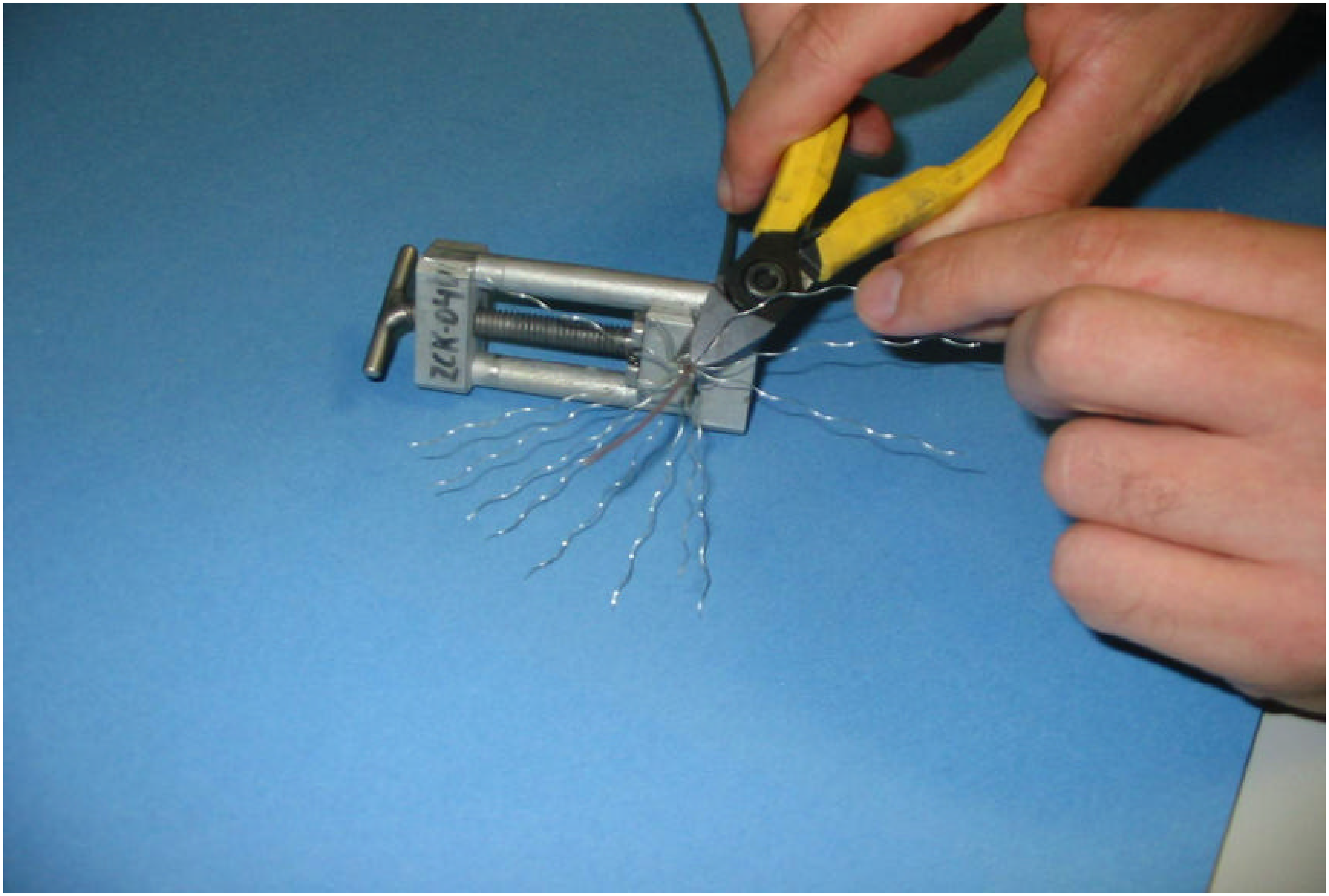
Pic.9 Partially Push Sleeve Down on Insert Using Jig
(enough to bend strands down along insert)



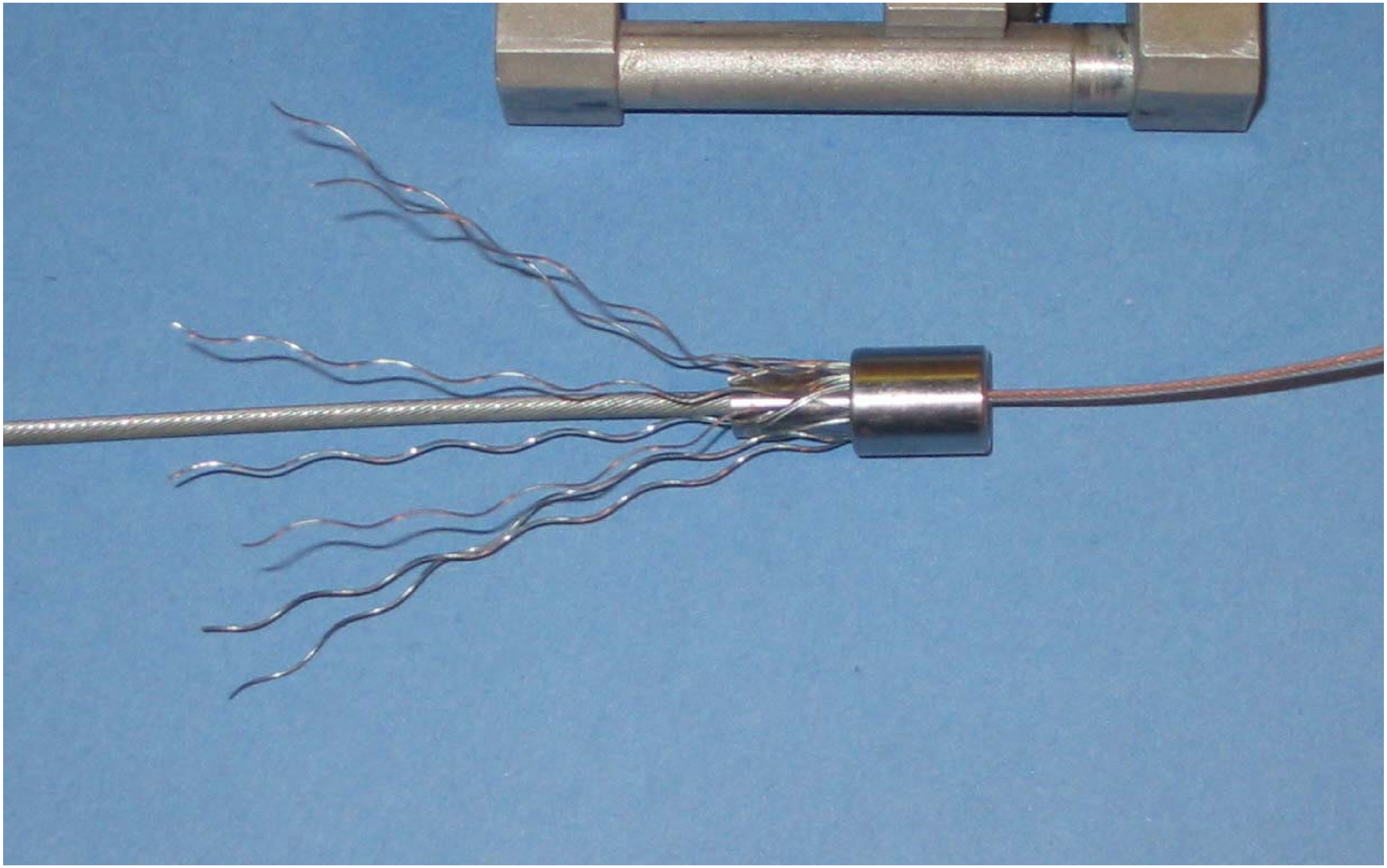
Pic.10 Trim Outer Wire Strands to Base of Insert.



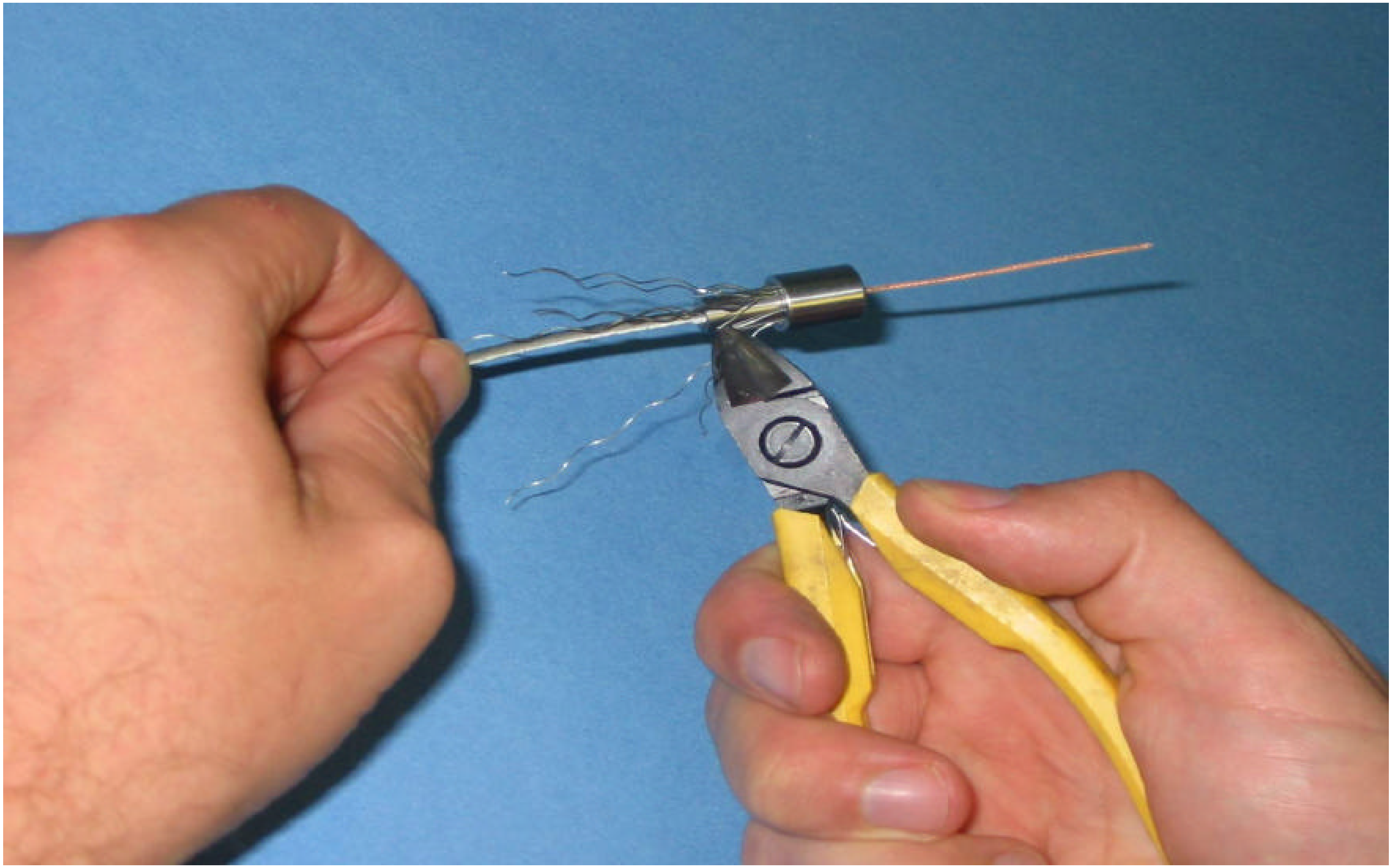
Pic.11 Unwind inner-layer strands of armor (exposing the insulated conductor wire)



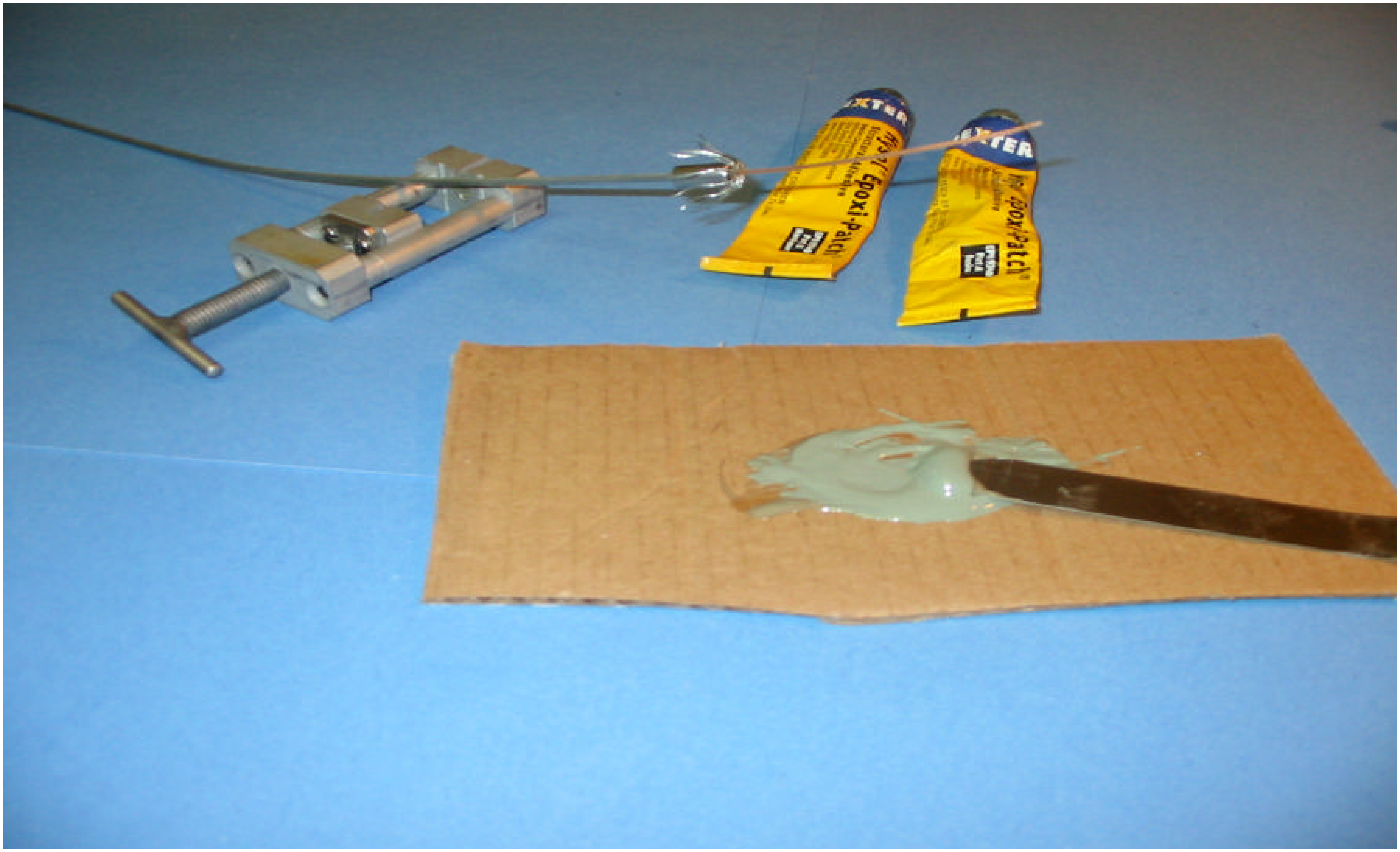
Pic.12 Clip 5 of the 12 inner armor strands close to the top of the insert



Pic.13 Bend down Remaining Inner Wire Strands
(Use jig and termination sleeve)

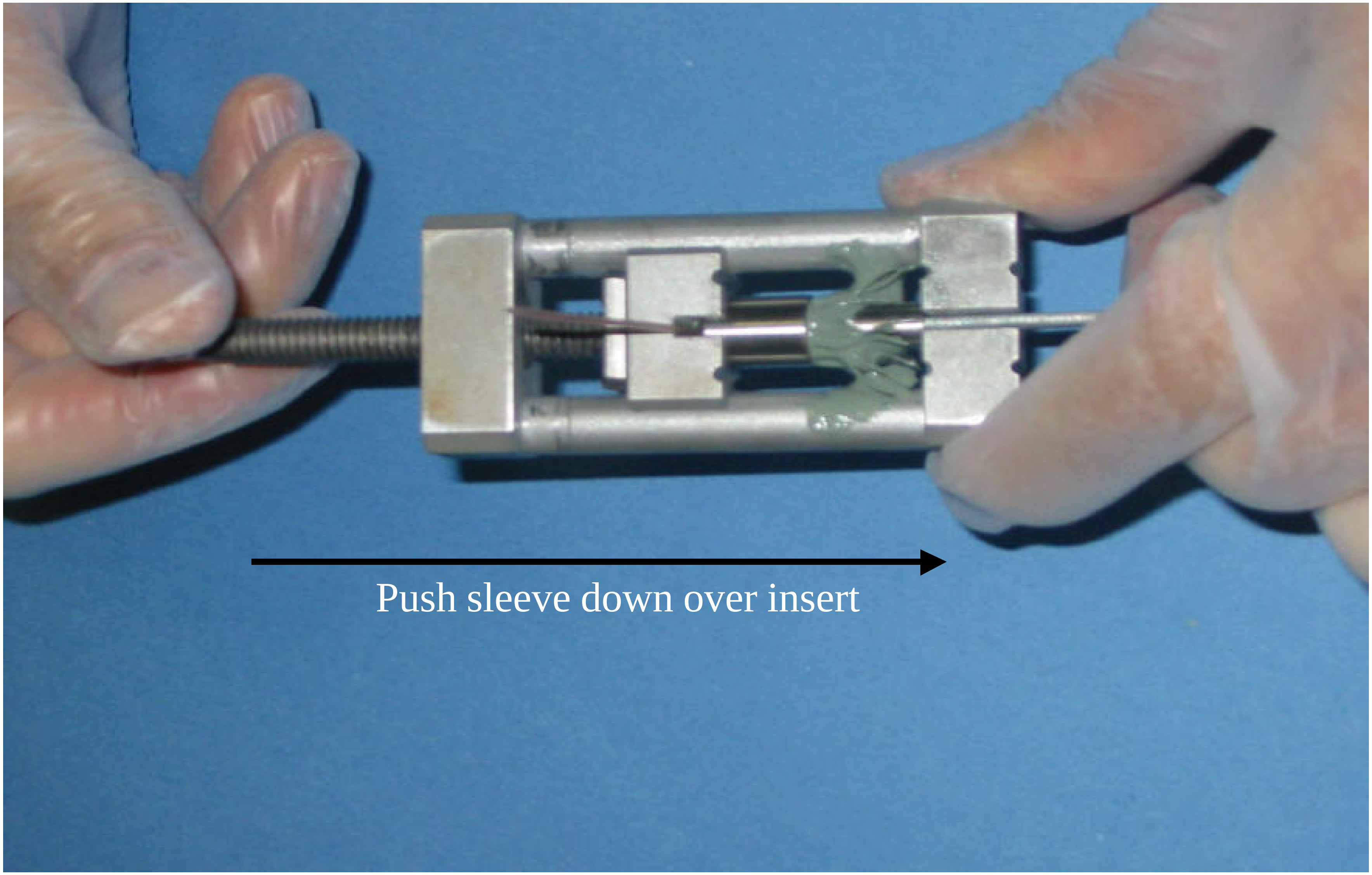


Pic.13 Trim Inner Wire Strands to Base of Insert

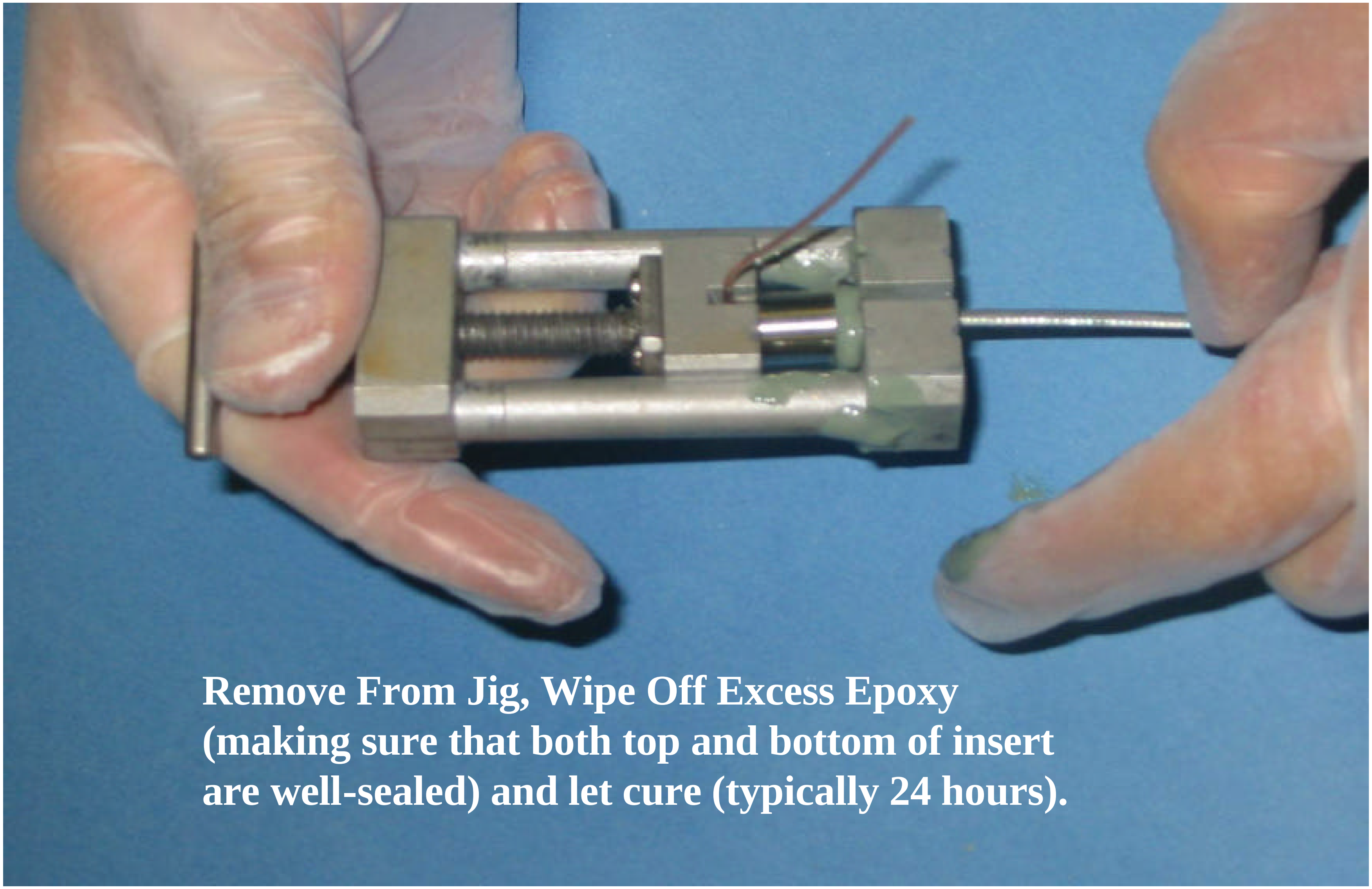


Pic.14 Mix epoxy

Pic.15 Apply epoxy. Cover the trimmed armor strands with epoxy



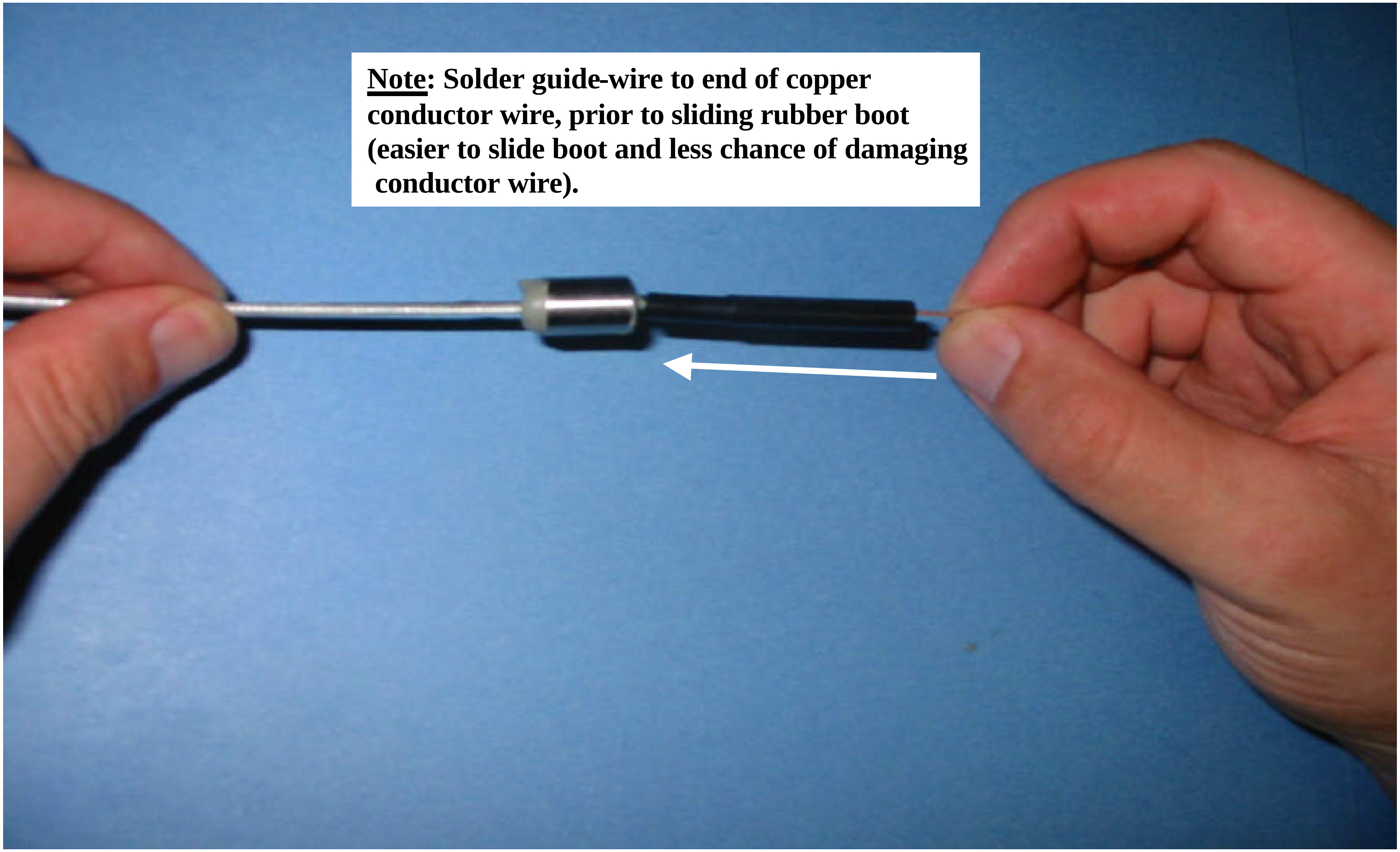
Pic.16 **Using the termination jig, push the termination sleeve completely down over the insert**



Remove From Jig, Wipe Off Excess Epoxy (making sure that both top and bottom of insert are well-sealed) and let cure (typically 24 hours).

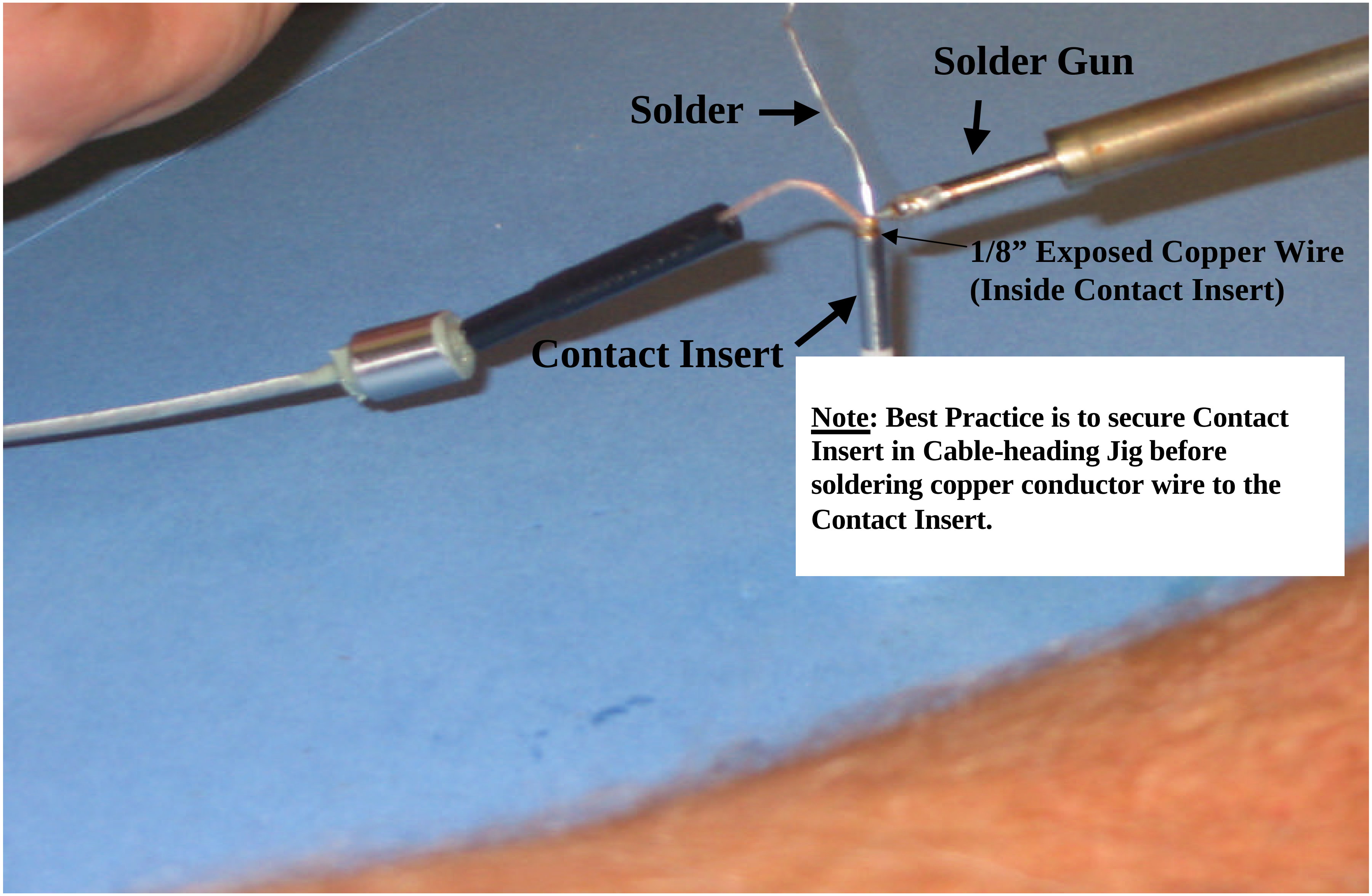
Pic.17 Termination Sleeve completely pushed down over insert

Pic.18 Apply silicon lubricant to the insulated conductor wire



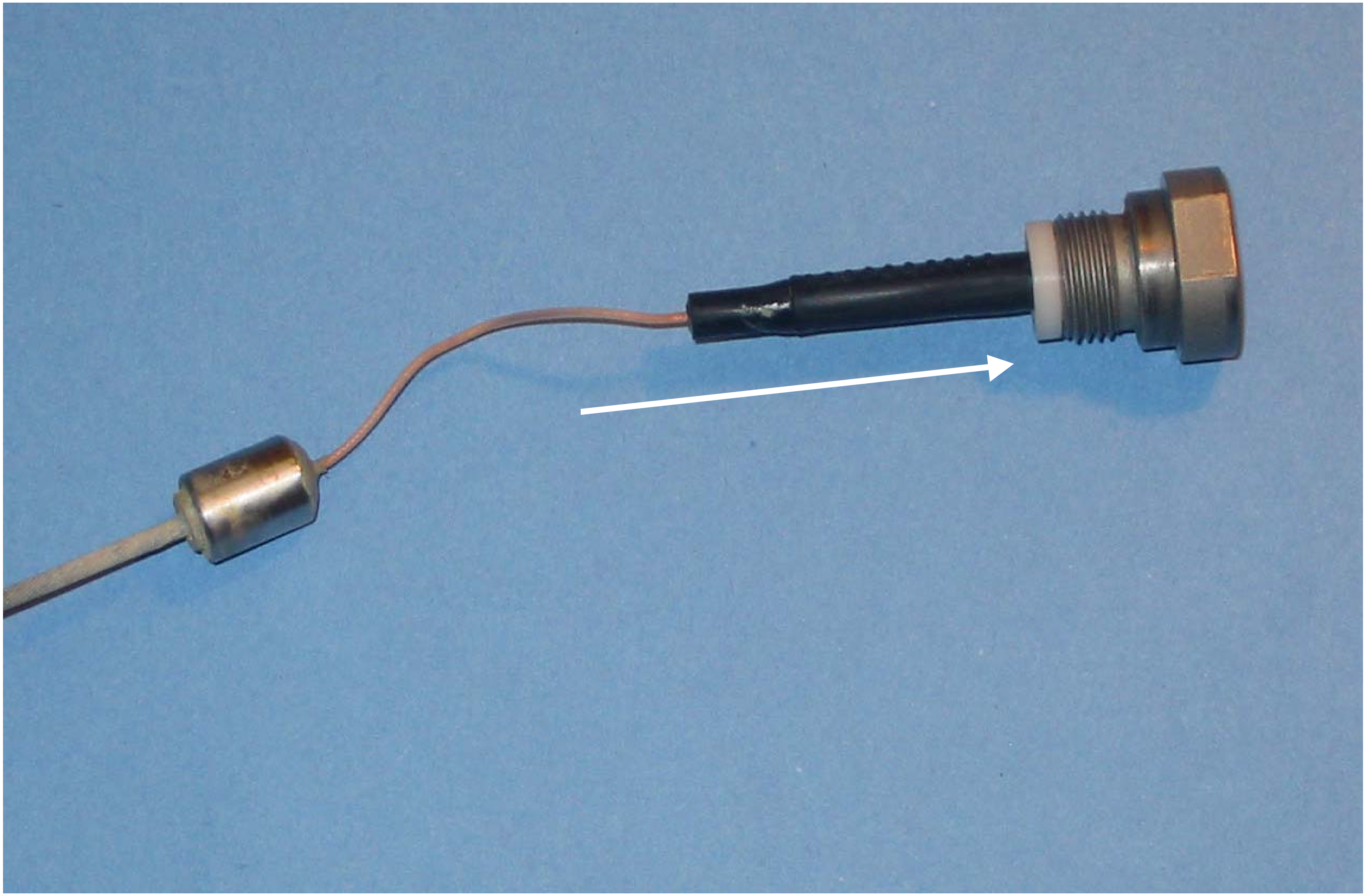
<u>**Note**</u>**: Solder guide-wire to end of copper conductor wire, prior to sliding rubber boot (easier to slide boot and less chance of damaging conductor wire).**

Pic.20 Slide the rubber boot towards the cablehead termination (final position)

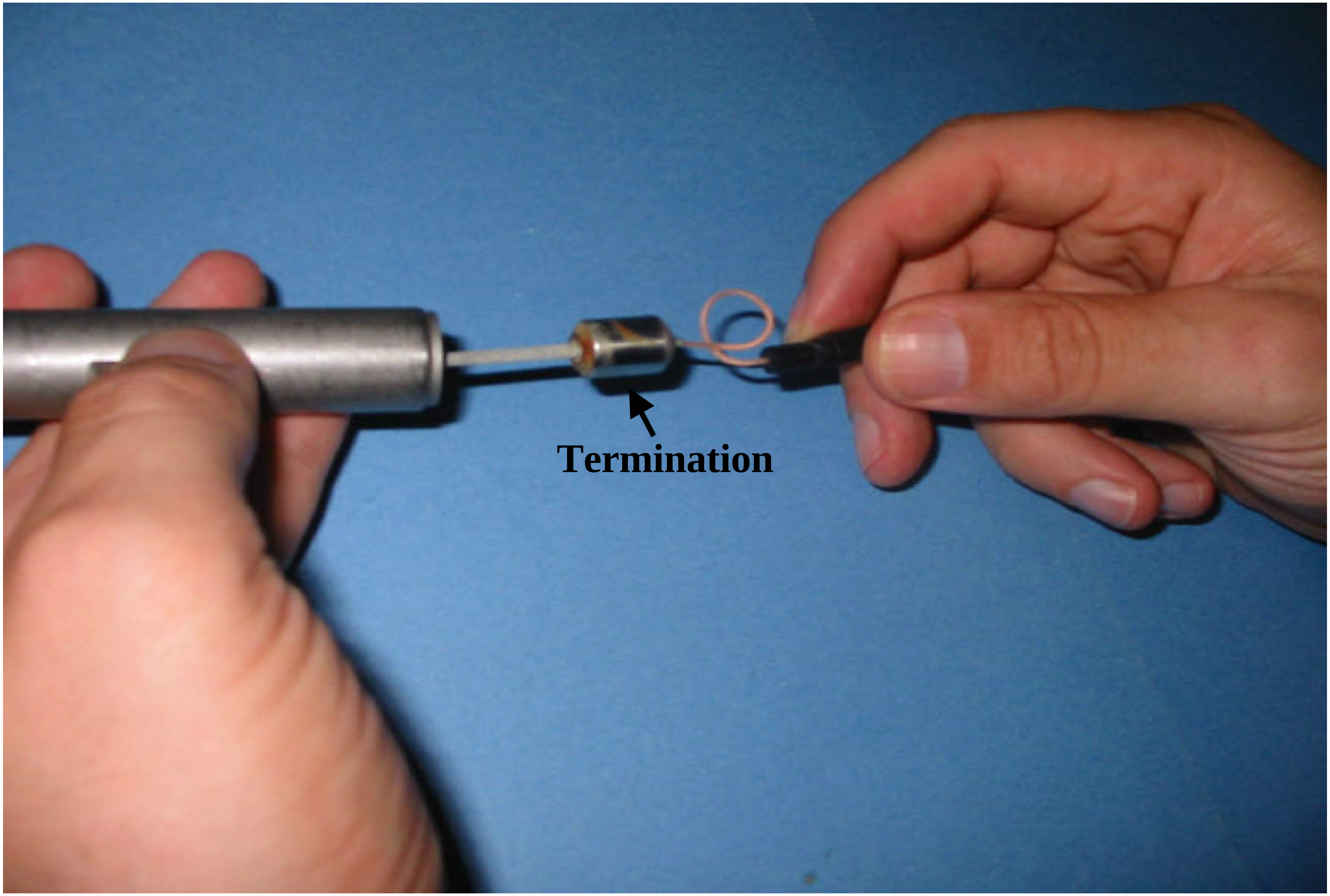


Note: Best Practice is to secure Contact Insert in Cable-heading Jig before soldering copper conductor wire to the Contact Insert.

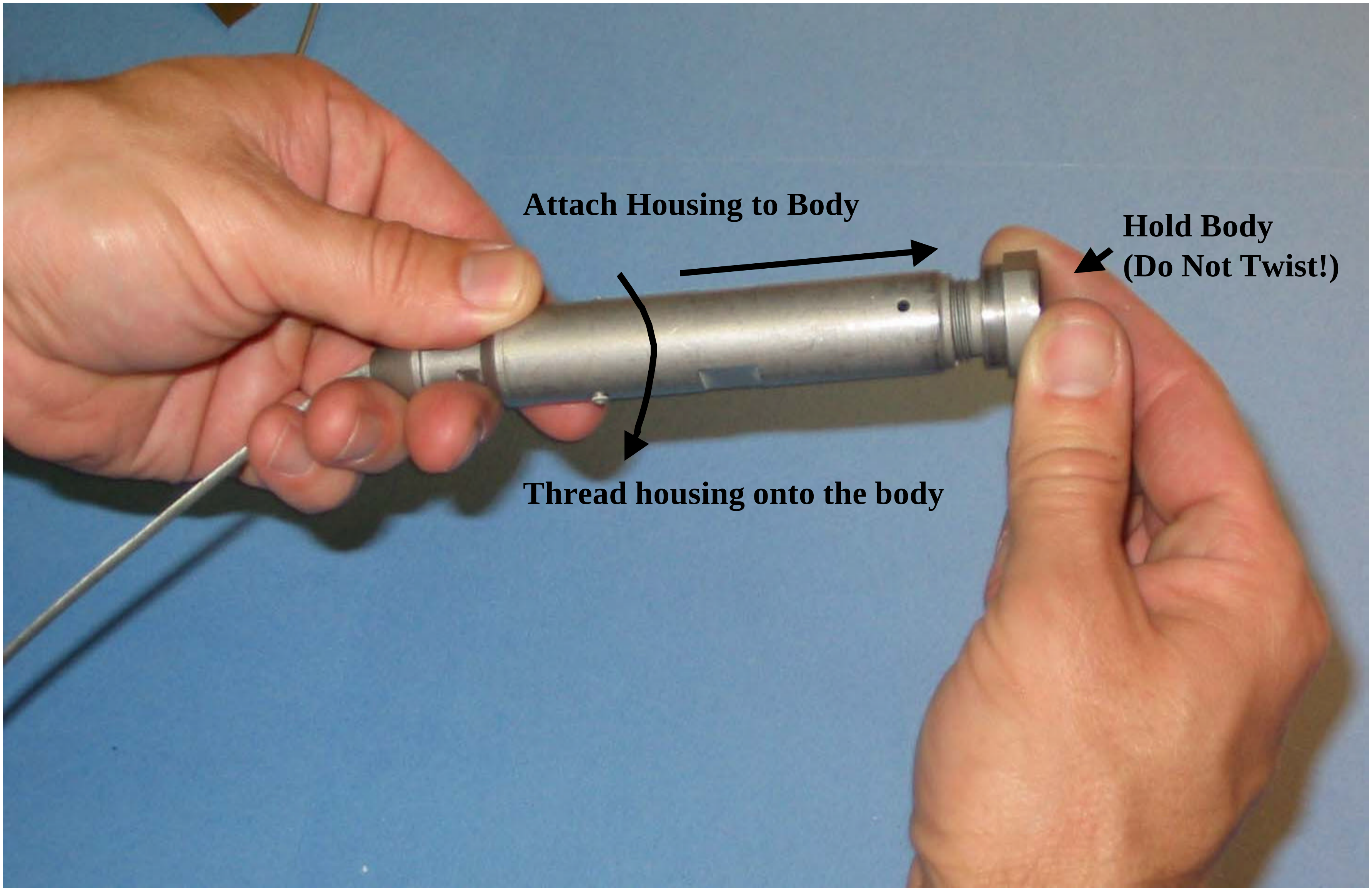
Pic.21 Solder 1/8 inch exposed copper wire (use wire strippers) into contact insert



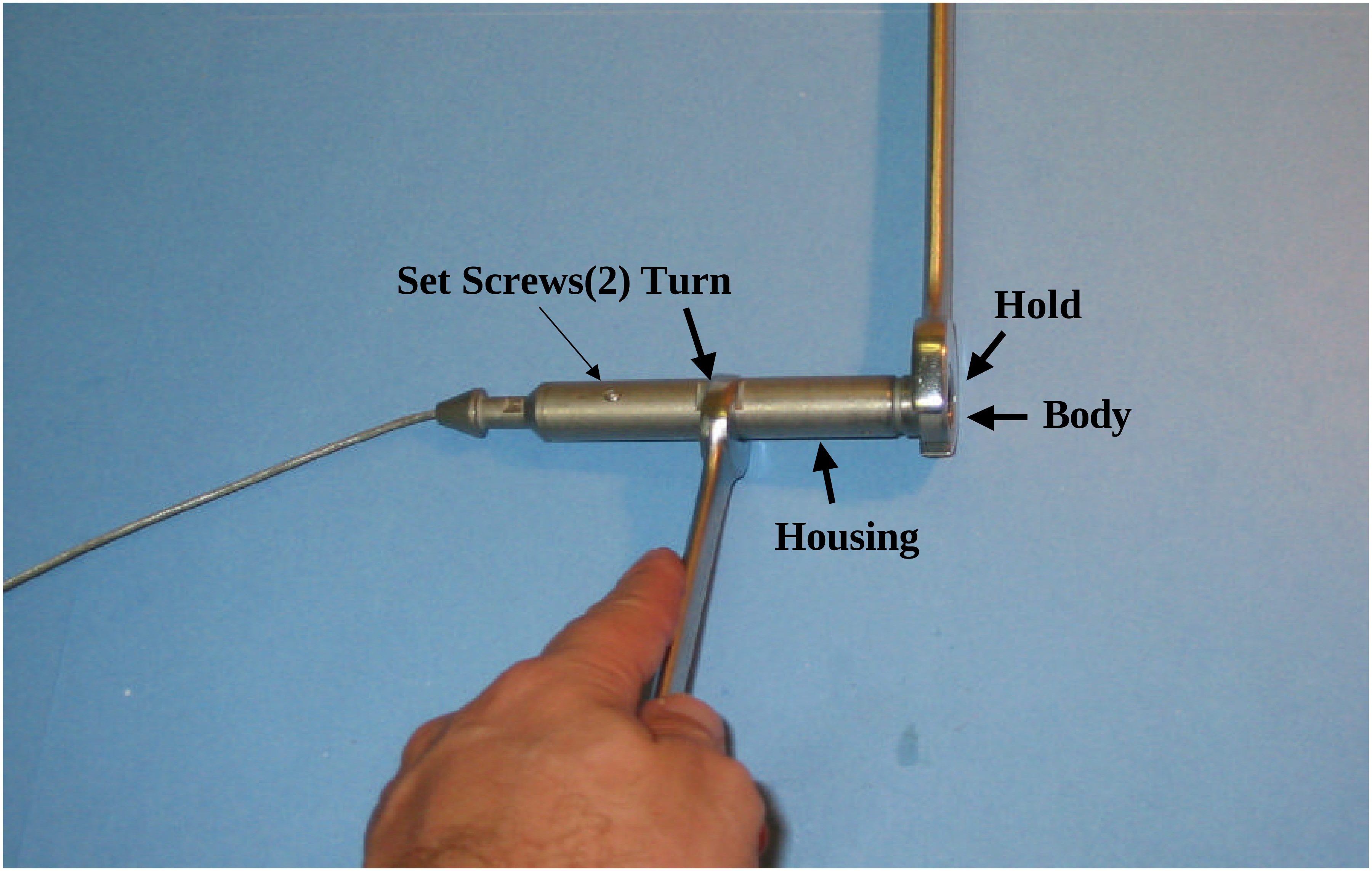
Pic.22 Slide the rubber boot down over the contact insert (when the solder has cooled)



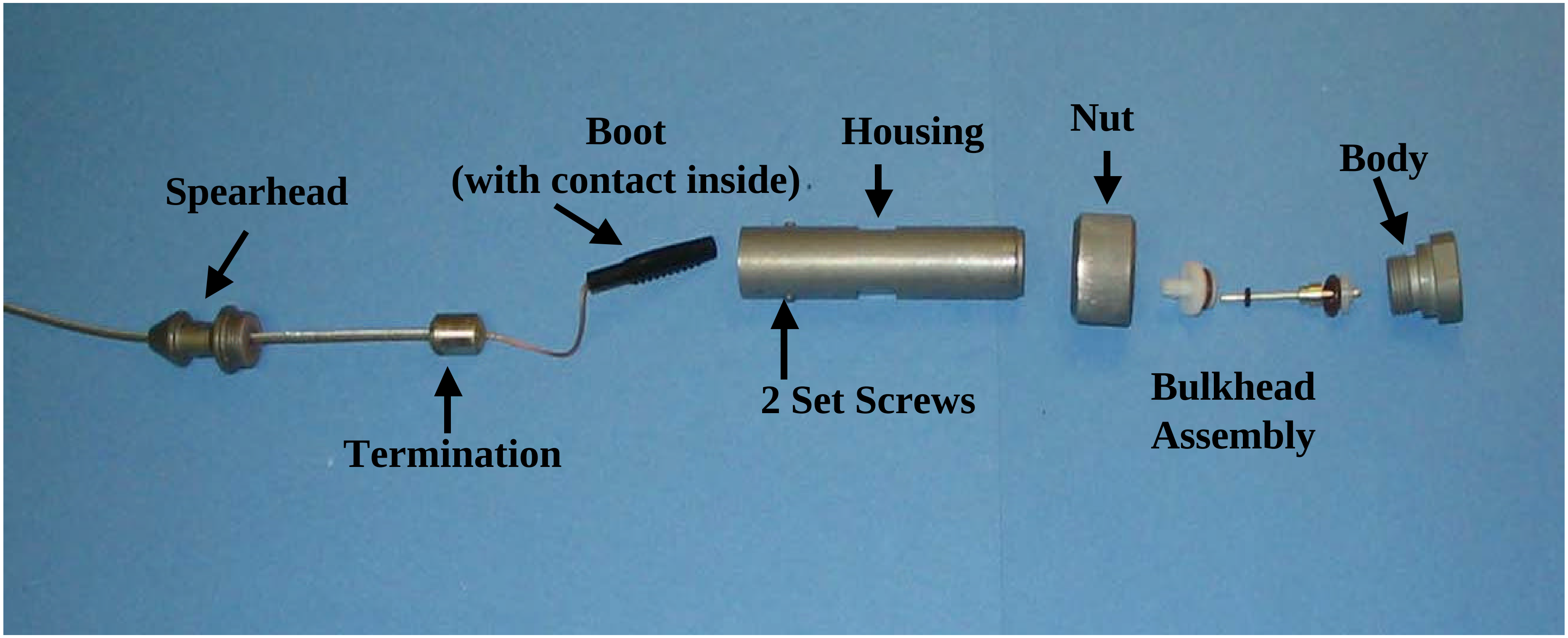
Pic.23 Create a loop in the conductor wire before sliding the cablehead housing down over the termination



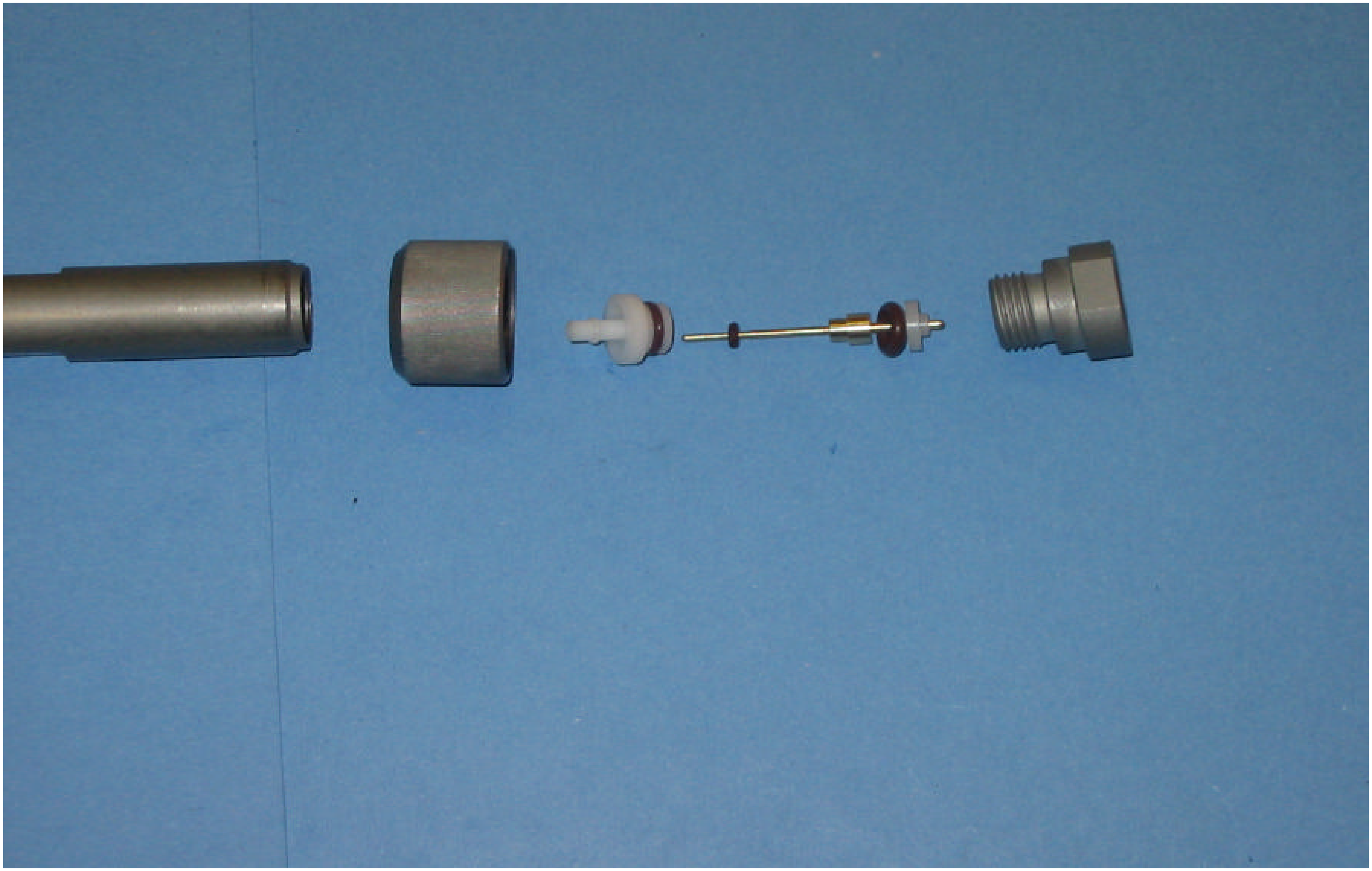
Pic.24 Thread the cablehead housing onto the body
(Do not twist the body! –this can damage the conductor wire)



Pic.25 Tighten the housing to the body
Tighten the set screws to complete re-assembly of the cablehead



Pic.26 Exploded view of cablehead assembly



Pic.27 Exploded view of bulkhead assembly

Attachment A: Standard Operating Procedure (SOP) #2

Passive Diffusion Bag (PDB) Sampling Protocol

1.0 Obtain PDB Sampler Hardware

- The hardware for each well in the sampling program will be custom-made by the PDB manufacturer (EON Products, Inc.) or by field sampling personnel, prior to the initiation of the field program.
- Each hardware kit is labeled for each well, and should closely match the dimensions submitted to the kit manufacturer.
- Open the hardware kit bag and carefully unwind the first few feet of cable or rope, to expose the first PDB station (colored zip ties or metal clips) from which the PDB samplers will hang.

2.0 Install PDB Sampler Hardware (Page 6, USGS, 2001)

- Unseal the appropriate PDB sampler hardware kit (match label to well name) and carefully retrieve hardware.
- Clip the first (bottom) PDB sampler onto the top and bottom PDB station using the available zip ties.
- Record time and bag position in the well.
- If this well is to be profiled, continue attaching PDB samplers to remaining PDB stations for this monitoring well.
- Otherwise, if this well is not scheduled to be profiled and has not yet been profiled, continue unwinding the hardware kit until the uppermost set of plastic disks is exposed and then attach the second PDB sampler.
- Once a well has been profiled and a specific depth has been selected from which to monitor groundwater quality, only one PDB sampler will be installed on the hardware kit – the depth interval will be noted on the field instruction form.
- Once the necessary PDB samplers have been installed, carefully lower the hardware kit until the stainless steel weight touches the well bottom.
- Confirm that the top clip (marker) roughly equals the top of casing and adjust as necessary to ensure a snug fit (slightly taught line) when the well cap is closed.
- Attach the end of the hardware line to the well head hanging device – make sure that the PDB sampler kit does not sag when well cap is closed.
- Secure the well.

3.0 Sample Naming/Recording

- Sample numbers will be generated as specified in the QAPP.
- Field personnel must include a depth for each sampler on the chain-of-custody.

- Record the relative position of each bag – they will be numbered in the order they will be retrieved (i.e., top → #1... #2... #n... → bottom) – in other words, the first PDB sampler to be installed will have the highest number and the last PDB sampler will have the lowest number.

4.0 PDB Sampler Retrieval (Page 9, USGS, 2001)

- Collect the appropriate number of VOA vials for the required number of VOC samples.
- Measure and record the corrected depth to water from the top of casing to ensure PDB are completely submerged below the water level.
- Note the time and begin reeling the PDB sampler hardware line.
- Field personnel must include a depth for each sampler on the chain-of-custody in the form of station number as recorded during bag placement.
- Important - the contents of each bag must be transferred to the VOA vials immediately after PDBs are removed from the well and before addressing any other sampling-related issues to avoid losing volatile compounds to atmosphere. Once the first bag leaves the water, the time limit starts at the same time for all exposed bags. All samples shall be contained in the VOA vials within 15 minutes of the PDB leaving the water.
- Extract the PDB sampler(s) from the well, remove the sampler cap and carefully empty the contents into VOA vials (preferably set up in a bottle holder), taking care not to over agitate the bag or water.
- Apply completed label to each VOA vial to ensure that they are not confused later.
- Repeat until all PDB samplers have been removed and contents transferred.
- QC duplicate samples consist of two separate sets of VOA vials filled from the same diffusion sampler.
- Store all filled VOA vials in Ziploc bags inside a properly cooled container.
- Follow above guidelines to re-install new PDB samplers as scheduled (profile or single-bag scenario).
- Dispose of all used passive diffusion sample bags and components appropriately as either IDW or recyclable material.
- Decontaminate all reusable equipment with clean water and ALCONOX.

5.0 User's Guide for Polyethylene-based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells

(See following pages)

USER'S GUIDE FOR POLYETHYLENE-BASED PASSIVE DIFFUSION BAG SAMPLERS TO OBTAIN VOLATILE ORGANIC COMPOUND CONCENTRATIONS IN WELLS

PART 1:
DEPLOYMENT, RECOVERY, DATA INTERPRETATION, AND QUALITY CONTROL AND ASSURANCE

Water-Resources Investigations Report 01-4060

Prepared in cooperation with the

U.S. AIR FORCE
U.S. NAVAL FACILITIES ENGINEERING COMMAND
U.S. ENVIRONMENTAL PROTECTION AGENCY
FEDERAL REMEDIATION TECHNOLOGIES ROUNDTABLE
DEFENSE LOGISTICS AGENCY
U.S. ARMY CORPS OF ENGINEERS and
INTERSTATE TECHNOLOGY AND REGULATORY COOPERATION WORK GROUP

U.S. Department of the Interior
U.S. Geological Survey

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User’s Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells

Part 1: Deployment, Recovery, Data Interpretation, and Quality Control and Assurance

By Don A. Vroblesky

U.S. Geological Survey

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2001

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Denver, CO 80225
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Stephenson Center–Suite 129
720 Gracern Road
Columbia, SC 29210-7651

Additional information about water resources in South Carolina is available on the World Wide Web at **http://sc.water.usgs.gov**

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Conversion Factors, Vertical Datum, Acronyms, and Abbreviations

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
square mile (mi^2)	2.590	square kilometer
	Flow	
foot per day (ft/d)	0.3048	meter per day
foot squared per day (ft^2/d)	0.09294	meter squared per day
gallon per minute (gal/min)	0.06308	liter per second
gallon per day (gal/d)	0.003785	cubic meter per day
inch per year (in/yr)	25.4	millimeter per year
	Volume	
gallon (gal)	3.785	liter

Temperature is given in degrees Celsius (°C), which can converted to degrees Fahrenheit (°F) by the following equation: °F = 9/5 (°C) + 32

Sea level refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Chemical concentration in water is expressed in metric units as milligrams per liter (mg/L) or micrograms per liter (µg/L).

Additional Abbreviations	
EDB	1,2-Dibromomethane
AFCEE	Air Force Center for Environmental Excellence
*c*DCE	*cis*-1,2-Dibromoethene
ft^3/d	cubic feet per day
ft^3/mg	cubic feet per milligram
°C	degrees Celsius
g	gram
ITRC	Interstate Technology Regulatory Cooperation
LDPE	low-density polyethylene
L	liter
µg	microgram
µm	micrometer
µL	microliter
mg	milligram
mL	milliliter
mL/min	milliliter per minute
MTBE	Methyl-*tert*-butyl ether
NAVFAC	Naval Facilities Engineering Command
NAPL	non-aqueous phase liquid
PDB	passive diffusion bag
PCE	Tetrachloroethene
TCE	Trichloroethene
USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
VOA	Volatile organic analysis
VOC	Volatile organic compound

User's Guide for Polyethylene-Based Passive Diffusion Bag Samplers to Obtain Volatile Organic Compound Concentrations in Wells

Part 1: Deployment, Recovery, Data Interpretation, and Quality Control and Assurance

By Don A. Vroblesky

EXECUTIVE SUMMARY

Water-filled passive diffusion bag (PDB) samplers described in this report are suitable for obtaining concentrations of a variety of volatile organic compounds (VOCs) in ground water at monitoring wells. The suggested application of the method is for long-term monitoring of VOCs in ground-water wells at well-characterized sites.

The effectiveness of the use of a single PDB sampler in a well is dependent on the assumption that there is horizontal flow through the well screen and that the quality of the water is representative of the ground water in the aquifer directly adjacent to the screen. If there are vertical components of intra-bore-hole flow, multiple intervals of the formation contributing to flow, or varying concentrations of VOCs vertically within the screened or open interval, then a multiple deployment of PDB samplers within a well may be more appropriate for sampling the well.

A typical PDB sampler consists of a low-density polyethylene (LDPE) lay-flat tube closed at both ends and containing deionized water. The sampler is positioned at the target horizon of the well by attachment to a weighted line or fixed pipe.

The amount of time that the sampler should be left in the well prior to recovery depends on the time required by the PDB sampler to equilibrate with ambient water and the time required for the environmental disturbance caused by sampler deployment to return to ambient conditions. The rate that the water within the PDB sampler equilibrates with ambient water depends on multiple factors, including the type of compound being sampled and the water temperature. The concentrations of benzene, *cis*-1,2-dichloroethene, tetrachlorethene, trichloroethene, toluene, naphthalene, 1,2-dibromoethane, and total xylenes within the PDB samplers equilibrated with the concentrations in an aqueous mixture of those compounds surrounding the samplers under laboratory conditions within approximately 48 hours at 21 degrees Celsius (°C). A subsequent laboratory study of mixed VOCs at 10 °C showed that tetrachloroethene and trichloroethene were equilibrated by about 52 hours, but other compounds required longer equilabration times. Chloroethane, *cis*-1,2-dichloroethene, *trans*-1,2-dichloroethene, and 1,1-dichloroethene were not equilibrated at 52 hours, but appeared to be equilibrated by the next sampling point at 93 hours. Vinyl chloride, 1,1,1-trichloroethane, 1,2-dichloroethane, and 1,1-dichloroethane were not equilibrated at 93 hours, but were equilibrated by the next sampling point at 166 hours. Different equilibration times may exist for other compounds. Differences in equilibration times, if any, between single-solute or mixed VOC solutions have not yet been thoroughly examined.

The samplers should be left in place long enough for the well water, contaminant distribution, and flow dynamics to restabilize following sampler deployment. Laboratory and field data suggest that 2 weeks of equilibration probably is adequate for many applications; therefore, a minimum equilibration time of 2 weeks is suggested. In less permeable formations, longer equilibration times may be required. When applying PDB samplers in waters colder than previously tested (10 °C) or for compounds without sufficient corroborating data, a side-by-side comparison with conventional methodology is advisable to justify the field equilibration time.

Following the initial equilibration period, the samplers maintain equilibrium concentrations with the ambient water until recovery. Thus, there is no specified time for sampler recovery after initial equilibration. PDB samplers routinely have been left in ground waters having concentrations of greater than 500 parts per million (ppm) of trichloroethene for 3 months at a time with no loss of bag integrity, and at one site, the PDB samplers have been left in place in VOC-contaminated ground water for 1 year with no reported loss of sampler integrity. The effects of long-term (greater than 1 month) PDB-sampler deployment on sampler and sample integrity have not yet been thoroughly tested for a broad range of compounds and concentrations, however. Moreover, in some environments, development of a biofilm on the polyethylene may be a consequence of long-term deployment. Investigations of semipermeable membrane devices (SPMDs) have shown that the transfer of some compounds across a heavily biofouled polyethylene membrane may be reduced, but not stopped. If a heavy organic coating is observed on a PDB sampler, it is advisable to determine the integrity of the sample by comparison to a conventional sampling method before continuing to use PDB samplers for long-term deployment in that well.

Recovery consists of removing the samplers from the well and immediately transferring the enclosed water to 40-milliliter sampling vials for analysis. The resulting concentrations represent an integration of chemical changes over the most recent portion of the equilibration period (approximately 48 to 166 hours, depending on the water temperature and the type of compound).

The method has both advantages and limitations when compared to other sampling methods. Advantages include the potential for PDB samplers to eliminate or substantially reduce the amount of purge water associated with sampling. The samplers are relatively inexpensive and easy to deploy and recover. Because PDB samplers are disposable, there is no downhole equipment to be decontaminated between wells, and there is a minimum amount of field equipment required. The samplers also have the potential to delineate contaminant stratification in the formation across the open or screened intervals of monitoring wells where vertical hydraulic gradients are not present. In addition, the samplers integrate concentrations over time, which may range between about 48 to 166 hours depending on the compound of interest. Because the pore size of LDPE is only about 10 angstroms or less, sediment does not pass through the membrane into the bag. Thus, PDB samplers are not subject to interferences from turbidity. In addition, none of the data collected suggest that VOCs leach from the LDPE material, or that there is a detrimental effect on the VOC sample from the PDB material.

Water-filled polyethylene PDB samplers are not appropriate for all compounds. The samplers are not suitable for inorganic ions and have a limited applicability for non-VOCs and for some VOCs. For example, although methyl-*tert*-butyl ether and acetone and most semivolatile compounds are transmitted through the polyethylene bag, laboratory tests have shown that the resulting concentrations were lower than in ambient water. A variety of factors influence the ability of compounds to diffuse through the polyethylene. These factors include the molecular size and shape and the hydrophobic nature of the compound. Unpublished laboratory test data of semivolatile compounds in contact with PDB samplers showed a higher concentration of phthalates inside the PDB sampler than outside the PDB sampler, suggesting that the polyethylene may contribute phthalates to the enclosed water. Thus, the samplers should not be used to sample for phthalates.

VOC concentrations in PDB samplers represent concentrations in the vicinity of the sampler within the well screen or open interval. This may be a limitation for PDB samplers and some other types of sampling, such as low-flow sampling, if the ground-water contamination is above or below the screen or not in the sample intervals providing water movement to the PDB samplers. If there is a vertical hydraulic gradient in the well, then the concentrations in the sampler may represent the concentrations in the water flowing vertically past the sampler rather than in the formation directly adjacent to the sampler. Vertically spaced multiple PDB samplers may be needed in chemically stratified wells or where flow patterns through the screen change as a result of ground-water pumping or seasonal water-level fluctuations.

The purposes of this document are to present methods for PDB sampler deployment, and recovery; to discuss approaches to determine the applicability of passive diffusion samplers; and to discuss various factors influencing interpretation of the data. The intended audience for the methodology sections of this report is managers and field personnel involved in using PDB samplers. The discussion of passive diffusion sampler applicability and interpretation of the data is suited for project managers, technical personnel, and the regulatory community. Part 2 of this report presents case studies of PDB sampler field applications.

INTRODUCTION

The use of PDB samplers for collecting ground-water samples from wells offers a cost-effective approach to long-term monitoring of VOCs at well-characterized sites (Vroblesky and Hyde, 1997; Gefell and others, 1999). The effectiveness of the use of a single PDB sampler in a well is dependent on the assumption that there is horizontal flow through the well screen and that the quality of the water is representative of the ground water in the aquifer directly adjacent to the screen. If there are vertical components of intra-borehole flow, multiple intervals of the formation contributing to flow, or varying concentrations of VOCs vertically within the screened or open interval, then deployment of multiple PDB samplers within a well may be more appropriate for sampling the well.

The samplers consist of deionized water enclosed in a LDPE sleeve (fig. 1) and are deployed adjacent to a target horizon within a screened or open interval of a well. The suggested application is for long-term monitoring of VOCs in ground-water wells. Where the screened interval is greater than 10 feet (ft), the potential for contaminant stratification and/or intra-borehole flow within the screened interval is greater than in screened intervals shorter than 10 ft. It is important that the vertical distribution of contaminants be determined in wells having 10-ft-long well screens, and that both the vertical distribution of contaminants and the potential for intra-borehole flow be determined in wells having screens longer than 10 ft. For many VOCs of environmental interest (table 1), the VOC concentration in water within the sampler approaches the VOC concentration in water outside of the PDB sampler over an equilibration period. The resulting concentrations represent an integration of chemical changes over the most recent part of the equilibration period (approximately 48 to 166 hours, depending on the water temperature and the type of compound being sampled). The approach is inexpensive and has the potential to eliminate or substantially reduce the amount of purge water removed from the well.

A variety of PDB samplers have been utilized in well applications (fig. 1). Although the samplers vary in specific construction details, a typical PDB sampler consists of a 1- to 2-ft-long LDPE tube closed at both ends and containing laboratory-grade deionized water (fig. 1). The typical diameter for PDB samplers used in a 2-inch-diameter well is approximately 1.2 inches; however, other dimensions may be used to match the well diameter. Equilibration times may be longer for larger diameter PDB samplers. On the outside of the PDB sampler, a low-density polyethylene-mesh sometimes is used for protection against abrasion in open boreholes and as a means of attachment at the prescribed depth. The PDB sampler can be positioned at the target horizon by attachment to a weighted line or by attachment to a fixed pipe.

PDB samplers for use in wells are available commercially. Authorized distributors as of March 2001 are Columbia Analytical Services (800-695-7222; www@caslab.com) and Eon Products (800-474-2490; www.eonpro.com). A current list of vendors and PDB-sampler construction details can be obtained from the U.S. Geological Survey Technology Transfer Enterprise Office, Mail Stop 211, National Center, 12201 Sunrise Valley Drive, Reston, Virginia 20192 (telephone 703-648-4344; fax 703-648-4408). PDB samplers employ patented technology (U.S. patent number 5,804,743), and therefore, require that the user purchase commercially produced samplers from a licensed manufacturer or purchase a nonexclusive license for sampler construction from the U.S. Geological Survey Technology Enterprise Office at the above address.

The purposes of this document are to present methods for PDB sampler deployment, and recovery; to discuss approaches for determining the applicability of passive diffusion samplers; and to discuss various factors influencing interpretation of the data. The intended audience for the methodology sections of this report is managers and field personnel involved in using PDB samplers. The discussion of PDB sampler applicability and interpretation of the data is suited for project managers, technical personnel, and the regulatory community. Part 2 of this report presents case studies of PDB-sampler field applications.

Figure 1. Typical water-filled passive diffusion bag samplers used in wells, including (A) diffusion bag with polyethylene mesh, (B) diffusion bag without mesh, and (C) bag and mesh attached to bailer bottom.

Table 1. Compounds tested under laboratory conditions for use with passive diffusion bag samplers

[From Vroblesky and Campbell, 2001]

Tested compounds showing good correlation (average differences in concentration of 11 percent or less between diffusion-sampler water and test-vessel water) in laboratory tests			
Benzene	2 Chlorovinyl ether	*cis*-1,2-Dichloroethene	1,1,1-Trichloroethane
Bromodichloromethane	Dibromochloromethane	*trans*-1,2-Dichloroethene	1,1,2-Trichloroethane
Bromoform	Dibromomethane	1,2-Dichloropropane	Trichloroethene
Chlorobenzene	1,2-Dichlorobenzene	*cis*-Dichloropropene	Trichlorofluoromethane
Carbon tetrachloride	1,3-Dichlorobenzene	1,2-Dibromoethane	1,2,3-Trichloropropane
Chloroethane	1,4-Dichlorobenzene	*trans*-1,3-Dichloropropene	1,1,2,2-Tetrachloroethane
Chloroform	Dichlorodifluoromethane	Ethyl benzene	Tetrachloroethene
Chloromethane	1,2-Dichloroethane	Naphthalene	Vinyl chloride
	1,1-Dichloroethene	Toluene	Total xylenes
Tested compounds showing poor correlation (average differences in concentration greater than 20 percent between diffusion-sampler water and test-vessel water) in laboratory tests			
Acetone*	Methyl-*tert*-butyl ether	Styrene	

*T.M Sivavec and S.S. Baghel, General Electric Company, written commun., 2000

Summary of Passive Diffusion Bag Sampler Advantages and Limitations

Advantages

1. PDB samplers have the potential to eliminate or substantially reduce the amount of purge water associated with sampling.

2. PDB samplers are inexpensive.

3. The samplers are easy to deploy and recover.

4. Because PDB samplers are disposable, there is no downhole equipment to be decontaminated between wells.

5. A minimal amount of field equipment is required.

6. Sampler recovery is rapid. Because of the small amount of time and equipment required for the sampling event, the method is practical for use where access is a problem or where discretion is desirable (that is, residential communities, business districts, or busy streets where vehicle traffic control is a concern).

7. Multiple PDB samplers, distributed vertically along the screened or open interval, may be used in conjunction with borehole flow meter testing to gain insight on the movement of contaminants into and out of the well screen or open interval or to locate the zone of highest concentration in the well. Analytical costs when using multiple PDB samplers sometimes can be reduced by selecting a limited number of the samplers for laboratory analysis based on screening by using field gas chromatography at the time of sample collection.

8. Because the pore size of LDPE is only about 10 angstroms or less, sediment does not pass through the membrane into the bag. Thus, PDB samplers are not subject to interferences from turbidity. In addition, none of the data collected suggest that VOCs leach from the LDPE material or that there is a detrimental effect from the PDB material on the VOC sample.

Limitations

1. PDB samplers integrate concentrations over time. This may be a limitation if the goal of sampling is to collect a representative sample at a point in time in an aquifer where VOC-concentrations substantially change more rapidly than the samplers equilibrate. Laboratory results obtained indicate that a variety of compounds equilibrated within 48 hours at 21 °C (Vroblesky and Campbell, 2001). Vinyl chloride, 1,1,1-trichloroethane, 1,2-dichloroethane, and 1,1-dichloroethane may require between 93 and 166 hours to equilibrate at 10 °C (T.M. Sivavec and S.S. Baghel, General Electric Company, written commun., 2000). The initial equilibration under field conditions may be longer to allow well water, contaminant distribution, and flow dynamics to restabilize following sampler deployment.

2. Water-filled polyethylene PDB samplers are not appropriate for all compounds. For example, although methyl-*tert*-butyl ether and acetone (Vroblesky, 2000; Paul Hare, General Electric Company, oral commun., 2000) and most semivolatile compounds are transmitted through the polyethylene bag, laboratory tests have shown that the resulting concentrations were lower than in ambient water. A variety of factors influence the ability of compounds to diffuse through the polyethylene membrane. These factors include the molecular size and shape and the hydrophobic nature of the compound. Compounds having a cross-sectional diameter of about 10 angstroms or larger (such as humic acids) do not pass through the polyethylene because the largest (transient) pores in polyethylene do not exceed about 10 angstroms in diameter (Flynn and Yalkowsky, 1972; Hwang and Kammermeyer, 1975; Comyn, 1985). The samplers are not appropriate for hydrophilic polar molecules, such as inorganic ions. A detailed discussion of the relation between hydrophobicity and compound transport through polyethylene can be found in Gale (1998). Unpublished laboratory test data (D.A. Vroblesky, U.S. Geological Survey, written commun., 1998) of semivolatile compounds in contact with PDB samplers showed a higher concentration of phthalates inside the PDB sampler than outside the PDB sampler, suggesting that the polyethylene may contribute phthalates to the enclosed water. Thus, the samplers should not be used to sample for phthalates.

3. PDB samplers rely on the free movement of water through the well screen. In situations where ground water flows horizontally through the well screen, the VOC concentrations in the open interval of the well probably are representative of the aquifer water in the adjacent formation (Gillham and others, 1985; Robin and Gillham, 1987; Kearl and others, 1992; Powell and Puls, 1993; Vroblesky and Hyde, 1997). In these situations, the VOC concentration of the water in contact with the PDB samplers, and therefore, the water within the diffusion samplers, probably represents local conditions in the adjacent aquifer. However, if the well screen is less permeable than the aquifer or the sandpack, then under ambient conditions, flowlines may be diverted around the screen. Such a situation may arise from inadequate well development or from iron bacterial fouling of the well screen. In this case, the VOC concentrations in the PDB samplers may not represent concentrations in

the formation water because of inadequate exchange across the well screen. PDB samplers have not yet been adequately tested to determine their response under such conditions.

4. VOC concentrations in PDB samplers represent ground-water concentrations in the vicinity of the screened or open well interval that move to the sampler under ambient flow conditions. This is a limitation if the ground-water contamination lies above or below the well screen or open interval, and requires the operation of a pump to conduct contaminants into the well for sampling.

5. In cases where the well screen or open interval transects zones of differing hydraulic head and variable contaminant concentrations, VOC concentrations obtained using a PDB sampler may not reflect the concentrations in the aquifer directly adjacent to the sampler because of vertical transport in the well. However, a vertical array of PDB samplers, used in conjunction with borehole flow meter testing, can provide insight on the movement of contaminants into or out of the well. This information then can be used to help determine if the use of PDB samplers is appropriate for the well, and to select the optimal vertical location(s) for the sampler deployment.

6. In wells with screens or open intervals with stratified chemical concentrations, the use of a single PDB sampler set at an arbitrary (by convention) depth may not provide accurate concentration values for the most contaminated zone. However, multiple PDB samplers distributed vertically along the screened or open interval, in conjunction with pump sampling (as appropriate), can be used to locate zone(s) of highest concentration in the well. Multiple PDB samplers also may be needed to track the zone of maximum concentration in wells where flow patterns through the screened interval change as a result of ground-water pumping or seasonal water-table fluctuations.

PASSIVE DIFFUSION BAG SAMPLER DEPLOYMENT

A variety of approaches can be used to deploy the PDB samplers in wells. A typical deployment approach, described in this section, is to attach the PDB samplers to a weighted line. It also is acceptable to attach the weights directly to the PDB sampler if the attachment point is of sufficient strength to support the weight. The weights attached to the bottom of the line are stainless steel and can be reused, but must be thoroughly decontaminated with a detergent before the first use or before using in a different well. Rope, such as 90 pound, 3/16 inch braided polyester, can be used as the line for single-use applications if it is of sufficient strength to support the weight and sampler, is nonbuoyant, and is subject to minimal stretch; however, the rope should not be reused because of the high potential for cross contamination. Stainless-steel or Teflon-coated stainless-steel wire is preferable. The weighted lines should not be reused in different wells to prevent carryover of contaminants. A possible exception is coated stainless-steel wire, which can be reused after sufficient decontamination. An alternative deployment approach, not discussed in this section, is to attach the PDB samplers to a fixed pipe in the well (Vroblesky and Peters, 2000, p. 3; also included in Part 2 of this publication). The PDB samplers should not contact non-aqueous phase liquid (NAPL) during deployment or retrieval to prevent cross contamination. An approach that can be utilized to deploy diffusion samplers through a layer of floating NAPL is described in the field test at Naval Station North Island, California (Vroblesky and Peters, 2000, p. 3-4; also included in Part 2 of this publication).

If the PDB sampler is to be compared with a conventional pumping approach to sampling, then it is suggested that both the pump and the PDB sampler be deployed at the same time, with the sampler attached near (such as directly below) the pump inlet. This approach eliminates potential concentration differences between the two methods that may result from well disturbance during equipment removal and deployment at the time of sampling. An alternative method is to deploy the PDB samplers independently of the pumps and recover the samplers immediately prior to placing the pump down the well.

PDB samplers are available either prefilled (field ready) with laboratory-grade deionized water or unfilled. The unfilled samplers are equipped with a plug and funnel to allow for field filling and sample recovery. To fill these samplers, remove the plug from the sampler bottom, insert the short funnel into the sampler, and pour laboratory-grade deionized water into the sampler. The sampler should be filled until water rises and stands at least half way into the funnel. Remove excess bubbles from the sampler. Remove the funnel and reattach the plug. A small air bubble from the plug is of no concern.

The following steps should be used for deploying PDB samplers in wells:

1. Measure the well depth and compare the measured depth with the reported depth to the bottom of the well screen from well-construction records. This is to check on whether sediment has accumulated in the bottom of the well, whether there is a nonscreened section of pipe (sediment sump) below the well screen, and on the accuracy of well-construction records. If there is an uncertainty regarding length or placement of the well screen, then an independent method, such as video imaging of the well bore, is strongly suggested.

2. Attach a stainless-steel weight to the end of the line. Sufficient weight should be added to counterbalance the buoyancy of the PDB samplers. This is particularly important when multiple PDB samplers are deployed. One approach, discussed in the following paragraphs, is to have the weight resting on the bottom of the well, with the line taut above the weight. Alternatively, the PDB sampler and weight may be suspended above the bottom, but caution should be exercised to ensure that the sampler does not shift location. Such shifting can result from stretching or slipping of the line or, if multiple samplers are attached end-to-end rather than to a weighted line, stretching of the samplers.

3. Calculate the distance from the bottom of the well, or top of the sediment in the well, up to the point where the PDB sampler is to be placed. A variety of approaches can be used to attach the PDB sampler to the weight or weighted line at the target horizon. The field-fillable type of PDB sampler is equipped with a hanger assembly and weight that can be slid over the sampler body until it rests securely near the bottom of the sampler. When this approach is used with multiple PDB samplers down the same borehole, the weight should only be attached to the lowermost sampler. An additional option is to use coated stainless-steel wire as a weighted line, making loops at appropriate points to attach the upper and lower ends of PDB samplers. Where the PDB sampler position varies between sampling events, movable clamps with rings can be used. When using rope as a weighted line, a simple approach is to tie knots or attach clasps at the appropriate depths. Nylon cable ties or stainless-steel clips inserted through the knots can be used to attach the PDB samplers. An approach using rope as a weighted line with knots tied at the appropriate sampler-attachment points is discussed below.

(a) For 5-ft-long or shorter well screens, the center point of the PDB sampler should be the vertical midpoint of the saturated well-screen length. For example, if the well screen is at a depth of 55 to 60 ft below the top of casing, and the measured depth of the well is 59 ft, then the bottom of the well probably has filled with sediment. In this case, the midpoint of the sampler between the attachment points on the line will be midway between 55 and 59 ft, or at 57 ft. Thus, for a 1.5-ft-long sampler, the attachment points on a weighted line should be tied at distances of 1.25 ft (2 ft – 0.75 ft) and 2.75 ft (2 ft + 0.75 ft) from the top of the sediment in the well, or the bottom of the well, making adjustments for the length of the attached weight. When the PDB sampler is attached to the line and installed in the well, the center of the sampler will be at 57-ft depth. If, however, independent evidence is available showing that the highest concentration of contaminants enters the well from a specific zone within the screened interval, then the PDB sampler should be positioned at that interval.

(b) For 5- to 10-ft-long well screens, it is advisable to utilize multiple PDB samplers vertically along the length of the well screen for at least the initial sampling (fig. 2). The purposes of the multiple PDB samplers are to determine whether contaminant stratification is present and to locate the zone of highest concentration. The midpoint of each sampler should be positioned at the midpoint of the interval to be sampled. For 1.5-ft-long samplers, at each sampling depth in the screened interval, make two attachment points on the weighted line at a distance of about 1.5 ft apart. The attachment points should be positioned along the weighted line at a distance from the bottom end of the weight such that the midpoint between the knots will be at the desired sampling depth along the well screen. Sampler intervals are variable, but a simple approach is to use the top knot/loop of one sampler interval as the bottom knot/loop for the overlying sampler interval.

Figure 2. Example of multiple PDB samplers prepared for deployment.

(c) PDB samplers should not be used in wells having screened or open intervals longer than 10 ft unless used in conjunction with borehole flow meters or other techniques to characterize vertical variability in hydraulic conductivity and contaminant distribution or used strictly for qualitative reconnaissance purposes. This is because of the increased potential for cross contamination of water-bearing zones and hydraulically driven mixing effects that may cause the contaminant stratification in the well to differ from the contaminant stratification in the adjacent aquifer material. If it is necessary to sample such wells, then multiple PDB samplers should be installed vertically across the screened or open interval to determine the zone of highest concentration and whether contaminant stratification is present.

4. The samplers should be attached to the weights or weighted line at the time of deployment. For samplers utilizing the hanger and weight assembly, the line can be attached directly to the top of the sampler. PDB samplers utilizing an outer protective mesh can be attached to a weighted line by using the following procedure:

(a) Insert cable ties through the attachment points in the weighted line.

(b) At each end of the PDB sampler, weave the ends of the cable ties or clamp through the LPDE mesh surrounding the sampler and tighten the cable ties. Thus, each end of the PDB sampler will be attached to a knot/loop in the weighted line by means of a cable tie or clamp. The cable ties or clamps should be positioned through the polyethylene mesh in a way that prevents the PDB sampler from sliding out of the mesh.

(c) Trim the excess from the cable tie before placing the sampler down the well. Caution should be exercised to prevent sharp edges on the trimmed cable ties that may puncture the LDPE.

5. When using PDB samplers without the protective outer mesh, the holes punched at the ends of the bag, outside the sealed portion, can be used to attach the samplers to the weighted line. Stainless-steel spring clips have been found to be more reliable than cable ties in this instance, but cable ties also work well.

6. Lower the weight and weighted line down the well until the weight rests on the bottom of the well and the line above the weight is taut. The PDB samplers should now be positioned at the expected depth. A check on the depth can be done by placing a knot or mark on the line at the correct distance from the top knot/loop of the PDB sampler to the top of the well casing and checking to make sure that the mark aligns with the lip of the casing after deployment.

7. Secure the assembly in this position. A suggested method is to attach the weighted line to a hook on the inside of the well cap. Reattach the well cap. The well should be sealed in such a way as to prevent surface-water invasion. This is particularly important in flush-mounted well vaults that are prone to flooding.

8. Allow the system to remain undisturbed as the PDB samplers equilibrate.

PASSIVE DIFFUSION BAG SAMPLER AND SAMPLE RECOVERY

The amount of time that the samplers should be left in the well prior to recovery depends on the time required by the PDB sampler to equilibrate with ambient water and the time required for environmental disturbances caused by sampler deployment to return to ambient conditions. The rate that the water within the PDB sampler equilibrates with ambient water depends on multiple factors, including the type of compound being sampled and the water temperature. The concentrations of benzene, *cis*-1,2-dichloroethene (*c*DCE), tetrachlorethene (PCE), trichloroethene (TCE), toluene, naphthalene, 1,2-dibromoethane (EDB), and total xylenes within the PDB samplers equilibrated with the concentrations in an aqueous mixture of those compounds surrounding the samplers under laboratory conditions within approximately 48 hours at 21 °C (Vroblesky and Campbell, 2001). A subsequent laboratory study of mixed VOCs at 10 °C showed that PCE and TCE were equilibrated by about 52 hours, but other compounds required longer equilibration times (T.M. Sivavec and S.S. Baghel, General Electric Company, written commun., 2000). Chloroethane, *c*DCE, *trans*-1,2-dichloroethene, and 1,1-dichloroethene were not equilibrated at 52 hours, but appeared to be equilibrated by the next sampling point at 93 hours. Vinyl chloride, 1,1,1-trichloroethane, 1,2-dichloroethane, and 1,1-dichloroethane were not equilibrated at 93 hours, but were equilibrated by the next sampling point at 166 hours. Different equilibration times may exist for other compounds. Differences in equilibration times, if any, between single-solute or mixed-VOC solutions have not yet been thoroughly examined.

Under field conditions, the samplers should be left in place long enough for the well water, contaminant distribution, and flow dynamics to restabilize following sampler deployment. The results of borehole dilution studies show that wells can recover to 90 percent of the predisturbance conditions within minutes to several hours for permeable to highly permeable geologic formations, but may require 100 to 1,000 hours (4 to 40 days) in muds, very fine-grained loamy sands, and fractured rock, and may take even longer in fractured shales, recent loams, clays, and slightly fractured solid igneous rocks (Halevy and others, 1967).

In general, where the rate of ground-water movement past a diffusion sampler is high, equilibration times through various membranes commonly range from a few hours to a few days (Mayer, 1976; Harrington and others, 2000). One field investigation showed adequate equilibration of PDB samplers to aquifer trichloroethene (TCE) and carbon tetrachloride (CT) concentrations within 2 days in a highly permeable aquifer (Vroblesky and others, 1999). In other investigations, PDB samplers recovered after 14 days were found to be adequately equilibrated to chlorinated VOCs (Obrien & Gere Engineers, Inc., 1997a, 1997b; Hare, 2000); therefore, the equilibration period was less than or equal to 14 days for those field conditions. Because it appears that 2 weeks of equilibration probably is adequate for many applications, a minimum equilibration time of 2 weeks is suggested. When applying PDB samplers in waters colder than previously tested (10 °C) or for compounds without sufficient corroborating field data, a side-by-side comparison with conventional sampling methodology is advisable to justify the field equilibration time.

In less permeable formations, longer equilibration times may be required. It is probable that water in the well bore eventually will equilibrate with the pore-water chemistry; however, if the rate of chemical change or volatilization loss in the well bore exceeds the rate of exchange between the pore water and the well-bore water, then the PDB samplers may underestimate pore-water concentrations. Guidelines for equilibration times and applicability of PDB samplers in low-permeability formations have not yet been established. Therefore, in such situations, a side-by-side comparison of PDB samplers and conventional sampling methodology is advisable to ensure that the PDB samplers do not underestimate concentrations obtained by the conventional method. A detailed discussion of diffusion rates relevant to diffusion sampler equilibrium in slow-moving ground-water systems can be found in Harrington and others (2000).

Following the initial equilibration period, the samplers maintain equilibrium concentrations with the ambient water until recovery. Thus, there is no specified maximum time for sampler recovery. PDB samplers have routinely been left in ground waters having concentrations of greater than 500 ppm of TCE for 3 months at a time with no loss of bag integrity, and at one site, the PDB samplers have been left in place in VOC-contaminated ground water for 1 year with no reported loss of sampler integrity (Paul Hare, General Electric Company, oral commun., 2000). The effects of long-term (greater than 1 month) PDB-sampler deployment on sampler and sample integrity have not yet been thoroughly tested for a broad range of compounds and concentrations. Moreover, in some environments, development of a biofilm on the polyethylene may be a consequence of long-term deployment. Investigations of semipermeable membrane devices (SPMDs) have shown that the transfer of some compounds may be reduced, but not stopped, across a heavily biofouled polyethylene membrane (Ellis and others, 1995; Huckins and others, 1996; Huckins and others, in press). If a heavy organic coating is observed on a PDB sampler, it is advisable to determine the integrity of the sample by comparing contaminant concentrations from the PDB sampler to concentrations from a conventional sampling method before continuing to use PDB samplers for long-term deployment in that well.

Recovery of PDB samplers is accomplished by using the following approach:

1. Remove the PDB samplers from the well by using the attached line. The PDB samplers should not be exposed to heat or agitated.

2. Examine the surface of the PDB sampler for evidence of algae, iron or other coatings, and for tears in the membrane. Note the observations in a sampling field book. If there are tears in the membrane, the sample should be rejected. If there is evidence that the PDB sampler exhibits a coating, then this should be noted in the validated concentration data.

3. Detach and remove the PDB sampler from the weighted line. Remove the excess liquid from the exterior of the bag to minimize the potential for cross contamination.

4. A variety of approaches may be used to transfer the water from the PDB samplers to 40-mL volatile organic analysis (VOA) vials. One type of commercially available PDB sampler provides a discharge device that can be inserted into the sampler. If discharge devices are used, the diameter of the opening should be kept to less than about 0.15 inches to reduce volatilization loss. Two options are presently available to recover water from the sample using discharge devices. One option involves removing the hanger and weight assembly from the sampler, inverting the sampler so that the fill plug is pointed upward, and removing the plug. The water can be recovered by directly pouring in a manner that minimizes agitation or by pouring through a VOC-discharge accessory inserted in place of the plug. The second approach involves piercing the sampler near the bottom with a small-diameter discharge tube and allowing water to flow through the tube into the VOA vials. In each case, flow rates can be controlled by tilting or manipulating the sampler. Alternatively, the PDB sampler can be cut open at one end using scissors or other cutting devices which have been decontaminated between use for different wells. Water can then be transferred to 40-ml VOA vials by gently pouring in a manner that minimizes water agitation. Acceptable duplication has been obtained using each method. Preserve the samples according to the analytical method. The sampling vials should be stored at approximately 4 °C in accordance with standard sampling protocol. Laboratory testing suggests that there is no substantial change in the VOC concentrations in PDB samplers over the first several minutes after recovery; however, the water should be transferred from the water-filled samplers to the sample bottles immediately upon recovery.

5. A cost-effective alternative when using multiple PDB samplers in a single well is to field screen water from each sampler using gas chromatography. These results can be used to decide which of the multiple PDB samplers should be sent to an EPA-approved laboratory for standard analysis. Typically, at least the sample containing the highest concentration should be analyzed by a laboratory.

6. If a comparison is being made between concentrations obtained using PDB samplers and concentrations obtained using a conventional sampling approach, then the well should be sampled by the conventional approach soon after (preferably on the same day) recovery of the PDB sampler. The water samples obtained using PDB samplers should be sent in the same shipment, as the samples collected by the conventional approach for the respective wells. Utilizing the same laboratory may reduce analytical variability.

7. Any unused water from the PDB sampler and water used to decontaminate cutting devices should be disposed in accordance with local, state, and Federal regulations.

DETERMINING APPLICABILITY OF PASSIVE DIFFUSION BAG SAMPLERS AND INTERPRETATION OF DATA

When attempting to determine whether the use of PDB samplers is appropriate at a particular well, a common approach is to do a side-by-side comparison with a conventional sampling method during the same sampling event. This approach is strongly suggested in wells having temporal concentration variability. In a well having relatively low temporal concentration variability, comparison of the PDB-sampler results to historical concentrations may provide enough information to determine whether the PDB samplers are appropriate for the well. In general, if both PDB and conventional sampling produce concentrations that agree within a range deemed acceptable by local, state, and Federal regulatory agencies and meet the site-specific data-quality objectives, then a PDB sampler may be approved for use in that well to monitor ambient VOC concentrations. If concentrations from the PDB sampler are higher than concentrations from the conventional method, it is probable that concentrations from the PDB sampler adequately represent ambient conditions because there usually is a greater potential for dilution from mixing during sampling using conventional methods than during sampling using PDB samplers.

If, however, the conventional method produces concentrations that are significantly higher than those obtained using the PDB sampler, then it is uncertain whether the PDB-sampler concentrations represent local ambient conditions. In this case, further testing can be done to determine whether contaminant stratification and/or intra-borehole flow is present. Multiple sampling devices can be used to determine the presence of contaminant stratification, and borehole flowmeters can be used to determine whether intra-borehole flow is present. When using flowmeters to measure vertical flow in screened boreholes, however, the data should be considered qualitative because of the potential for water movement through the sand pack. Borehole dilution tests (Halevy and others, 1967; Drost and others, 1968; Grisak and others, 1977; Palmer, 1993) can be used to determine whether water is freely exchanged between the aquifer and the well screen.

Once the source of the difference between the two methods is determined, a decision can be made regarding the well-specific utility of the PDB samplers. Tests may show that VOC concentrations from the PDB samplers adequately represent local ambient conditions within the screened interval despite the higher VOC concentration obtained from the conventional method. This may be because the pumped samples incorporated water containing higher concentrations either from other water-bearing zones induced along inadequate well seals or through fractured clay (Vroblesky and others, 2000), from other water-bearing zones not directly adjacent to the well screen as a result of well purging prior to sampling (Vroblesky and Petkewich; 2000), or from mixing of chemically stratified zones in the vicinity of the screened interval (Vroblesky and Peters, 2000).

The mixing of waters from chemically stratified zones adjacent to the screened interval during pumping probably is one of the more important sources of apparent differences between the results obtained from PDB sampling and conventional sampling because such stratification probably is common. Vertical stratification of VOCs over distances of a few feet has been observed in aquifer sediments by using multilevel sampling devices (Dean and others, 1999; Pitkin and others, 1999), and considerable variation in hydraulic conductivity and water chemistry has been observed in an aquifer in Cape Cod, Massachusetts, on the scale of centimeters (Wolf and others, 1991; Smith and others 1991; Hess and others, 1992). Multiple PDB samplers have been used to show a change in TCE concentration of 1,130 (µg/L over a 6-ft vertical screened interval in Minnesota (Vroblesky and Petkewich, 2000). Tests using PDB samplers in screened intervals containing VOC stratification showed that the PDB-sampler data appeared to be point-specific, whereas the pumped sample integrated water over a larger interval (Vroblesky and Peters, 2000).

The decision on whether to use PDB samplers in such situations depends on the data-quality objectives for the particular site. If the goal is to determine and monitor higher concentrations or to examine contaminant stratification within the screened interval, then the PDB samplers may meet this objective. If the goal is to determine the average concentrations for the entire screened interval, then a pumped sample or an average from multiple diffusion samplers may be appropriate.

As an aid in the decision-making process, the following section examines the influences that hydraulic and chemical heterogeneity of an aquifer can have on sample quality in long-screened wells. Because VOC concentrations from PDB samplers commonly are compared to VOC concentrations from other sampling methodologies, the second section examines the differences in sample quality between these methodologies in situations of hydraulic and chemical heterogeneity.

Influences of Hydraulic and Chemical Heterogeneity on Sample Quality in Long-Screened Wells

Sampling biases and chemical variability in long-screened wells, which can be loosely defined as wells having significant physical and chemical heterogeneity within the screened interval and in the adjacent aquifer (Reilly and Leblanc, 1998), have been the subject of numerous investigations. Sources of chemical variability in such wells include non-uniform flow into wells (Robbins and Martin-Hayden, 1991; Reilly and Gibs, 1993; Chiang and others, 1995; Church and Granato, 1996; Reilly and LeBlanc, 1998), lithologic heterogeneity (Reilly and others, 1989; Robbins, 1989; Martin-Hayden and others, 1991; Gibs and others, 1993; Reilly and Gibs, 1993), and in-well mixing. In a well open across a chemically or hydraulically heterogeneous section of the aquifer, differences in the sampling methodology can produce significant differences in the sampling results.

Long-screened wells have the potential to redistribute chemical constituents in the aquifer where there are vertical hydraulic gradients within the screened interval. Water can move into the well from one horizon and exit the well at a different horizon (Church and Granato, 1996; Reilly and LeBlanc 1998). If there is vertical flow in the screened or open interval, and the zone of low hydraulic head (outflow from the well) is within the contaminated horizon, then the PDB samplers (or any standard sampling methodology) can underestimate or not detect the contamination. The reason is that, in this case, the contaminated horizon does not contribute water to the well under static conditions. Instead, water from other horizons with higher hydraulic head will invade the contaminated horizon by way of the well screen. Under pumped conditions, the majority of the extracted water will be from the most permeable interval, which may not be the contaminated zone. Even when pumping induces inflow from the contaminated interval, much of that inflow will be a reflection of the residual invaded water from other horizons. In this situation, a substantial amount of purging would be required before water representative of the aquifer could be obtained (Jones and Lerner, 1995). Such sampling is not likely to reflect a significant contribution from the contaminated zone, and concentrations in the contaminated zone probably will be underestimated.

Similarly, if VOC-contaminated water is flowing into the well and is exiting the well at a different horizon, then VOCs will be present along the screened interval between the two horizons. In this case, VOC concentrations in the screened interval may be representative of aquifer concentrations at the inflow horizon, but may not be representative of aquifer concentrations near the outflow horizon.

In areas where vertical stratification of VOC concentrations is anticipated, using multiple PDB samplers may more fully characterize the contaminated horizon than using a single PDB sampler. This is particularly true in wells having screens 10 ft or longer; however, significant VOC stratification has been observed over intervals of less than 5 ft (Vroblesky and Peters, 2000). Because of the increased probability of vertical concentration or hydraulic gradients within the open interval of long-screened (greater than 10 ft) wells, it is advisable to determine the zones of inflow and outflow within the screened or open interval of these wells using borehole flowmeter analysis (Hess, 1982; 1984; 1986; 1990; Young and others, 1998).

Comparison of Passive Diffusion Bag Sampling Methodology to Conventional Methodologies

Traditional sampling methodologies, such as the purge-and-sample (or conventional purging method), low-flow or low-volume sampling, and using straddle packers and multilevel samplers, produce VOC concentrations that may differ from VOC concentrations obtained from PDB samplers because the methodologies sometimes are influenced in different ways by aquifer hydraulic and chemical heterogeneity. This section examines potential sources of concentration differences between traditional methodologies and the PDB methodology.

The purge-and-sample approach to ground-water monitoring differs from the diffusion-sampler approach primarily because the area of the screened or open interval that contributes water to the purged sample typically is greater than for the PDB sampler, and the potential for mixing of stratified layers is higher. When pumping three or more casing volumes of water prior to collecting a sample, chemical concentrations in the discharging water typically change as the well is pumped (Keely and Boateng, 1987; Cohen and Rabold, 1988; Martin-Hayden and others, 1991; Robbins and Martin-Hayden, 1991; Reilly and Gibs, 1993; Barcelona and others, 1994; Martin-Hayden, 2000), due to mixing during pumping and other factors, such as the removal of stagnant water in the casing and changing patterns of inflow and outflow under ambient and pumping conditions (Church and Granato, 1996). The induction of lateral chemical heterogeneity during pumping also may produce variations in the sampled concentrations. The amount of mixing during purging can be highly variable (Barber and Davis, 1987; Church and Granato, 1996; Reilly and LeBlanc, 1998; Martin-Hayden, 2000), and may result in concentrations that are not locally representative (Reilly and Gibs, 1993). Substantial vertical hydraulic gradients, even in shallow homogeneous aquifers, have been observed to bias sampling using conventional purging because the majority of the pumped water may come from a particular horizon not related to the contaminated zone and because the intra-well flow that intruded the aquifer may not be adequately removed during purging (Hutchins and Acree, 2000). Thus, differences may be observed between concentrations obtained from a pumped sample and from a PDB sample in a chemically stratified interval if the pumped sample represents an integration of water collected from multiple horizons and the PDB sampler represents water collected from a single horizon.

Low-flow purging and sampling (Barcelona and others, 1994; Shanklin and others, 1995) disturbs the local ground water less than conventional purge-and-sample methods. Thus, samples obtained by PDB samplers are likely to be more similar to samples obtained by using low-flow purging than to those obtained by using conventional purge-and-sample methods. Even under low-flow conditions, however, purging still can integrate water within the radius of pumping influence, potentially resulting in a deviation from VOC concentrations obtained by PDB sampling. One investigation found that in low hydraulic conductivity formations, low-flow sampling methodology caused excessive drawdown, which dewatered the screened interval, increased local ground-water velocities, and caused unwanted colloid and soil transport into the ground-water samples (Sevee and others, 2000). The authors suggest that in such cases, a more appropriate sampling methodology may be to collect a slug or passive sample from the well screen under the assumption that the water in the well screen is in equilibrium with the surrounding aquifer.

Isolating a particular contributing fracture zone with straddle packers in an uncased borehole allows depth-discrete samples to be collected from the target horizon (Hsieh and others, 1993; Kaminsky and Wylie, 1995). Strategically placed straddle packers often can minimize or eliminate the impact of vertical gradients in the sampled interval. However, even within a packed interval isolating inflowing fracture zones, deviations between VOC concentrations in water from PDB samplers and water sampled by conventional methods still may occur if the conventional method mixes chemically stratified water outside the borehole or if the packed interval straddles chemically heterogeneous zones.

The use of multilevel PDB samplers and other types of multilevel samplers (Ronen and others, 1987; Kaplan and others, 1991; Schirmer and others, 1995; Gefell and others, 1999; Jones and others, 1999) potentially can delineate some of the chemical stratification. Diffusion sampling and other sampling methodologies, however, can be influenced by vertical hydraulic gradients within the well screen or the sand pack. When vertical hydraulic gradients are present within the well, water contacting the PDB sampler may not be from a horizon adjacent to the PDB sampler. Rather, the water may represent a mixing of water from other contributing intervals within the borehole. In a screened well, even multilevel samplers with baffles to limit vertical flow in the well cannot prevent influences from vertical flow in the gravel pack outside the well screen. Such vertical flow can result from small vertical differences in head with depth. A field test conducted by Church and Granato (1996) found that vertical head differences ranging from undetectable to 0.49 ft were sufficient to cause substantial flows (as much as 0.5 liters/minute) in the well bore.

QUALITY CONTROL AND ASSURANCE

The sources of variability and bias introduced during sample collection can affect the interpretation of the results. To reduce data variability caused during sampling, a series of quality-control samples should be utilized.

Replicate samples are important for the quality control of diffusion-sampler data. Sample replicates provide information needed to estimate the precision of concentration values determined from the combined sample-processing and analytical method and to evaluate the consistency of quantifying target VOCs. A replicate sample for water-filled diffusion samplers consists of two separate sets of VOC vials filled from the same diffusion sampler. Each set of VOC vials should be analyzed for comparison. Approximately 10 percent of the samplers should be replicated.

The length of the PDB sampler can be adjusted to accommodate the data-quality objectives for the sampling event. The length can be increased if additional volume is required for collection of replicate and matrix spike/matrix spike duplicate samples.

Trip blanks are used to determine whether external VOCs are contaminating the sample due to bottle handling and/or analytical processes not associated with field processing. Trip blanks are water-filled VOA vials prepared offsite, stored and transported with the other bottles used for collecting the environmental sample, and then submitted for analysis with the environmental sample. Consideration also should be given to the collection of a predeployment PDB trip blank to determine if the PDB samplers are exposed to extraneous VOCs prior to deployment. The predeployment trip blank should be a PDB sampler that is stored and transported with the field PDB samplers from the time of sampler construction to the time of deployment in the wells. An aliquot of the predeployment blank water should be collected from the PDB sampler in a VOA vial and submitted for analysis at the time of sampler deployment.

Water used to construct the diffusion samplers should be analyzed to determine the presence of background VOCs. Although many VOCs accidentally introduced into the diffusion-sampler water probably will reequilibrate with surrounding water once the diffusion samplers are deployed, some VOCs may become trapped within the diffusion-sampler water. For example, acetone, which is a common laboratory contaminant, does not easily move through the polyethylene diffusion samplers (Paul Hare, General Electric Company, oral commun., 1999). Thus, acetone inadvertently introduced into the diffusion-sample water during sampler construction may persist in the samplers, resulting in a false positive for acetone after sampler recovery and analysis.

SUMMARY

Water-filled passive diffusion bag (PDB) samplers described in this report are suitable for obtaining a variety of VOCs in ground water at monitoring wells. The suggested application for PDB samplers is for long-term monitoring of VOCs in ground-water wells at well-characterized sites. Where the screened interval is greater than 10 ft, the potential for contaminant stratification and/or intra-borehole flow within the screened interval is greater than in screened intervals shorter than 10 ft. It is suggested that the vertical distribution of contaminants be determined in wells having 10-ft-long well screens, and that both the vertical distribution of contaminants and the potential for intra-borehole flow be determined in wells having screens longer than 10 ft. A typical PDB sampler consists of a 1- to 2-ft-long low-density polyethylene lay-flat tube closed at both ends and containing deionized water. The sampler is positioned at the target horizon by attachment to a weighted line or fixed pipe.

The amount of time that the samplers should be left in the well prior to recovery depends on the time required by the PDB sampler to equilibrate with ambient water and the time required for environmental disturbances caused by sampler deployment to return to ambient conditions. The rate that water within the PDB sampler equilibrates with ambient water depends on multiple factors, including the type of compound being sampled and the water temperature. Concentrations of benzene, *cis*-1,2-dichloroethene, tetrachlorethene, trichloroethene, toluene, naphthalene, 1,2-dibromoethane, and total xylenes within the PDB samplers equilibrated with the concentrations in an aqueous mixture of those compounds surrounding the samplers under laboratory conditions within approximately 48 hours at 21 °C. A subsequent laboratory study of mixed VOCs at 10 °C showed that tetrachloroethene and trichloroethene were equilibrated by about 52 hours, but other compounds required longer equilabration times. Chloroethane, *cis*-1,2-dichloroethene, *trans*-1,2-dichloroethene, and 1,1-dichloroethene were not equilibrated at 52 hours, but appeared to be equilibrated by the next sampling point at 93 hours. Vinyl chloride, 1,1,1-trichloroethane, 1,2-dichloroethane, and 1,1-dichloroethane were not equilibrated at 93 hours but were equilibrated by the next sampling point at 166 hours. Different equilibration times may exist for other compounds. Differences in equilibration times, if any, between single-solute or mixed-VOC solutions have not yet been thoroughly examined.

The samplers should be left in place long enough for the well water, contaminant distribution, and flow dynamics to restabilize following sampler deployment. Laboratory and field data suggest that 2 weeks of equilibration probably is adequate for many applications. Therefore, a minimum equilibration time of 2 weeks is suggested. In less permeable formations, longer equilibration times may be required. When deploying PDB samplers in waters colder than previously tested (10 °C) or for compounds without sufficient corroborating data, a side-by-side comparison with conventional methodology is advisable to justify the field equilibration time.

Following the initial equilibration period, the samplers maintain equilibrium concentrations with the ambient water until recovery. Thus, there is no specified maximum time for sampler recovery after initial equilibration. PDB samplers have routinely been left in ground waters having concentrations of greater than 500 ppm of TCE for 3 months at a time with no loss of bag integrity, and at one site, the PDB samplers were left in place in VOC-contaminated ground water for 1 year with no reported loss of sampler integrity. The effects of long-term (greater than 1 month) PDB-sampler deployment on sampler and sample integrity have not yet been thoroughly tested for a broad range of compounds and concentrations. In some environments, development of a biofilm on the polyethylene may be a consequence of long-term deployment. Investigations of semipermeable membrane devices (SPMDs) have shown that the transfer of some compounds across a heavily biofouled polyethylene membrane may be reduced, but not stopped. If a heavy organic coating is observed on a PDB sampler, it is advisable to determine the integrity of the sample by comparing sampler results to a conventional sampling method concentrations before continuing to use PDB samplers for long-term deployment in that well.

PDB methodology is suitable for a broad variety of VOCs, including chlorinated aliphatic compounds and petroleum hydrocarbons. The samplers, however, are not suitable for inorganic ions and have a limited applicability for non-VOCs and for some VOCs. For example, although methyl-*tert*-butyl ether and acetone and most semivolatile compounds are transmitted through the polyethylene bag, laboratory tests have shown that the resulting concentrations were lower than in ambient water. The samplers should not be used to sample for phthalates because of the potential for the LDPE to contribute phthalates to the water sample.

When attempting to determine whether the use of PDB samplers is appropriate at a particular well, a common approach is to do a side-by-side comparison with a conventional sampling method. This approach is strongly suggested in wells having temporal concentration variability. In a well having relatively low temporal concentration variability, comparison of the PDB-sampler results to historical concentrations may provide enough information to determine whether the PDB samplers are appropriate for the well. In general, if the two approaches produce concentrations that agree within a range deemed acceptable by the local, state, and Federal regulatory agencies, then use of a PDB sampler in that well will provide VOC concentrations consistent with the historical record. If concentrations from the PDB sampler are higher than concentrations from the conventional method, then it is probable that the concentrations from the PDB sampler are an adequate representation of ambient conditions. If, however, the conventional method produces concentrations that are substantially higher than the concentrations found by using the PDB sampler, then the PDB sampler may or may not adequately represent local ambient conditions. In this case, the difference may be due to a variety of factors, including mixing or translocation due to hydraulic and chemical heterogeneity of the aquifer within the screened or open interval of the well and the relative permeability of the well screen.

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HYDRASleeve

Simple by Design

US Patents No. 6,481,300; No. 6,837,120; others pending

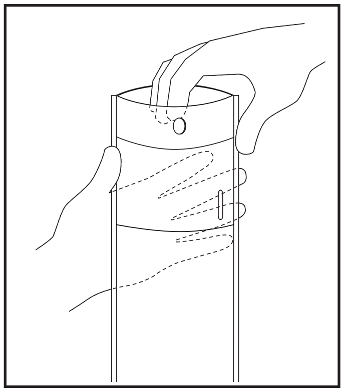
Field Manual

Introduction

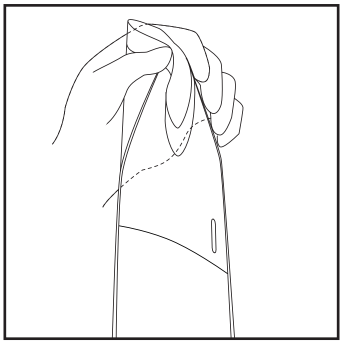
The HydraSleeve groundwater sampler can be used to collect a representative sample for most physical and chemical parameters without purging the well. It collects a whole water sample from a user-defined interval (typically within the well screen), without mixing fluid from other intervals. One or more HydraSleeves are placed within the screened interval of the monitoring well, and a period of time is allocated for the well to re-equilibrate. Hours to months later, the sealed HydraSleeve can be activated for sample collection. When activated, HydraSleeve collects a sample with no drawdown and minimal agitation or displacement of the water column. Once the sampler is full, the one-way reed valve collapses, preventing mixing of extraneous, non-representative fluid during recovery.

Assembly

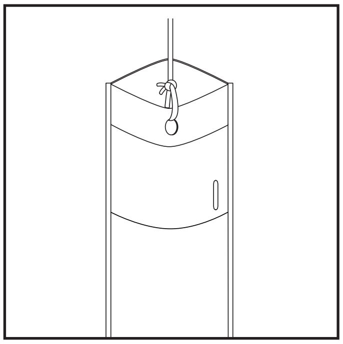
Assembling the HydraSleeve is simple, and can be done by one person in the field, taking only a minute or two.



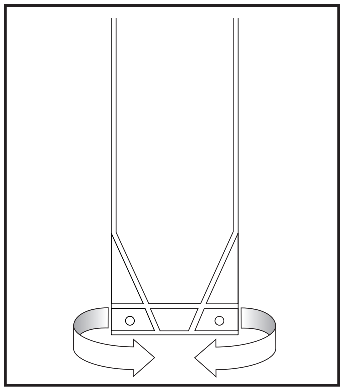
1 Remove HydraSleeve from package and grasp top to "pop" open.



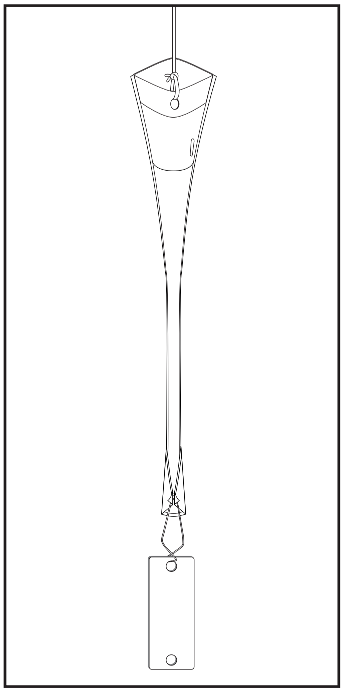
2 Squeeze side fins together at top to bend reinforcing strips outward.



3 Attach line to hole at top of HydraSleeve.



4 Fold the two holes at bottom of HydraSleeve together and attach weight



5 Sampler is ready to insert into the well.

Placing the HydraSleeve(s)

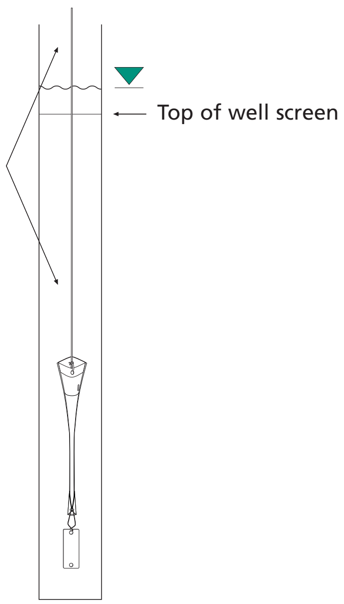
To collect a representative groundwater sample without purging, the well must be allowed time to re-equilibrate after placement of the sampler. When any device is lowered into a well, some mixing of the water column occurs. The diameter of the device and its shape greatly affect the degree of mixing. The flat cross-section of the empty HydraSleeve minimizes the disturbance to the water column as the sampler is lowered into position, reducing the time needed for the well to return to equilibrium.

There are three basic methods for holding a HydraSleeve in position as the well equilibrates.

TOP DOWN DEPLOYMENT (Figure 1)
Measure the correct amount of suspension line needed to "hang" the top of the HydraSleeve(s) at the desired sampling depth (in most cases, this will be at the bottom of the sampling zone). The upper end of the tether can be connected to the well cap to suspend the HydraSleeve at the correct depth until activated for sampling.

Note: For deep settings, it may be difficult to accurately measure long segments of suspension line in the field. Factory prepared, custom suspension line and attachment points can be provided.

Figure 1

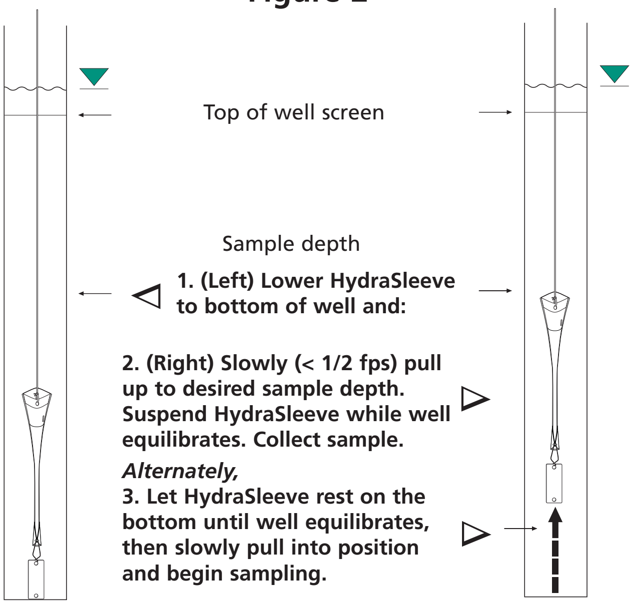


Suspend HydraSleeve at correct depth from top of well by accurately measuring the tether length.

BOTTOM DEPLOYMENT (Figure 2)
Sound the well to determine the exact depth. Lower the weighted HydraSleeve into the well and let it touch the bottom. Very slowly (less than 1/2 foot per second) raise the sampler to the point where the check valve is at the depth the sample is to be collected. Attach the suspension line to the top of the well to suspend it at this depth. (It is often easier to measure a few feet from the bottom of the well up to the sample point, than it is to measure many feet from the top of the well down.)

Alternately, the sampler can be left on the bottom until the well re-equilibrates. For sampling, it can be very slowly pulled (< 1/2 fps) to sampling depth, then activated (see "Sample Collection," p. 6) to collect the sample, and retrieved to the surface.

Figure 2



1. (Left) Lower HydraSleeve to bottom of well and:

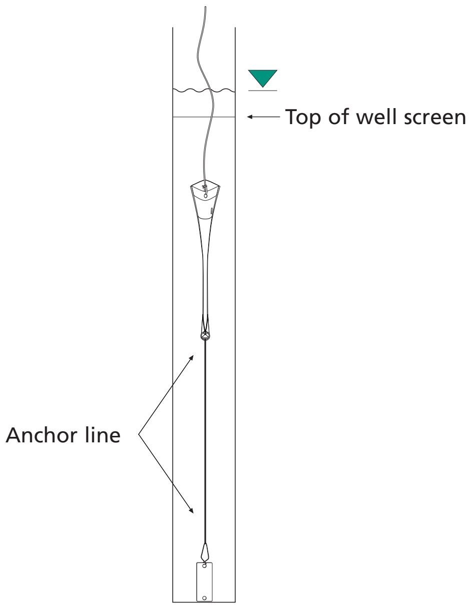
2. (Right) Slowly (< 1/2 fps) pull up to desired sample depth. Suspend HydraSleeve while well equilibrates. Collect sample.

Alternately,
3. Let HydraSleeve rest on the bottom until well equilibrates, then slowly pull into position and begin sampling.

BOTTOM ANCHOR (Figure 3)

Determine the exact depth of the well. Calculate the distance from the bottom of the well to the desired sampling depth. Attach an appropriate length anchor line between the weight and the bottom of the sampler and lower the assembly until the weight rests on the bottom of the well, allowing the top of the sampler to float at the correct sampling depth.

Figure 3



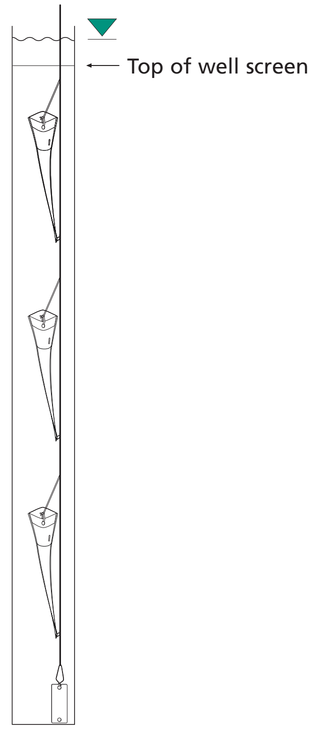
Multiple Interval Deployment

There are two basic methods for placing multiple HydraSleeves in a well to collect samples from different levels simultaneously.

ATTACHED TO A SINGLE TETHER (Figure 4)

To use 3 or more samplers simultaneously, we recommend attaching them all to a tether for support to prevent the sampling string from pulling apart. The weight is attached to a single length of suspension line and allowed to rest on the bottom of the well. The top and bottom of each HydraSleeve are attached to the tether at the desired sample intervals. Cable tie or stainless steel clips (supplied) work well for attaching the HydraSleeves to the line. Simply push one end of the clip between strands of the rope at the desired point before attaching the clip to the HydraSleeve.

Figure 4

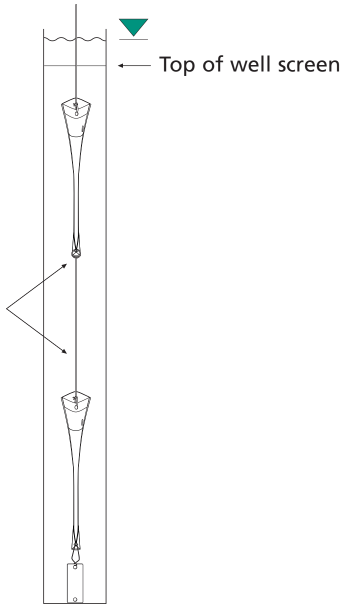


Separate HydraSleeves to the desired spacing by measuring along the tether when attaching samplers.

ATTACHED END TO END (Figure 5)

To place 2 or 3 stacked HydraSleeves for vertical profiling, use one of the methods described above to locate the bottom sampler. Attach the bottom of the top sampler to the top of the following HydraSleeve(s) with a carefully measured length of suspension cable. Connect the weight to the bottom sampler. Note: if many HydraSleeves are attached to a tether, more weight may be required than with a single sampler.

Figure 5



Separate HydraSleeves to the desired spacing by measuring tether between samplers.

Sample Collection

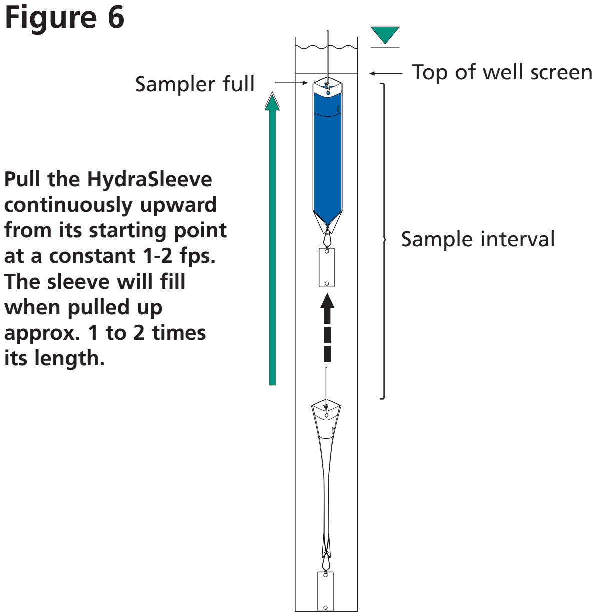
The HydraSleeve must move upward at a rate of one foot per second or faster (about the speed a bailer is usually pulled upward) for water to pass through the check valve into the sample sleeve. The total upward distance the check valve must travel to fill the sample sleeve is about 1 to 2 times the length of the sampler. For example, a 24-inch HydraSleeve needs a total upward movement of 24 to no more than 48 inches to fill. The upward motion can be accomplished using one long continuous pull, several short strokes, or any combination that moves the check valve the required distance in the open position. A special technique is used for sampling low-yield wells.

CONTINUOUS PULL (Figure 6)

Pull the HydraSleeve continuously upward from its starting point at a constant 1 to 2 feet per second until full. This method usually provides the least turbid samples and is analogous to coring the water column from the bottom up.

Note: When using this method, the screen interval should be long enough so the sampler fills before exiting the top of the screen.

Figure 6



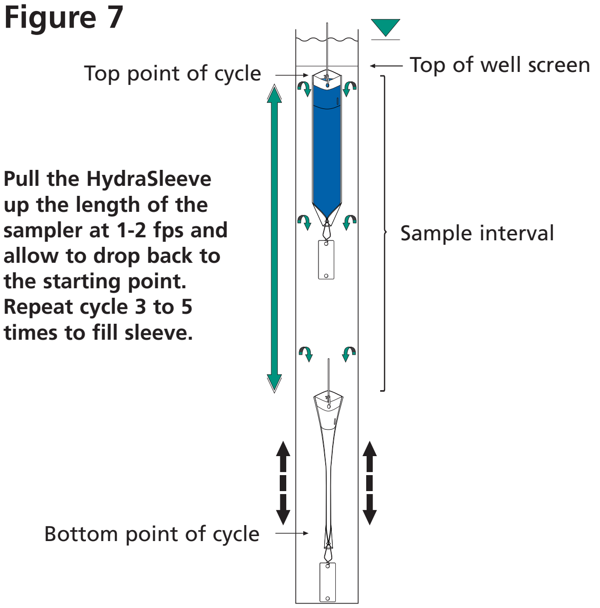
Pull the HydraSleeve continuously upward from its starting point at a constant 1-2 fps. The sleeve will fill when pulled up approx. 1 to 2 times its length.

SHORT STROKES (Figure 7)

Pull the sampler upward at about 1 to 2 feet per second for the length of the sampler and let it drop back to the starting point. Repeat the cycle 3 to 5 times.

This method provides a shorter sampling interval than the continuous pull method (above), and usually reduces the turbidity levels of the sample below that of numerous rapid, short cycles (below). The sample comes from between the top of the cycle and the bottom of the sampler at its lowest point.

Figure 7

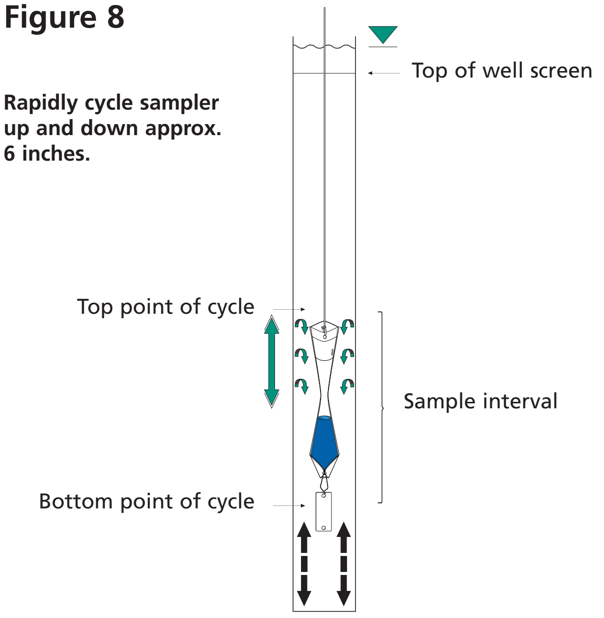


Pull the HydraSleeve up the length of the sampler at 1-2 fps and allow to drop back to the starting point. Repeat cycle 3 to 5 times to fill sleeve.

RAPID, SHORT CYCLES (Figure 8)

Cycle the HydraSleeve up and down using rapid, short strokes (6-inch cycle at a minimum of 1 cycle per second) 5 to 8 times. This method provides the shortest sampling interval. Dye studies have shown that when using this method the sample flows into the check valve from along the length of the sampler and immediately above the check valve. The sample interval is from the bottom the sampler at its lowest point in the cycle to the top of the check valve at the peak of the cycle.

Figure 8

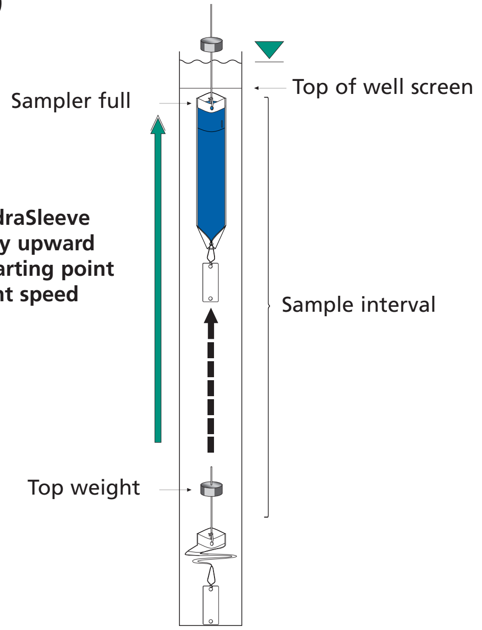


Rapidly cycle sampler up and down approx. 6 inches.

SAMPLING LOW-YIELD WELLS (Figure 9)

HydraSleeve provides the best available technology for sampling low yield wells. When pulled upward after the well re-equilibrates, the HydraSleeve will collect a water core from the top of the sampler to about its own length above that point. The sample is collected with no drawdown in the well and minimal sample agitation. An optional top weight can be attached to compress the sampler in the bottom of the well if needed for an extremely short water column. With a top weight, the check valve is pushed down to within a foot of the bottom of the well.

Figure 9



Pull the HydraSleeve continuously upward from the starting point at a constant speed

Sample Discharge

The best way to remove a sample from the HydraSleeve with the least amount of aeration and agitation is with the short plastic discharge tube (included).


1


2


3

First, squeeze the full sampler just below the top to expel water resting above the flexible check valve. (Photo 1, top left)

Then, push the pointed discharge tube through the outer polyethylene sleeve about 3-4 inches below the white reinforcing strips. (Photo 2, middle left)

Discharge the sample into the desired container. (Photo 3, bottom left)

Raising and lowering the bottom of the sampler or pinching the sample sleeve just below the discharge tube will control the flow of the sample. The sample sleeve can also be squeezed, forcing fluid up through the discharge tube, similar to squeezing a tube of toothpaste. With a little practice, and using a flat surface to set the sample containers on, HydraSleeve sampling becomes a one-person operation.

GeoInsight

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Attachment A: Standard Operating Procedure (SOP) #4
Supply and Irrigation Well Sampling Protocol

1.0 Sample Collection

Samples are collected from three former Fort Ord supply wells (Well 29(A), 30 (B), and 31 (C)[1]) operated by the Marina Coast Water District (MCWD), and on private off post irrigation well (Mini-Storage). Samples from these wells are analyzed for VOCs by EPA Test Method 8260 SIM (selected ion monitoring) OUCTP A-Aquifer COC list on a quarterly basis[2]. Samples are collected in three 40 milliliter (mL) VOA vials pre-preserved with hydrochloric acid (HCl). The water from these wells is collected prior to treatment or chlorination; therefore, the addition of sodium thiosulfate as a preservative is not needed.

2.0 Sample Techniques

Upon arriving at the supply well, the MCWD field technician will inform the sampler if the well is on (pumping) or off. If the pump is off, the sampler should remain outside the building until the MCWD field technician has started the pump due to noise associated with the pump's initial start-up. Once the pump is running, the sampler must open the sampling port, a small Teflon or copper tube coming from the main water flow pipe. The MCWD filed technician can help locate the sampling port if the sampler is unable to identify it. Let the spigot run approximately one minute at high flow to flush the sampling port tube. A drain located in the floor near the spigot collects the discharge water. Adjust the flow rate downward until you are able to fill the 40mL VOA vials with no splashing or bubbling, letting the water flow down the side of the container. Do not overfill or rinse the container or the preservative will be lost. The 40m: VOA vials should be completely filled to the point where the water's meniscus forms a convex shape above the lip of the container. Replace the container's cap and secure snugly making sure not to over tighten, and check for headspace or bubbles. VOA vials are zero headspace and therefore if a bubble appears inside the bottle after capping, a new sample must be collected. The sample bottles are to be labeled, stored in a Ziploc bag, and placed on ice in a sample cooler immediately. The chain of custody (COC) and daily field logbook shall be filled out completely prior to moving on to the next well.

The Mini-Storage well is located in the Marina Mini-Storage yard on the north side of Reservation Road in Marina. The pump head is located just north of the parking area in the main lot. Two spigots are on the top of the pump head just outside a small garden box container. A hose may be attached to one or both spigots. The spigot where the sample will be collected should be turned on and the water allowed to flow for at least a minute. A pressure gauge is located on the pipe and will indicate when the pump has been activated. After the pump has turned on, allow the water to run for another one to one and a half minutes. Remove any hoses attached to the spigot, adjust the flow as low as reasonable, and collect the sample in the same fashion as described for the Supply Wells. When finished replace any hoses that have been removed from the spigots. The sample bottles are to be labeled, stored in Ziploc bags, and placed on ice in a sample cooler immediately. The COC and daily field logbook shall be filled out completely prior to moving on to the next well.

---

[1] These wells are identified as FO-29, FO-30, and FO-31, respectively.

[2] Unless a well is inoperable.

Attachment A: Standard Operating Procedure (SOP) #5

OU2 and Sites 2/12 GWTSs and OUCTP EISB Extraction Well Sample Handling and Custody Requirements

Table of Contents

1.0 Sample Types

Project samples may be extraction well groundwater samples, Groundwater Treatment Plant (GWTP) process water samples, or quality control/quality assurance samples. Standard operating procedures for the collection of these water samples are described in this document.

1.1 Extraction Well Samples

Extraction well samples (standard field samples) will be generated to evaluate the effectiveness of the remedial action in containing the groundwater contamination plume, removing contaminant mass from the groundwater, and achieving remedial action objectives. Data generated will be applied to decision rules identified in the QAPP to determine operational status and sampling frequency for individual extraction wells.

1.2 GWTP Process Samples

GWTP process samples (standard field samples) will be generated to evaluate the effectiveness and efficiency of GWTP components in removing chemicals of concern (COCs) from extracted groundwater, determining the timing for replacing granular activated carbon (GAC) in the GAC vessels, and maintaining discharge limits for COCs in treated water.

1.3 Quality Control (QC)

Field QC samples will be generated to evaluate the precision, accuracy, and integrity of field sampling and laboratory analytical procedures. Quality control samples are introduced into the sample analysis stream along with environmental samples. The frequency of field QC sample generation is based on project Data Quality Objectives (DQOs), as well as the total number of samples submitted and the nature and intensity of the investigative process that is being monitored or evaluated. The following QC samples will be employed during the field program.

1.3.1 Trip Blanks

Trip blanks are prepared by the laboratory using contaminant-free water (e.g., nitrogen purged deionized water) which is poured into Volatile Organic Analysis (VOA) vials and shipped to Ahtna Environmental Inc. (Ahtna) by the laboratory. The laboratory also provides pre-cleaned and hydrochloric acid (HCl) acid-preserved sample containers for collecting water samples for Volatile Organic Compound (VOC) analysis. Trip blanks will accompany sample containers into the field and will be shipped back to the laboratory with every cooler that contains samples for VOC analyses. Trip blanks will be analyzed for all VOC analytes specified for environmental samples in the corresponding cooler.

1.3.2 Field Duplicate Samples

Duplicate samples are submitted to the contract laboratory for the purpose of assessing the effect of the sample matrix on analytical measurement precision.

The laboratory will not be informed as to the identity of duplicate samples and no special sample handling protocol will be employed during collection, shipment, or analysis of these samples. These “blind” duplicate samples will be submitted and analyzed on a frequency of one in ten of the total environmental sampling effort for each matrix sampled. Areas of known contamination or critical sampling points may be preferentially selected for submittal as blind duplicates. Duplicate samples will be analyzed for the same parameters as the corresponding primary sample.

2.0 Field Documentation

Field activities and sample collection will be documented using the following forms and information as appropriate: sample label, chain of custody form, groundwater sampling form, well completion details, well development form, cooler receipt form, waste management label, and hazardous waste label. The purpose of standardized field documentation and sampling procedures is to maintain integrity of field documentation and field samples throughout the remediation process. Each field sample will be labeled and sealed immediately after collection. Sample identification documents will be carefully prepared to maintain control of sample disposition. Field sample custody procedures are described in Section 4.1. Standard procedures for documentation of field activities are presented below.

2.1 Field Logbooks

Field procedures relevant to sample collection and field activities will be recorded daily in permanently bound notebooks. Each individual in the field will maintain a bound field logbook with serially numbered pages. The logbook is signed and dated prior to daily initiation of field work. If logbook duties are transferred, the individuals relinquishing and receiving will both sign and date the logbook and record the transfer time. Logbook corrections are made by a single line strikeout of the incorrect entry and entering the correct information that is initialed by the person making the entry. If the correction is made at a later time or date, the correction date is also entered. Unused partial or whole logbook pages are crossed out and unused pages signed and dated at the end of each workday. All entries must be legible, in ink, and primarily factual in content. Hypothetical information can be entered but should be noted accordingly. Logbook entries may include the following information as necessary:

- Project name and number.
- Site name and location.
- Arrival and departure date/time.
- Name and affiliation of personnel onsite (including site visitors), and personnel contacted.
- Author name and date.
- Field instrument calibration methods and identification number.
- Chronology and location of activities.
- Sampling locations.
- Sample identification numbers, amount collected, sampling method and container (size/type) for each sample collected, including QC samples. Sample processing techniques such as filtration, compositing, and preservation techniques should be noted. Alternatively, this information may be contained on the COC form, groundwater sampling form, or other field form. The logbook will then contain a unique identifier linking the field log book entry to the field form.
- Date and time of sample collection, name of sampler.
- Field observations including weather conditions and applicable comments.

- Number of shipping coolers packaged and sent.
- Name and address of all receiving laboratories.
- Any modifications or deviations from quality assurance project plan.

Written reports of all significant non-routine events for field and laboratory work will be sent to the USACE Contracting Officer within 48 hours of occurrence. These reports will identify the problem, corrective action, and verbal written instructions from the USACE Project Manager (PM) to Ahtna regarding corrective action. Significant non-routine events are occurrences that impact cost of work, work schedule, work quality, and analytical data quality.

2.2 Sample Identification and Labels

2.2.1 Sample Identification

Two sample identifiers, the sample number and the station number, will be used to designate samples and sampling locations. Sample numbers will be used for coding, tracking, and reporting chemical data. Station numbers will encode sample type, site identification, and boring number or monitoring well sequence. Conventions for generating sample and station numbers are presented below.

The sample number is a coded identification designed to satisfy project and database criteria. Each sample number:

- Will contain up to 12 characters.
- Will be unique.
- Will be traceable to a specific sampling event.
- Will be traceable to a specific sampler.
- Will incorporate a specific site designation.
- Will not obviously indicate to the laboratory the sample depth, station number, or type of sample (i.e., original sample and duplicate).

All chemical data produced by the contract laboratory will be reported using the sample number. Samples will be numbered as follows (no spaces in actual sample numbers):

YR WK X SSS 000 Z

Where:

YR = Calendar year

WK = Week of the year

X = One-letter ID code assigned to each field sampler

SSS = Three-character site identification code: “OU2” or “212”

000 = Three-digit sequence number for each sample

Z = Assigned QC sample code

Assigned sample QC codes are as follows:

- A = Trip blank

- B = Not used for groundwater treatment system (GWTS) sampling
- C = Not used for GWTS sampling
- D = Field duplicate
- E = Not used for GWTS sampling
- F = Standard field sample

For example, sample number 1704M212015A represents the fifteenth sample collected by sampler "M" and is a trip blank (QC code A) collected at Sites 2/12 during Week 4 of 2017. Each sample collector will start with sequence number 001 and continue consecutively through 999. Field personnel are responsible for keeping track of their own sequence in the field logbook. Field audits will include checks of this sample numbering system to ensure that correct procedures are being followed.

Week numbers are assigned to week-long periods ending on Friday. For example, Week 4 of 2017 is the week ending January 27, 2017. Week numbers below 9 must contain a zero (i.e., 01 through 08). For aqueous samples, multiple sample containers for each discrete sample may be required to fulfill analytical requirements. In these instances, the same sample number will be used on all sample containers.

The station description is a sequence of characters designed to identify site-specific samples. Station descriptions will not be included on the laboratory copy of the chain of custody form. The station description field on the chain of custody form will be used to record the site, sample type, sequence number, and other relevant sample characteristics.

The convention for station description naming is as follows:

ST-SSS-000-XXX

Where:

ST = Sample type

SSS = Three-character site identification code (same as for sample numbering scheme)

000 = Station number unique to each station

XXX = Sample depth or aquifer

Station description names will not include spaces. Example sample type codes are as follows:

- EW = Extraction well
- MP = Multi-port well
- MW = Monitoring well
- SG = Soil gas
- SL = Sludge
- PZ = Piezometer
- TS = Treatment system
- WW = Wastewater
- VE = Vapor extraction

Sample depth may indicate the actual depth the sample was collected relative to ground surface or top of well casing (e.g. the pump intake depth), the port the sample was collected from in a multi-port well, or the aquifer the sample was collected from. Example sample depth codes for aquifers at the former Fort Ord are as follows:

- A = A-Aquifer
- 180 = Upper or Lower 180-Foot Aquifer

For example, station name EW-OU2-13-A represents an extraction well station 13 at the OU2 site with a sample depth in the A-Aquifer.

2.2.2 Sample Label

All samples will be properly labeled to prevent misidentification of samples. Preprinted sample labels will be provided. The label will be affixed to the sample container prior to transportation to the laboratory and will contain the following information:

- Project name, number, and location
- Site name
- Name of collector
- Date and time of collection
- Sample identification number
- Preservative, if any
- Requested test methods or analyses

2.3 Chain of Custody Record

A chain of custody (COC) record will be filled out for and will accompany every sample to the analytical laboratory for documentation of sample possession from the time of collection to sample receipt. A carbonless copy of the chain of custody form will be retained in the investigation files according to project number. The primary laboratory will upload copies of the cooler receipt forms and associated chain of custody forms to its LabLink website for review by the Project Chemist within 24 hours of sample receipt. The forms will contain the following information:

- Sample number or identification
- Name and signature of collector, sampler, or recorder
- Name, number, and location of project
- Project manager's name
- Date of collection
- Place of collection (station description)
- Sample type
- Analyses requested
- Dates and times of possession changes

- Signature of persons relinquishing and receiving sample
- Laboratory sample number, where applicable
- Date and time of laboratory sample receipt

2.4 Transfer and Review of Field Documentation

During site-specific field operations, copies of each field logbook page will be telefaxed or hand delivered to the Task Manager on a daily basis. In the absence of a facsimile, field staff will be in contact with the Task Manager, via mobile telephones.

At the end of each week of field operations, all field documentation will be copied, and originals sent to the Task Manager or Project Manager for review and verification. Original field documents will be kept in the project files. Verification and review of field documentation will include at a minimum, the following checks:

- Consistency of dates and times of activities; among the various field records and forms
- Consistency of sample location and identification documentation among the various field records and forms
- Accuracy and correctness of well completion details
- Correctness of sample preservation techniques

Errors or inconsistencies identified during the review process will trigger a nonconformance investigation to be conducted by the Project Chemist or Quality Control System Manager (QCSM). Appropriate corrective action will be implemented and documented if systemic errors are identified.

3.0 Groundwater Sampling

This section describes groundwater sampling procedures to be followed prior to, during, and after groundwater sample collection from monitoring wells. Procedures for collecting grab groundwater samples are described at the end of this section.

3.1 Sampling Preparation

Prior to sampling, the well vault or GWTS process sampling port will be examined for signs of tampering or deterioration and observations noted. After a well vault is opened, the Activity Hazard Analysis (AHA) may call for the air in the wellhead vicinity to be tested for organic vapors with the Photo Ionization Detector (PID) or Flame Ionization Detector (FID) and/or for explosive atmospheres with an oxygen/combustible gas indicator (see Appendix E of the Site Safety and Health Plan). Results will be recorded in the field notebook. (Note: well vault air testing is not required for routine groundwater sampling as long as previous results indicate that organic vapors or explosive atmosphere are not present). All measuring and sampling equipment will be decontaminated prior to use in any well (see Section 3.5).

Extraction wells that are not normally operated will be run to purge a minimum of three well volumes prior to sample collection. Pumped purge volumes will be estimated using the flow meter in the well vault. The volume of water purged and the withdrawal rates will be recorded. Purge rates will be sustainable and executed at a rate that minimizes drawdown to prevent water from cascading into the well. Prior to sample collection, ports for extraction well and process sampling will be purged with the port valve completely open for a minimum of 1 minute to ensure stagnant water and any foreign matter or debris are discharged so a representative sample may be collected.

If a well is purged dry before three casing volumes have been removed, VOC samples will be collected immediately. Other samples will be taken after the well has recovered to within 80 percent of the static water level prior to purging, or after 4 hours, or when sufficient water volume is available to meet analytical requirements, whichever occurs first.

Pre-cleaned sample containers will be provided by the laboratory. The containers for each sample will be labeled in advance of the sampling event with the date, sample number, project name, sampler's name or initials, parameters for analysis (method numbers where possible), and preservation.

3.2 Sampling Procedures

After purging, samples will be collected using designated sampling ports in extraction well vaults or designated GWTS process sampling ports. Water samples will be collected carefully by discharging directly from the sample port to the appropriate sample containers.

Water samples for VOC analysis will be collected in VOA vials, which will be filled by inserting the sample port spout to the bottom of the VOA vial and keeping the spout beneath the surface of the liquid as it fills the vial until there is a convex meniscus over the neck of the bottle. The Teflon side of the septum (in the cap) will be positioned against the meniscus, and the cap screwed on tightly; the sample will be inverted, and the vial tapped lightly. The absence of an air bubble indicates a successful seal; if a bubble is evident, the sample will be discarded and the process repeated.

All sample bottles and equipment will be kept away from fuels and solvents. Gasoline (used in generators) will be transported in a different vehicle from the vehicle containing sampling equipment, sample bottles, etc. If possible, one person should be designated to handle samples and another person should operate the generators and refuel equipment, if required. Disposable gloves will be worn for each separate activity and then properly disposed. Care will be taken to avoid fuel spillage.

All samples will be packaged and transported appropriately, as described in Section 4.3.

3.3 Water-Level Measurement

The methods presented below are intended to produce water-level measurements that are consistent over multiple measurement events. Calibration and precision requirements for water-level measurements are summarized in Section 3.4.

Groundwater levels may be measured using an electrical sounder, a steel tape, or a pressure transducer. All water-level measurements will be taken from an obvious survey mark at the top edge of the well casing. Water levels will be measured using the following procedures.

Electrical Sounder

The standard equipment for making individual water-level measurements will be a battery-powered sounder. The sounder must have firmly affixed or permanent marks on the sounder line at regular intervals (minimum interval of 0.01 foot).

Calibration checks on the electrical sounder will be made periodically. The sounder markings will first be checked for the proper spacing by physically comparing the spacing with a graduated steel tape. Accuracy rechecks will be made after any incident that might alter the measuring capability of the instrument, such as cable stretching, entanglement, or sensor tip replacement.

Portions of the cable that are inserted in wells will be decontaminated after use according to the procedure described in Section 3.5. Sounders will be maintained in a clean and functional condition.

Steel Tape

A graduated steel tape (with 0.01-foot graduations) can be used for water-level measurements in conjunction with other methods and, when required, for a quality control check of other methods. The steel tape will be periodically checked for kinks, and if kinked tapes are found, the tape will be labeled as unusable and taken out of service. Portions of the tape that are inserted in wells will be cleaned after use according to the procedure described in Section 3.5. Tapes will be maintained in a clean and functional condition.

3.4 Sampling Equipment Calibration Procedures

Included is a description of the procedure or a reference to an applicable standard operating procedure, the calibration frequency, and the calibration standards used. All instruments and manufacturers' instructions and specifications are maintained in the project files. All instruments are calibrated prior to being sent to the field. Field calibration procedures will be documented in the Field Logbook.

Water-Level Measurement Instruments

Electrical sounder: Checked against steel surveyor's tape prior to initial use. Battery and sensitivity checked daily.

Graduated steel tape: Referred to new steel tape; manufacturer-supplied temperature correction is applied if appropriate for field conditions.

Pressure transducer: Factory calibrated once, in-house calibration checked with water columns prior to aquifer tests, and weekly field checks made against steel tape or electrical sounder.

3.5 Decontamination Procedures

All reusable equipment that may come in contact with potentially contaminated soil, sediment, or water will be decontaminated prior to use to reduce the potential for cross-contamination during field activities. Decontamination will consist of steam cleaning (high pressure, hot water washing); non-phosphate detergent wash; solvent rinse; distilled, deionized (DI), or clean water rinse; pesticide-grade methanol rinse; and final rinse with DI water, as appropriate.

The procedures for decontaminating sampling equipment are described below:

- Wash steel tapes, well sounders, transducers, and water quality probes in a non-phosphate detergent solution, and rinse in distilled or DI water, or wipe clean after each use, depending upon site conditions. Clean the portion of these devices inserted into wells with a mild non-phosphate detergent solution.

4.0 Sample Handling Procedures

Appropriate sample handling techniques are necessary to protect the samples and maintain sample custody protocol requirements following collection. Sample handling includes custody, container/preservative type, transfer, storage, and disposal.

4.1 Field Sample Custody

Standardized sample custody procedures will be followed through sample collection, transfer, storage, analysis, and ultimate disposal. Sample custody begins with shipment of the empty sample container sent to the office or site. All sample containers are shipped from the laboratory in sealed containers or cartons with appropriate seals and custody information. Sample quantities, types, and locations will be specified before the actual field work commences.

A sample is considered under custody if one or more of the following criteria are met:

- The sample is in the sampler's possession
- The sample is in the sampler's view
- The sample is in a designated secure area after being in the sampler's possession

4.2 Sample Containers and Preservation

Samples should be collected and containerized in order of the analyte volatilization sensitivity. A preferred collection order is listed below:

- Volatile organic compounds
- Sulfate and chloride

Methods of sample preservation are intended to retard biological action, retard hydrolysis, and reduce sorption effects. Preservation methods are generally limited to pH control, chemical addition, refrigeration, and protection from light.

All sample containers will be properly labeled (see Section 2.2) and monitored for temperature control in the field and during laboratory transport and storage. Temperature blanks will be used in all coolers containing samples requiring preservation at reduced temperature (4°C).

4.3 Sample Transfer and Shipment

Samples will always be accompanied by a chain of custody record. When transferring samples, both the individuals relinquishing and receiving the samples will sign, date, and note the transference time on the chain of custody record. Samples will be packaged properly for shipment, including isolation of samples suspected of high chemical concentrations, and dispatched to the appropriate laboratory for analysis. Custody seals will be used when samples are shipped via courier service, and must be placed on the container so that the seals have to be broken before the container can be opened. The seal must be signed and dated by the field personnel. Custody seals are not deemed necessary when the samples will be in the continuous possession of project, field, or laboratory personnel. The chain of custody record(s) will accompany each sample shipment. Samples will be packaged for shipment as follows:

- Print the following information clearly in waterproof ink on the label; the test methods requested, the preservative(s) used (if any), the sample number, the project number, the initials of the sample collector, and the date and time the sample was collected.

- Fill out field sample log and chain of custody record as described in Sections 1.2.1 and 1.2.3, respectively.
- Place each sample bottle or set of VOA vials in a separate plastic bag and seal the bag. Squeeze air from the bag before sealing.
- If using a plastic cooler as a shipping container, tape shut the drain plug from the inside and outside, and line the cooler with a large plastic bag. If sample containers are glass, place approximately 3 inches of inert packing material, such as asbestos-free vermiculite, perlite, or Styrofoam beads in the bottom of the container or wrap the sample containers in other appropriate protective packing material (e.g., bubble wrap. Other commercial shipping containers (cardboard or fiber boxes complete with separators and preservatives) may be used but should be preapproved by the USACE.
- Place the bottles upright in the lined plastic cooler and position to avoid contact during shipment. Cardboard separators may be placed between the bottles at the discretion of the shipper.
- Transport all samples to the laboratory on ice chilled to 4°C ± 2°C.
- Place additional inert packing material in the cooler to partially cover the sample bottles (more than halfway). If samples are required to be shipped to the laboratory with ice, place ice in double bags around, among, and on top of the sample bottles, fill the cooler with inert packing material, and tape the liner shut.
- Place paperwork going to the lab inside a plastic bag. Seal the bag and tape to the inside of the cooler lid. Include the original of the COC form in the paperwork sent to the laboratory. The last block on the COC form should indicate the over-night carrier and air bill number, if applicable. Fill out the air bill before the samples are handed over to the carrier. Notify the laboratory if the shipper suspects that the sample contains any other substance that would require laboratory personnel to take additional safety precautions.
- Close the cooler and tape it securely shut.
- Place at least two signed custody seals on the cooler, one on the front and one on the side. Additional seals may be used if the sampler or shipper deems necessary. Affix "fragile" and "this end up" labels on coolers, as appropriate.
- Samples may be hand delivered to the laboratory, transported by commercial or laboratory couriers, or shipped to the laboratory using an overnight shipper.

4.4 Laboratory Custody

A designated laboratory sample custodian will accept custody of the samples and verify that the information on the sample label matches that on the chain of custody form(s). Pertinent information as to sample condition, shipment, pickup, and courier will also be checked on the chain of custody form(s). In addition, a Cooler Receipt Form (e.g., cooler receipt form) will also be completed by the custodian and copies will be sent to the project chemist within 24 hours of sample receipt. On receiving samples at the laboratory, the temperature inside the cooler and of the temperature blank will be measured immediately after opening the cooler and the results recorded on the cooler receipt form. Information on the date and time of receipt, method of shipment, and sample condition also will be recorded on this form. The custodian will then enter the appropriate data into the laboratory sample tracking system. The laboratory custodian will use the sample number on the sample label as well as assign a unique laboratory number to each sample. The custodian will then transfer the sample(s) to the proper analyst(s) or store the sample(s) in the appropriate secure area.

Laboratory personnel are responsible for the care and custody of samples from the time they are received through sample disposal. Data sheets and laboratory records will be retained by the laboratory as part of the permanent documentation for a period of at least 3 years.

Attachment A: Standard Operating Procedure (SOP) #6
Low Flow Groundwater Quality Parameter Collection

1.0 Scope and Application

This Standard Operating Procedure (SOP) describes the procedures for calibrating and operating the field equipment necessary for collecting groundwater stabilization parameters by low flow. Groundwater stabilization parameters are obtained by using electronic equipment and are required to meet calibration standards.

2.0 Equipment List

- Decontamination equipment including soap, de-ionized and tap water
- Health and safety equipment including safety glasses and nitrile/latex exam gloves
- Field logbook, indelible ink pens and field forms
- Tools to open wells
- Horiba U-50 Series multi-meter or equivalent
- Electronic water level meter such as the Solinst Model 101 or equivalent
- Rinse water receptacle and disposal area
- Horiba pH4 multi-calibration solution or equivalent
- Horiba oxygen-reduction potential (ORP) standard powder No. 160-22 or No. 160-51 or equivalent.
- Flow-through-cell/chamber for Horiba
- Dedicated or non-dedicated submersible low flow 12 volt Geosquirt pump or equivalent
- Vehicle battery to power pump with pump controller
- Sample tubing (dedicated or non-dedicated) 3/8 inch (”) or ½” inner diameter (ID) Polyethylene

3.0 Procedures

3.1 Multi-Meter Calibration

Water parameters are primarily recorded with the **Horiba U-50 Series** (Horiba) multi-meter (or equivalent). A wide variety of measurements can be obtained, but for groundwater stabilization parameter purposes only temperature, specific conductivity, dissolved oxygen (DO), pH, ORP, and turbidity are needed. All these parameters require calibration with the exception of temperature. According to the Horiba manual utilize approximately 200 milliliters (mL) of calibration fluid in the calibration cup. While calibrating turbidity, the lower fill line in the calibration cup is used. Remember to remove any protective caps from the sensors prior to calibration and use of the meter.

The Horiba instrument utilizes simultaneous Auto Calibration of **DO, pH, conductivity, and turbidity** with the standard pH 4 calibration solution. At a standard temperature of 25 degrees Celsius (°C); pH is calibrated to 4.01, conductivity is calibrated to 4.49 milliSiemens per centimeter (mS/cm), DO is calibrated to 8.92 milligrams per liter (mg/L), and turbidity calibrated to 0 nephelometric turbidity units (NTU). Be sure the calibration solution is approximately the same temperature as the ambient air, if this cannot be confirmed, allow a one hour equilibration time. To perform auto calibration of the parameters listed above, follow the steps below:

1. Turn the Horiba unit on and let it warm up for approximately 20 minutes.
2. Remove the sensor guard and wash the sensor probe two to three times with deionized (DI) water.
3. Remove the transparent calibration cup.
4. Fill the transparent calibration cup to the “With TURB” labeled lower line with pH 4 standard solution.
5. Press the Horiba’s “CAL” key or navigate to the Calibration menu to set the calibration mode.
6. Select “Auto Calibration”.
7. Immerse the sensor probe in the transparent calibration cup.
8. Check that there are no air bubbles and the appropriate sensors are submerged.
9. Place the transparent cup with probe into the black calibration cup.
10. When all the sensor values have stabilized, press the “ENTER” key to start calibration.
11. Calibration is finished when the message “Cal complete. MEAS to measure” appears.
12. Press “MEAS” to begin reading parameters.
13. Finally, remove the calibration cup and rinse sensors and cup with DI water.

ORP is calibrated with another set of steps and materials as described below. ORP standard solution is not stable for more than an hour and therefore cannot be stored. For measuring low concentrations measurements may not be repeatable, start the measurement immediately after submersion.

1. Fill a clean beaker with one bag of ORP standard powder No. 160-22 or No. 160-51.
2. Add 250 mL of DI water and agitate the solution thoroughly (there will be some excess quinhydrone [a black powder] that floats on the surface when agitating the solution).
3. Fill the transparent calibration cup to the reference line (the upper line “Without TURB”) with this ORP solution.
4. Wash the sensor probe two to three times with DI water then submerge probe into the transparent calibration cup.
5. Press the Horiba’s “CAL” key or navigate to the Calibration menu to set the calibration mode.
6. Select “Manual Calibration”.
7. Select “ORP”.
8. Set the millivolts (mV) value of the ORP standard solution appropriate for specific temperature conditions as specified in the table below.

Temperature (°C)	ORP Powder 160-22	ORP Powder 160-51
5	+274	+112
10	+271	+107
15	+267	+101
20	+263	+95
25	+258	+89
30	+254	+83
35	+249	+76
40	+244	+69

9. Once the value has stabilized, press “ENTER” to start calibration.
10. Calibration is finished when the message “Cal complete. ENT to manual cal menu” appears.
11. Press “ENT” and then “MEAS” to begin reading parameters.
12. Finally, remove the calibration cup and rinse sensors and cup with DI water.

The auto multi-calibration and the ORP calibration of the Horiba should be performed daily. Record the auto multi-calibration and ORP calibrations were performed in the daily field logbook and other paperwork as necessary. Remember to replace any protective caps on the sensors following calibration or use of the meter and decontamination.

3.2 Site Control

- Upon arrival at groundwater monitoring well or sample station, position field vehicle in location convenient to access well as necessary for use of pump and field equipment while collecting parameters. Consider using the field vehicle to provide safety from traffic or shade from the sun.
- Establish a work area as needed. Lay out equipment in an orderly manner so as to avoid creating trip hazards. This is an important consideration in regards to cords and tubing. If necessary, use traffic cones or caution tape to define a work area and do not allow the public or subcontractors to enter your work area. Control activities in the sample collection work area so as to preserve the quality and integrity of the parameters being collected.

3.3 Water Level Measurement

Water level indicators (sounders) need to be calibrated and checked for accuracy. If more than one instrument is to be used, they should be checked by measuring a single well using both instruments to assure that measurements are consistent. A single water level meter can be checked against another tape (i.e. 100 foot reel measuring tape). Turn on unit and test the audible detector by depressing button on the site of unit before use.

Prior to leaving field office or before beginning water level measurements, decontaminate the probe and cable. Inspect well casing and locking cap for tampering, damage, maintenance needs or rust and make note of the conditions on the appropriate *Well Maintenance Form* and in the field logbook.

Use care when removing the well cap or J-plug and observe if there is a pressure difference between the closed well and atmospheric pressure. If project groundwater wells tend to build pressure attach a lanyard to well cap to eliminate the potential for injury from rapid pressure release. Never place body, face or head directly over a well while opening the well cap. Each well shall be marked with a permanent, easily identified reference point for water level measurements whose location and elevation have been surveyed. In the event a marking is not visible or well is not yet surveyed, take the water level reading from the north-side top of casing.

Don disposable silicone or nitrile exam gloves before lowering well sounder probe and measuring tape into the well. After decontaminating the sounder following water level measurement, properly dispose of exam gloves. A fresh pair of exam gloves should be used for each well or monitoring station.

Slowly lower probe into the monitoring well until contact with the water surface. An audible alarm on the water level meter will occur when the probe touches the water. Gently lift and lower the probe until an accurate measurement can be determined. Adjust well sounder sensitivity as necessary to get a good reading. Obtain the reading from the established mark on the well casing and measure to the nearest 0.01 foot. Record water level on the appropriate field forms.

After a water level measurement is collected at a groundwater monitoring well, decontaminate the measuring tape and reel. After decontamination is completed, properly secure the sounder in the sampling vehicle before moving on to the next location.

3.4 Equipment Setup

- Lie out and connect electric cords to vehicle battery from the pump. Lie out and connect pump discharge tubing from pump to flow-through-cell and from flow-through-cell to purge water storage tank. Keep tubing and equipment in shade whenever possible.
- Check the specifications for the well and place the pump at the specified depth after collecting a depth to water measurement, collecting any necessary analytical samples, and removing any hardware in the well. Make sure the pump is decontaminated accordingly with deionized water and soap between locations. Discharge tubing should be securely attached to the pump head and decontaminated or replaced between locations. Secure the pump electrical line and discharge tubing to the top of the well in a manner to avoid kinking once the desired depth has been reached. Record depth to water and depth to pump in the field log.
- Attach the end of the discharge tubing to the flow through cell that has been setup with the calibrated Horiba multi-meter. Attach the discharge of the flow through cell to a bucket for collecting purge water.
- Attach the end of the pump's electrical connector to the controller and connect the controller to the battery. The pump should start running once the controller is on and hooked up but it may

take a few minutes for water to come up to the surface. Adjust the flow accordingly if no water is being produced. Allow the flow through cell to fill before taking the first reading.

- Measure and monitor the flow rate with a graduated cylinder and record it as milliliters per minute (mL/min). Also record the cumulative volume purged as liters (L) and the water quality parameters temperature, pH, conductivity, dissolved oxygen, oxidation reduction potential, and turbidity.

Low-flow dedicated pump purging and sampling will consist of low flow 12 volt Geosquirt, or equivalent, low flow type pump to purge wells. This pump type is meant to pull water from approximately 120 feet below ground surface or shallower. If the well is too deep to pump adequately, lift the pump in the water column and record the pump depth on the field log.

The pumping rate will be maintained within the range of 0.25 to 1.0 liters per minute, limited to minimize the drawdown of the water table. Water level measurements will be collected before purging and after purging to ensure that drawdown in the well is not causing the well to go “dry”. Any well that should go “dry” during the course of sampling will be noted in the field notebook as well as on the appropriate field monitoring data sheet. After recharge time is allowed purging may be reattempted at a slower rate.

3.5 Groundwater Quality Parameter Collection

Parameters are measured from the wells by low-flow dedicated or non-dedicated pumping with a Horiba multi-meter or equivalent. Begin well documentation by filling out the top half of the water sampling log as needed.

The Horiba will be connected to a flow through cell. Parameter measurements are recorded on the sample log as follows:

- Time of measurement
- Pump intake depth (feet below top of casing)
- Flow rate (mL/min)
- Cumulative volume (L)
- Temperature (°C)
- Conductivity (mS/cm)
- DO (mg/L)
- pH (unitless)
- ORP (mV)
- Turbidity (NTU)
- Additional comments, if any

Each successive measurement will be recorded within 3-5 minutes. At least three measurements will be taken but there must be three successive readings stabilized according to the requirements below:

- pH: ± 0.1 units
- Electrical conductivity: ± 3% mS/cm

- ORP: ± 10 mV
- Dissolved oxygen: ± 10 percent mg/L
- Temperature: ± 1.0 °C
- Turbidity: ± 10% or less than 10.0 NTU

Well purging will be continued until the field parameters meet the criteria above, or until a maximum of three well volumes have been purged. An additional water level measurement should also be taken after monitoring is completed to assure the drop in water level is not excessive. Complete paperwork as needed.

3.6 Demobilization and Equipment Decontamination

- Stop purging the well, remove pump if non-dedicated and tubing and electrical line from the well. Re-install hardware and deploy passive diffusion bag (PDB) for next sampling event as necessary.
- Install the well cap or J-plug. Store dedicated discharge tubing in well or contain on vehicle as applicable. Decontaminate non-dedicated pump and tubing with water and soap, purging tubing by operating the pump.
- If possible, purge wells in order of lowest to highest contaminant of concern (COC) concentrations to reduce the chance of carryover from non-dedicated equipment.
- For wells located in a busy street, once all sampling equipment is packed, travel to the next scheduled location before decontaminating field equipment.
- Pumps should not be stored in an area where volatile sources (e.g., household cleaning chemicals, fuels, oils) are present; pumps shall not be stored without appropriate decontamination. Prior to use, the outside of the pump and tubing should be thoroughly rinsed with reagent grade water. Decontaminate all other equipment that contacted the well discharge water, including the water level sounder and the field meter flow-through-cell and probes.
- Collect all cords, tubing, tools and equipment and store in field vehicle in an orderly manner. Police site for trash and investigative derived waste and place in a trash bag.
- Collect any traffic control equipment while paying attention to potential traffic hazards. Never turn your back to oncoming traffic while on the street or when de-mobilizing traffic control from your work area.

3.7 Waste Management

Purged groundwater will be collected in temporary storage tanks, buckets or drums and transferred to proper storage tank for disposal at the Sites 2 and 12 groundwater treatment plant (2/12 GWTP). Non-hazardous solid wastes such as latex and nitrile gloves, plastic bags and paper towels will be collected and discarded to an approved municipal solid waste collection container.

Attachment A: Standard Operating Procedure (SOP) #7 Downhole Meter Groundwater Quality Parameter Collection

1.0 Scope and Application

This Standard Operating Procedure (SOP) describes the procedures for calibrating and operating the field equipment necessary for collecting groundwater quality parameters by downhole meter.

2.0 Equipment List

- Decontamination equipment including soap, de-ionized and tap water
- Health and safety equipment including safety glasses and nitrile/latex exam gloves
- Field logbook, indelible ink pens and field forms
- Rinse water receptacle and disposal area
- Water level meter
- Tools to open wells
- YSI 6-Series (6920) Multi-parameter Water Quality Sonde or equivalent downhole multi-parameter probe
- Calibration cup
- Probe guard
- Battery if required
- Ruler
- Barometer recommended
- Calibration solutions:
    - Conductivity: 10 milliSiemen per centimeter (mS/cm) YSI 3163 or 1 mS/cm YSI 3165 or equivalent
    - pH: pH 7 and pH 10 buffer solutions or pH 4 and pH 7 buffer solutions
    - Oxygen-reduction potential (ORP): Zobell standard recommended
    - Turbidity: two standards 0 nephelometric turbidity unit (NTU) and 100 NTU of formazin prepared by YSI, Hach, or other approved vendor.
    - Water for dissolved oxygen (DO)
- Ring stand recommended
- YSI 200 foot Sonde cable (for deeper wells)
- YSI 100 foot Sonde cable (for shallower wells)

3.0 Procedures

3.1 Downhole Meter Calibration

If the Sonde did not come with the sensors installed, install and activate the appropriate sensors per manufacturer’s instructions. Remove protective caps on the sensors before calibration or use of the meter. If the meter is rented, calibration has already been performed by the vendor and field calibration is not necessary during field events lasting less than 1 month. If the meter is rented, it is assumed that, unless warranted by erroneous field data, the meter will not require any maintenance.

To perform calibration of the Sonde, follow the general procedures below or specific manufacturer directions.

1. If installed, remove the Sonde probe guard.
2. Use the calibration cup supplied with the Sonde for all calibrations.
3. Rinse the Sonde probe and calibration cup with water and shake off excess.
4. Rinse the Sonde probe and calibration cup with a small amount of calibration solution if there is sufficient volume.
5. While calibrating the Sonde can be upright or inverted, but the sensors should be fully submerged.
6. Turn on the YSI meter and select Calibrate on the menu.

The following approximate volumes of calibration solution are to be used (check calibration solution and meter directions).

- Conductivity: 320 milliliters (mL) upright (150 mL inverted)
- Dissolved Oxygen: 1/8 inch (”) water vented to air
- pH/ORP: 200 mL upright (150 mL inverted)
- Optical sensors (turbidity): 225 mL upright (do not calibrate inverted)

7. Fill the calibration cup with the appropriate amount and type of calibration standard.
    a. For conductivity, be sure the probe is dry prior to immersing and no salt deposits. Make sure the sensor is completely immersed past the vent hole. Rotate the Sonde to remove air bubbles from sensor. Allow the temperature to equilibrate for approximately one minute after submersion.
    b. When calibrating dissolved oxygen, place 3 millimeters (mm) or 1/8” of water in the calibration cup. Engage only one or two threads of the calibration cup to vent to air. Loosen the bottom cap if the probe is inverted. Do not immerse DO or temperature sensors in the water. Wait approximately 10 minutes for the air in the calibration cup to become water saturated and for temperature equilibration.
    c. For pH, allow approximately one minute for temperature stabilization.
8. Screw the cup onto the probe. It is recommended to use a ring stand to prevent the probe from falling over.
9. In the Sonde Menu select “Calibrate”.
10. Input the calibration type you are performing (i.e., conductivity, Dissolved Oxygen, pH, ORP, Turbidity).
    a. Select Specific Conductivity for Conductivity calibration.
    b. Calibrating for percent (%) DO will also calibrate for milligrams per liter (mg/L) DO.
    c. For pH, enter 2-point calibration for two buffer solutions.
    d. For turbidity, enter 2-point calibration.

11. Once a parameter is selected, some will have a number that appears in parenthesis, which is the default value to be used for calibration.
12. Check the number is correct on the calibration standard being used, and press Enter or change the calibration value accordingly.
    a. For pH you must enter the calibration value, which is usually temperature dependent.
    b. For DO, you must enter the current barometric pressure. If you do not have a barometer, check the local weather station and calculate according to actual elevation. Barometric pressure must be entered in mm Hg. If given in in Hg, multiply by 25.4. To calculate for elevation take the barometric pressure at sea level in your area and subtract the following; divide your location's altitude in feet above sea level by 100 and multiply by 2.5.
    c. For turbidity, the 0 NTU standard must be calibrated first.
13. A real time value will display, with all enabled sensors reading values, not just the sensor currently being calibrated.
    a. For turbidity activate the wiper function to remove any bubbles if necessary.
14. Observe the stabilization of the sensor value being calibrated. When the reading stabilizes for approximately 30 seconds, press Enter to accept calibration.
15. Press Enter to return to the Calibration menu, and proceed to the next calibration. Repeat steps 3-13 for each calibration standard. For pH and turbidity 2-point calibrations, the Sonde will prompt you for the second calibration solution. Dry the Sonde between readings.
16. Once completed rinse and dry the Sonde.

The Sonde is now ready to be used for readings throughout the day. Recalibrate as necessary if field conditions present erroneous data or the Sonde experiences mechanical issues. Record the calibrations were performed in the daily field logbook and other paperwork as necessary. Remember to replace any protective caps on the sensors following calibration or use of the meter and decontamination.

3.2 Site Control

- Upon arrival at groundwater monitoring well or sample station, position field vehicle in location convenient to access well as necessary for use of pump and field equipment while collecting parameters. Consider using the field vehicle to provide safety from traffic or shade from the sun.
- Establish a work area as needed. Lay out equipment in an orderly manner so as to avoid creating trip hazards. This is an important consideration in regards to cords and tubing. If necessary, use traffic cones or caution tape to define a work area and do not allow the public or subcontractors to enter your work area. Control activities in the sample collection work area so as to preserve the quality and integrity of the parameters being collected.

3.3 Water Level Measurement

Water level indicators (sounders) need to be calibrated and checked for accuracy. If more than one instrument is to be used, they should be checked by measuring a single well using both instruments to assure that measurements are consistent. A single water level meter can be checked against another tape (i.e. 100 foot reel measuring tape). Turn on unit and test the audible detector by depressing button on the site of unit before use.

Prior to leaving field office or before beginning water level measurements, decontaminate the probe and cable. Inspect well casing and locking cap for tampering, damage, maintenance needs or rust and make note of the conditions on the appropriate *Well Maintenance Form* and in the field logbook.

Use care when removing the well cap or J-plug and observe if there is a pressure difference between the closed well and atmospheric pressure. If project groundwater wells tend to build pressure attach a lanyard to well cap to eliminate the potential for injury from rapid pressure release. Never place body, face or head directly over a well while opening the well cap. Each well shall be marked with a permanent, easily identified reference point for water level measurements whose location and elevation have been surveyed. In the event a marking is not visible or well is not yet surveyed, take the water level reading from the north-side top of casing.

Don disposable silicone or nitrile exam gloves before lowering well sounder probe and measuring tape into the well. After decontaminating the sounder following water level measurement, properly dispose of exam gloves. A fresh pair of exam gloves should be used for each well or monitoring station.

Slowly lower probe into the monitoring well until contact with the water surface. An audible alarm on the water level meter will occur when the probe touches the water. Gently lift and lower the probe until an accurate measurement can be determined. Adjust well sounder sensitivity as necessary to get a good reading. Obtain the reading from the established mark on the well casing and measure to the nearest 0.01 foot. Record water level on the appropriate field forms.

After a water level measurement is collected at a groundwater monitoring well, decontaminate the measuring tape and reel. After decontamination is completed, properly secure the sounder in the sampling vehicle before moving on to the next location.

3.4 Equipment Setup

Remove any sample or hardware from the well and allow settling time before deployment of the downhole meter, approximately five minutes. Remove hardware and take water level readings in a manner to minimize disturbance of the water column in the monitoring well, lower and remove equipment slowly.

Be sure the Sonde and cables have been decontaminated prior to deployment in the monitoring well. Connect the Sonde to the power source if needed and connect communication cable from the Sonde to the probe.

Remove the probe guard and any protective sensor caps before using the Sonde. After calibration of the meter, confirm the sensors and parameters that are needed (turbidity, temperature, DO, ORP, and conductivity) are all reading on the instrument display. Replace the probe guard and keep in place during deployment. Check the pump intake depth for the current monitoring well and attach the correct length of Sonde cable to the meter (100 foot or 200 foot cable available).

Deploy the meter into the monitoring well and secure at the top of the well once the appropriate depth has been reached as to avoid kinking. Attempt to not disturb the water column too much while deploying by lowering the meter slowly. Allow settling time before collecting parameters, approximately two minutes.

3.5 Groundwater Quality Parameter Collection

On the YSI meter menu, Select Run. Choose Discrete Sampling on the meter's menu. Discrete sampling is used for spot sampling and short term sampling. In the Discrete Sampling Menu, set the appropriate sample interval sample time length. The default sample interval is four seconds and is appropriate for most discrete sampling. Optionally, identify the location by entering a filename and site name. Then select Start Sampling. Once the sample interval time has passed (4 seconds), the data will be displayed and it can be saved by selecting Log Last Sample.

When using the downhole meter, place the meter at the specified pump depth and record one measurement on the field paperwork once stabilized. If no other readings are required, remove the Sonde and cable from the monitoring well. Replace the hardware and deploy a passive diffusion bag (PDB) as necessary for the next sampling event. Replace the well cap and secure well.

3.6 Equipment Decontamination and Waste Disposal

Decontaminate the Sonde, meter cables, and all sensor probes with deionized water and a mild detergent. A small brush may be used on the sensors if necessary. The cable connector port must always be covered to prevent moisture from entering. If the cable is not connected cover the port with the pressure cap.

For short term storage place approximately 0.5 inches of water in the calibration or storage cup and place it on the Sonde. The use of a moist sponge is also acceptable instead of water. Do not immerse the sensors. The purpose is to keep the air in the cup at 100% humidity. Any type of water may be used such as tap water, distilled water, or deionized water. Make sure the cup is on tight to prevent evaporation. Check periodically to make sure there is still water/moisture present. For Sondes with level sensors, keep the tube sealed and dry.

Containerize any decontaminate water and dispose at the Sites 2 and 12 groundwater treatment plant (2/12 GWTP). Bag up any non-hazardous solid wastes, such as disposable gloves and paper towels, for disposal in a garbage receptacle.

Analytical SOPs

MS010.7	Analysis of Volatile Organics by GC/MS Select Ion Monitoring (SIM) (VOCs by 8260 SIM)
MET108.03	Metals by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP) (Metals by 6010D)
GN228.9	Determination of Inorganic Anions by Ion Chromatography (Chloride by 9056A)
SAM101.19	Sample Receipt and Storage
SAM108.10	Sample and Laboratory Waste Disposal

ANALYSIS OF VOLATILE ORGANICS BY GC/MS SELECT ION MONITORING (SIM)

Prepared by: Norm Farmer Date: 08/28/17

Approved by: Juan Garcia Date: 08/30/17

Annual Review

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TITLE: ANALYSIS OF VOLATILE ORGANICS BY GC/MS SELECT ION MONITORING (SIM)

REFERENCES: SW846 8260B

REVISED SECTIONS: 1.1.8, 4.6, 7.5.2.2-7.5.2.4 and 11.1

1.0 SCOPE AND APPLICATION, SUMMARY

1.1 Scope and Application

1.1.1 This method is used to determine the concentrations of various volatile organic compounds in water utilizing a gas chromatograph equipped with a mass spectrometer detector. This SOP was written primarily for the analysis of 1,4-dioxane but the analytes listed in Table 1 have also been validated by this method.

1.1.2 Unlike conventional full scan 8260, this method utilizes the instrument's selected ion monitoring (SIM) capabilities. By monitoring for a few specific ions the sensitivity can be increased 10 to 20 fold.

1.1.3 Utilizing a heated purge greatly improves the purge efficiency of 1,4-dioxane from water.

1.1.4 The Lower Limit of Quantitation (LLOQ) or Reporting limits (RL) are based on the sample amount and the lowest calibration standard. LLOQs may vary depending on matrix complications and sample volumes. The LLOQ for 1,4-dioxane by this method are 1.0 ug/l for aqueous samples and 5.0 ug/kg for solid samples. The LLOQs for the additional analytes listed in Table 1 are 0.1 to 0.5ug/l for aqueous samples and 5 to 25ug/kg for methanol soils. Solid matrices are reported on a dry weight basis.

1.1.5 The Method Detection Limit (MDL) for each analyte is evaluated on an annual basis for each matrix and instrument. MDLs are pooled for each matrix, and the final pooled MDLs are verified. The verified MDLs are stored in the LIMS and should be at least 2 to 3 times lower than the LLOQ. Exceptions may be made on a case by case basis; however, at no point shall the MDL be higher than the reported LLOQ.

1.1.6 The LLOQ for each analyte is evaluated on an annual basis for each matrix and instrument. The LLOQ verifications are prepared by spiking a clean matrix at 0.5 to 2 times the current LLOQ level. This LLOQ verification is carried through the same preparation and analytical procedures as the samples. Recovery of the analytes should be within the established limits. The DOD QSM requirements for Limit of Detection (LOD) and Limit of Quantitation (LOQ) verifications are different. See SOP QA020 for complete requirements for MDL, LOD, LOQ, and LLOQ.

1.1.7 Compounds detected at concentrations between the LLOQ and MDL are quantitated and qualified as estimated values and reported with either a “J” or “I” qualifier. Some program or project specifications may require that no values below the LLOQ be reported.

1.1.8 For DOD projects refer to QSM 4.2, Table F4; QSM 5.0, Table 4; or QSM 5.1, Table B-4 for additional method requirements and data qualifying guidance.

1.2 Summary

1.2.1 This method is adapted from SW846 method 8260B.

1.2.2 Samples are received, stored, and analyzed within the appropriate holding times.

1.2.3 Sample preparation is performed in accordance with SGS Accutest - Orlando SOP OP020 and OP021.

1.2.4 The samples are analyzed on a gas chromatograph equipped with mass spectrometer detector.

1.2.5 The peaks detected are identified by comparison to characteristic ions and retention times specific to the known target list of compounds.

1.2.6 Library searches cannot be performed on data acquired in SIM mode because data was only acquired for selected ions.

1.2.7 Manual integrations are performed in accordance with SOP QA029.

2.0 PRESERVATION AND HOLDING TIME

2.1 Preservation

Aqueous Samples:

2.1.1 Samples should be preserved to a pH < 2. The pH should be checked and recorded immediately after the sample analysis. If the sample is not preserved to a pH < 2, it must be noted on the report.

2.1.2 The samples must be stored in capped vials, with minimum headspace, at ≤ 6 °C in an area free of solvent fumes. The size of any bubble caused by degassing upon cooling should not exceed 5-6mm.

Solid Samples:

2.1.3 Special 40ml vials for purge-and-trap of solid samples, as well as the collection and preservation options are described in OP020.

2.1.4 Low level soil samples are preserved by storing them in sealed VOA vials at temperatures between –10 °C to –20 °C. High level soil samples are preserved by storing them in methanol at a ratio of 1 gram of soil to 1ml of methanol.

2.2 Holding Time

2.2.1 Aqueous samples are to be analyzed within 14 days of collection, unless otherwise specified by the contract. Samples that are not preserved should be analyzed within 7 days of collection; however, the preservation deficiency must be noted in the report.

2.2.2 Solid and waste samples must be analyzed within 14 days of collection.

3.0 INTERFERENCES

3.1 Data from all blanks, samples, and spikes must be evaluated for interferences.

3.2 Impurities in the purge gas, organic compounds out-gassing from the plumbing ahead of the trap, and solvent vapors in the laboratory account for the majority of contamination problems. The analytical system must be demonstrated to be free from contamination under the conditions of the analysis by running laboratory blanks. The use of non-TFE tubing, non-TFE thread sealants, or flow controllers with rubber components in the purging device should be avoided.

3.3 Samples can be contaminated by diffusion of volatile organics (particularly methylene chloride and fluorocarbons) through the septum seal into the sample during shipment and storage. A trip blank can serve as a check on such contamination.

3.4 Contamination by carry-over can occur whenever high level and low-level samples are sequentially analyzed. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of reagent water to check for carry-over.

3.5 SIM may provide a lesser degree of confidence in compound identification unless multiple ions are monitored for each compound. In general, SGS Accutest monitors 3 ions per compound.

3.6 Historically 1,4-dioxane was used as a stabilizer for various chlorinated solvents such as trichlorethene and tetrachloroethene. Samples that contain 1,4-dioxane often contain trichloroethene and/or tetrachloroethene at orders of magnitude higher concentrations. Because of this, it is best to analyze samples for 1,4-dioxane on a system dedicated to only the analysis of 1,4-dioxane.

4.0 DEFINITIONS

4.1 Batch: A group of samples which are similar with respect to matrix and the testing procedures being employed and which are processed as a unit. A sample batch is limited to a maximum of 20 samples or samples loaded on an instrument within the same 12-hour shift, whichever comes first.

4.2 Blank Spike (BS): An analyte-free matrix spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. Blank Spike recoveries are used to document laboratory performance for a given method. This may also be called a Laboratory Control Sample (LCS).

4.3 Continuing Calibration Verification (CCV): A check standard used to verify instrument calibration throughout an analytical run. For all MS methods, a CCV must be analyzed at the beginning of each analytical run. For DoD QSM 5 and 5.1 projects, an additional CCV must be analyzed at the end of the run.

4.4 Holding Time: The maximum times that samples may be held prior to preparation and/or analysis and still be considered valid.

4.5 Internal Standards: An organic compound which is similar to the target analyte(s) in chemical composition and behavior, but which is not normally found in environmental samples. Internal standards for mass spec methods are often deuterated forms of target analytes. Internal standards are used to compensate for retention time and response shifts during an analytical run.

4.6 Initial Calibration (ICAL): A series of standards used to establish the working range of a particular instrument and detector. The low point should be at a level equal to or below the LLOQ.

4.7 Initial Calibration Verification (ICV): A standard from a source different than that used for the initial calibration. A different vendor should be used whenever possible. The ICV is used to verify the validity of an Initial Calibration. This may also be called a QC check standard.

4.8 Matrix Spike (MS): A sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike recoveries are used to document the bias of a method in a given sample matrix.

4.9 Matrix Spike Duplicate (MSD): A replicate sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike duplicate recoveries are used to document the precision and bias of a method in a given sample matrix.

4.10 Method Blank (MB): An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is processed simultaneously with the samples through all the steps of the analytical procedure. The method blank is used to document contamination resulting from the analytical process.

4.11 Sample Duplicate (DUP): A replicate sample which is used to document the precision of a method in a given sample matrix.

4.12 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical integrity of the sample.

4.13 Surrogate: An organic compound which is similar to the target analyte(s) in chemical composition and behavior, but which is not normally found in environmental samples. Surrogates are used to measure the purge efficiency.

4.14 Trip Blank: A sample of analyte-free matrix taken from the laboratory to the sampling site and returned to the laboratory unopened. A trip blank is used to document contamination attributable to shipping and field handling procedures. This type of blank is useful in documenting contamination of volatile organic samples.

5.0 REAGENTS

5.1 Reagent water – distilled or deionized water free of interferences

5.2 Methanol – purge-and-trap grade or equivalent

5.3 Hydrochloric acid (HCl) – ACS reagent grade or equivalent

5.4 Inert Gas – UHP Helium or UHP Nitrogen

5.5 1,4-Dioxane stock standards – traceable to Certificate of Analysis

5.6 4-Bromofluorobenzene (BFB) – instrument tuning mix

5.7 Surrogate standards – (varies based on analytes being reported)

Dibromofluoromethane
1,2-Dichloroethane-d_4
Toluene-d_8

5.8 Internal standards – (varies based on analytes being reported)

Fluorobenzene
Chlorobenzene-d_5
1,4-Dioxane-d_8

6.0 APPARATUS

6.1 Gas Chromatograph – Agilent Technologies 6890 or 7890

6.1.1 Gas Chromatograph

The analytical system that is complete with a temperature programmable gas chromatograph and all required accessories, analytical columns, and gases.

6.1.2 The injection port is designed for split-splitless injection with capillary columns. The injection port must have an appropriate interface for sample introduction.

6.2 Mass Spectrometer– Agilent Technologies 5973 or 5975

The mass spectrometer must be capable of scanning from 35-300 amu every second or less, utilizing 70-volt (nominal) electron energy in the electron impact ionization mode. It must also be capable of producing a mass spectrum that meets all the criteria in section 7.5.1.1 when injecting 50 ng of bromofluorobenzene (BFB).

6.3 Purge and Trap – OI Analytical 4560 or 4660 with OI Analytical 4552 or 4551

6.3.1 The following autosampler models are used for purging, trapping and desorbing the sample onto GC column.

- O.I. Model 4560 sample concentrator with 4552 Water/Soil multisampler
- O.I. Model 4660 sample concentrator with 4552 Water/Soil multisampler
- O.I. Model 4660 sample concentrator with 4551 Water multisampler

6.3.2 The sample purge vessel must be designed to accept 5 ml samples with a water column at least 3 cm deep.

6.3.3 The multisampler or concentrator is equipped with a heater capable of maintaining the purge chamber at 60 °C to improve purging efficiency.

6.3.4 The desorber should be capable of rapidly heating the trap to the manufacturer recommended desorb temperature.

6.4 Data System – Agilent Technologies MS Chemstation rev. DA 02.0x, DA 03.0x or EA 02.0x.

6.4.1 A computer system interfaced to the mass spectrometer that allows for the continuous acquisition and storage of all mass spectral data obtained throughout the duration of the chromatographic program.

6.4.2 The computer utilizes software that allows searching any GC/MS data file for ions of a specific mass and that can plot such ion abundances versus time or scan number. This type of plot is defined as an Extracted Ion Current Profile (EICP).

6.4.3 The software should allow for integrating the abundances in any EICP between specific time or scan number limits. See Table 2.

6.4.4 Data is archived to a backup server for long term storage.

6.5 Trap – OI #10 or equivalent: Tenax, Silica Gel, and Carbon Molecular Sieve. The trap should be conditioned according to the manufacturer's recommendations.

6.6 Columns – RTX-624 or equivalent: 60m X 0.25mm 1.4um.
– RTX-VMS or equivalent: 40m X 0.18mm 1.0um

6.7 Gas-tight syringes and class "A" volumetric glassware for dilutions of standards and samples.

7.0 PROCEDURE

7.1 Standards Preparation

Standards are prepared from commercially available certified reference standards. All standards must be logged in the Volatile Standards Logbook. All standards shall be traceable to their original source. The standards should be stored at temperatures between –10 °C and –20 °C, or as recommended by the manufacturer. Calibration levels, spike and surrogate concentrations, preparation information, and vendor part numbers can be found in the MSVOA STD Summary in the Active SOP directory.

7.1.1 Stock Standard Solutions

Stock standards are available from several commercial vendors. All vendors must supply a "Certificate of Analysis" with the standard. The certificate will be retained by the lab. Hold time for unopened stock standards is until the vendor's expiration date. Once opened, the hold time is reduced to six months (one month for gases) or the vendor's expiration date (whichever is shorter).

7.1.2 Intermediate Standard Solutions

Intermediate standards are prepared by quantitative dilution of the stock standard with methanol. The hold time for intermediate standards is one month (one week for gases) or the vendor's expiration date (whichever is shorter). Intermediate standards may need to be remade if comparison to other standards indicates analyte degradation or concentration changes.

7.1.3 Calibration Standards

Calibration standards for the volatile organics are prepared at a minimum of five concentration levels through quantitative dilutions of the intermediate standard. The low standard concentration is at or below the LLOQ, and the remaining standards define the working range of the detector.

Calibration standard concentrations are verified by the analysis of an initial calibration verification (ICV) standard.

7.2 Instrument Conditions

Gas Chromatograph/ Mass Spectrometer

Carrier gas flow	1.0-1.3 ml/min
Transfer line temperature	220 - 280 °C
Analyzer temperature	150 °C

Oven program – 45 °C for 2.5 minutes (RTX-VMS 40m)
10 °C/min to 80 °C for 0 minutes
15 °C/min to 185 °C for 0 minutes
30 °C/min to 240 °C for 2.5 minutes

Oven program – 35 °C for 2.5 minutes (RTX-VMS 40m)
4 °C/min to 60 °C for 0 minutes
25 °C/min to 220 °C for 0 minutes
30 °C/min to 240 °C for 1.2 minutes

Oven program – 45 °C for 2.0 minutes (RTX-624)
10 °C/min to 80 °C for 0 minutes
14 °C/min to 210 °C for 0 minutes
16 °C/min to 240 °C for 4.2 minutes

GC conditions are optimized for each instrument. Actual conditions may vary slightly from those listed above.

MS Descriptors – Monitor 3 characteristic ions for each target analyte, and 2 characteristic ions for each surrogate and internal standard. Each descriptor may have up to 30 ions; however, the more ions in a descriptor, the less the sensitivity. Therefore, it is beneficial to use multiple descriptors for longer analytes lists. Refer to the specific instrument methods for actual descriptors.

7.3 Purge and Trap Device conditions

Purge Gas:	Helium or Nitrogen at 30-45 ml/min
Sample Temp:	Aqueous (60°C)
	Soils (40°C)
Trap Temp:	<25°C
Purge Time:	6 or 11 min
Desorb:	1 min. at 190°C
Bake:	5 min. at 210°C

Purge and Trap conditions are optimized for each instrument. Actual conditions may vary slightly from those listed above.

NOTE: Due to the poor purge efficiency of 1,4-dioxane, purge times of less than 11 minutes should not be used when analyzing for 1,4-dioxane.

7.4 Sample Preparation

7.4.1 Water Samples

A 5ml aliquot of sample is loaded onto the purge-and-trap device and purged for 6 or 11 minutes at 60°C. Detailed procedures are described in SOP OP021.

7.4.2 Solid Samples

A 5-gram aliquot of sample is loaded onto the purge-and-trap device. 5mls of reagent water is added along with internal standards and surrogates. The sample is then purged for 6 or 11 minutes while heated to 40°C and mechanically agitated. Detailed procedures are described in SOP OP020.

Alternatively a methanol aliquot from the sample is loaded onto the purge-and-trap device. 5mls of reagent water is added along with internal standards and surrogates. The sample is then purged for 6 or 11 minutes. Detailed procedures are described in SOP OP020 and OP021.

7.5 Gas Chromatographic Analysis

Instrument calibration consists of two major sections:

Initial Calibration Procedures
Continuing Calibration Verification

7.5.1 Initial Calibration Procedures

Before samples can be run, the GC/MS system must be tuned, the injection port inertness must be verified, and the instrument must be calibrated.

7.5.1.1 Tune Verification (BFB)

The instrument should be hardware tuned per manufacturer's instructions. Verify the instrument tune by injecting 50ng of BFB solution onto the instrument. The BFB standard may also be purged. The resulting BFB spectra should meet the criteria in the following table.

BFB KEY IONS AND ION ABUNDANCE CRITERIA

Mass	Ion Abundance Criteria
50	15-40% of mass 95
75	30-60% of mass 95
95	Base peak, 100% relative abundance
96	5-9% of mass 95
173	<2% of mass 174
174	>50% of mass 95
175	5-9 % of mass 174
176	>95% and <101% of mass 174
177	5-9% of mass 176

Evaluate the tune spectrum using three mass scans from the chromatographic peak and a subtraction of instrument background. This procedure is performed automatically by the MS Chemstation software by running "autofind" on the BFB peak.

Select the scans at the peak apex and one to each side of the apex. Calculate an average of the mass abundances from the three scans.

Background subtraction is required. Select a single scan in the chromatogram that is absent of any interfering compound peak and no more than 20 scans prior to the elution of BFB. The background subtraction should be designed only to eliminate column bleed or instrument background ions. Do not subtract part of the tuning compound peak.

Alternatively, the average spectra over the entire peak may be used. **All subsequent tune evaluations must use the same procedure that was used for the Initial Calibration.**

If the criteria are not achieved, the analyst must retune the mass spectrometer and repeat the test until all criteria are met.

Analysis must not begin until the tuning criteria are met. The injection time of the acceptable tune analysis is considered the start of the 12-hour clock. The same mass spec settings must be used for the calibration standards and samples that were used for the tune evaluation standard. The exception being that the tune evaluation standard must be acquired in full scan mode and all others in SIM mode.

7.5.1.2 Internal Standard Calibration

A minimum 5-point calibration curve is created for the volatile organic compounds and surrogates using an internal standard technique. SGS Accutest Laboratories routinely performs a 6-point calibration to maximize the calibration range.

Historically, many analytical methods have relied on linear models of the calibration relationship, where the instrument response is directly proportional to the amount of a target compound. The linear model has many advantages including simplicity and ease of use. However, given the advent of new detection techniques and because many methods cannot be optimized for all the analytes to which they may be applied, the analyst is increasingly likely to encounter situations where the linear model neither applies nor is appropriate. The option of using non-linear calibration may be necessary to address specific instrumental techniques. However, it is not EPA's intent to allow non-linear calibration to compensate for detector saturation or avoid proper instrument maintenance.

NOTE: Because of this concern, select programs including SC DHEC do not support the use of non-linear regressions.

The low point may be omitted from the calibration table for any compound with an LLOQ set at the level two standard. Additionally, the high point may be omitted for any compound that exhibits poor linearity at the upper end of the calibration range.

An entire level may be omitted provided that a minimum of 5 points remain. There must be technical justification to omit an entire level. This should be documented in the run log.

Response factors (RF) for each analyte are determined as follows:

$$RF = (A_{analyte} \mathbf{X} C_{istd})/(A_{istd} \mathbf{X} C_{analyte})$$

$A_{analyte}$ = area of the analyte
A_{istd} = area of the internal standard
$C_{analyte}$ = concentration of the analyte
C_{istd} = concentration of the internal standard.

The mean RF and standard deviation of the RF are determined for each analyte. The percent relative standard deviation (%RSD) of the response factors is calculated for each analyte as follows:

%RSD = (Standard Deviation of RF X 100) / Mean RF

If the %RSD $\leq$ 15%, linearity through the origin can be assumed and the mean RF can be used to quantitate target analytes in the samples. Alternatively, a calibration curve of response vs. amount can be plotted. This method allows for the use of average response factors, linear regressions, and non-linear regressions. Linear regressions may be unweighted or weighted as 1/x or $1/x^2$. If the correlation coefficient (r) is $\geq$0.995 ($r^2 \geq 0.990$) then the curve can be used to quantitate target analytes in the samples. Regardless of which calibration model is chosen, the laboratory should visually inspect the curve plots to see how the individual calibration points compare to the plot.

Alternatively, either of the two techniques described below may be used to determine whether the calibration function meets acceptable criteria. These involve refitting the calibration data back to the model. Both % Error and Relative Standard Error (RSE) evaluate the difference between the measured and the true amounts or concentrations used to create the model.

Calculation of the % Error

% ERR = (xi-x’i) / xi * 100

x’i = Measured amount of analyte at calibration level i, in mass or concentration units.

xi = True amount of analyte at calibration level i, in mass or concentration units.

Percent error between the calculated and expected amounts of an analyte should be ≤ 30% for all standards. For some data uses, ≤50% may be acceptable for the lowest calibration point.

Calculation of Relative Standard Error (%RSE)

$$RSE = 100 \times \sqrt{\sum_{i=1}^{n} \left[\frac{x_i' - x_i}{x_i}\right]^2 \Big/ (n-p)}$$

x’i = Measured amount of analyte at calibration level i, in mass or concentration units.

xi = True amount of analyte at calibration level i, in mass or concentration units.

p = Number of terms in the fitting equation. (average = 1, linear = 2, quadratic = 3)

n = Number of calibration points.

The %RSE acceptance limit criterion is ≤15% for good performing compounds and ≤30% for poor performing (PP) compounds.

7.5.1.3 Initial Calibration Verification (ICV)

The validity of the initial calibration curve must be verified through the analysis of an initial calibration verification (ICV) standard. The ICV should be prepared from a second source at a mid-range concentration.

The %D for all analytes of interest should be ≤ 20%. If the %D > 20%, the analysis of samples may still proceed if the analyte failed high and the analyte is not expected to be present in the samples. However, if a reportable analyte is detected in a sample and the %D for that analyte was greater than 20% in the ICV, the sample will need to be reanalyzed on a system with a passing ICV for that analyte.

NOTE: For any DoD QSM project, the %D for all target compounds should be ≤ 20%. If samples must be analyzed with an analyte of interest having a %D > 20%, then the data must be qualified accordingly.

If the ICV does not meet this criteria, a second standard should be prepared. If the ICV still does not meet criteria, analyze an ICV prepared from a third source. If this ICV meets criteria, proceed with sample analysis. If the ICV still does not meet criteria, determine which two standards agree. Make fresh calibration standards and an ICV from the two sources that agree. Recalibrate the instrument.

7.5.2 Continuing Calibration Verification (CCV)

7.5.2.1 Inject 2ul of the tune evaluation mix at the beginning of each 12-hour shift. Evaluate the resultant peaks against the criteria in section 7.5.1.1. The injection time of this standard starts the 12-hour window.

When the analyst is running an unattended second 12-hour window, they may opt to purge the BFB standard. This can be performed by purging an additional blank (which contains BFB) just prior to the second CCV.

7.5.2.2 Analyze a continuing calibration check standard. The CCV should be at or below the mid-point of the calibration curve.

The percent difference (%D) for each analyte of interest will be monitored. The |%D| should be ≤ 20% for each analyte.

If the first continuing calibration verification does not meet criteria, a second standard may be injected. If the second standard does not meet criteria, the system must be recalibrated. If the second standard meets criteria then the system is considered in control and results may be reported.

Rationale for second standard such as instrument maintenance, clipped column, remade standard, etc should be documented in the run log or maintenance log. Reanalysis of second standard without valid rationale may require the analysis of a third standard (in which case both the second and third standard would have to pass).

NOTE: For any DoD QSM project, if the second standard meets criteria, then a third standard must be analyzed. If the third standard also meets criteria then the system is considered in control and results may be reported.

If the |%D| is greater than 20%, then documented corrective action is necessary. This may include recalibrating the instrument and reanalyzing the samples, performing instrument maintenance to correct the problem and reanalyzing the samples, or qualifying the data. Under certain circumstances, the data may be reported, i.e., the CCV failed high, the associated QC passed, and the samples were ND.

NOTE: For any DoD QSM project, if samples must be reported with a target analyte having a %D > 20%, then the data must be qualified accordingly, regardless of whether the analyte was detected or not.

NOTE: Any target analytes that are detected in the samples must be bracketed by an acceptable initial calibration curve and acceptable CCV standards; otherwise, the samples must be reanalyzed or the data must be qualified.

7.5.2.3 For DoD QSM 5.0 and 5.1 compliance, an additional CCV must be analyzed at the end of each run. The closing CCV should be within the 12-hour Tune window.

The %D for all target compounds in this CCV should be ≤ 50%. If the %D > %50 for any target compound, then the samples should be reanalyzed at least once at the appropriate dilution. If the %D > %50 for the analytes in the reanalysis, the department supervisor shall review the data and determine what further action is necessary. This may include reanalyzing the samples at a higher dilution or qualifying the data.

NOTE: If samples are ND and an analyte in the CCV fails high, then the sample does not need to be reanalyzed.

7.5.2.4 If any of the internal standard area change by a factor of two (-50% to +100%) or retention time changes by more than 30 seconds (10 seconds for DOD QSM 5.1 compliance) from the midpoint standard of the last initial calibration or from the daily CCV, the mass spectrometer must be inspected for malfunctions and corrections made, as appropriate. Corrective action may include re-calibration (initial Calibration) of the instrument.

7.5.3 Sample Analysis

7.5.3.1 Samples are analyzed in a set referred to as an analysis sequence or batch. A batch consists of the following:

Tune Evaluation Mix
Initial Calibration Standards (or CCV)
QC Samples
Samples

7.5.3.2 One microliter of internal standard/surrogate solution is added to every 5ml of sample in the sparge vessel. Generally, 5ml of sample are transferred to the sparge vessel.

7.5.3.3 After purging, the system will automatically reverse flow and rapidly heat the trap to desorb the sample analytes onto the GC column.

7.5.3.4 Qualitative identification

The target compounds shall be identified by analysts with competent knowledge in the interpretation of mass spectra by comparison of the sample mass spectrum to the mass spectrum of a standard of the suspected compound. The criteria required for a positive identification are:

The intensities of the characteristic ions of a compound maximize in the same scan or within one scan of each other. Selection of a peak by a data system target compound search routine where the search is based on the presence of a target chromatographic peak containing ions specific for the target compound at a compound-specific retention time will be accepted as meeting this criterion.

The sample component must elute at the same relative retention time (RRT) as the daily standard. The RRT of sample component must be within ± 0.06 RRT units of the standard.

All ions monitored in the standard mass spectra should be present in the sample spectrum.

The relative intensities of these ions must agree within ± 30% between the daily standard and sample spectra, (e.g., for an ion with an abundance of 50% in the standard spectra, the corresponding sample abundance must be between 20 and 80%).

Structural isomers that produce very similar mass spectra should be identified as individual isomers if they have sufficiently different GC retention times. Sufficient GC resolution is achieved if the height of the valley between two isomer peaks is less than 25% of sum of the two peak heights. Otherwise, structural isomers are identified as isomeric pairs.

If peak identification is prevented by the presence of interferences, the sample must be diluted so that the interference does not mask any analytes.

7.5.3.5 Quantitative analysis

When a target compound has been identified, concentration will be based on the integrated area of the quantitation ion, which is normally the base peak.

The sample matrix may produce an interference with the primary ion. This may be characterized by an excessive background signal of the same ion, which distorts the peak shape beyond a definitive integration. The interference could also, severely inhibit the response of the internal standard ion.

If the analyte response exceeds the linear range of the system, the extract must be diluted and reanalyzed. It is recommended that samples be diluted so that the response falls into the middle of the calibration curve.

7.6 Maintenance and Trouble Shooting

7.6.4 Refer to SOP GC001 for routine instrument maintenance and trouble shooting.

7.6.5 All instrument maintenance must be documented in the appropriate "Instrument Repair and Maintenance" log. The log will include such items as problem, action taken, correction verification, date, and analyst.

7.6.6 Repairs performed by outside vendors must also be documented in the log. The analyst or Department Supervisor responsible for the instrument must complete the log if the repair technician does not.

7.6.7 PC and software changes must be documented in the "Instrument Repair and Maintenance" log. Software changes may require additional validation.

8.0 METHOD PERFORMANCE

Method performance is monitored through the routine analysis of negative and positive control samples. These control samples include method blanks (MB), blank spikes (BS), matrix spikes (MS), and matrix spike duplicates (MSD). The MB and BS are used to monitor overall method performance, while the MS and MSD are used to evaluate the method performance in a specific sample matrix.

Blank spike, matrix spike, and matrix spike duplicate samples are compared to statistically generated control limits. These control limits are reviewed and updated annually. Control limits are stored in the LIMS. Additionally, blank spike accuracy is regularly evaluated for statistical trends that may be indicative of systematic analytical errors.

9.0 QUALITY ASSURANCE / QUALITY CONTROL

Accuracy and matrix bias are monitored by the use of surrogates and by the analysis of a QC set that is prepared with each batch (maximum of 20 samples) of samples. The QC set consists of a method blank (MB), blank spike (BS), matrix spike (MS), and matrix spike duplicate (MSD).

9.1 Internal Standards

9.1.1 Fluorobenzene, Cclorobenzene-d_5, and 1,4-dioxane-d_8 may be used as the internal standards for this method. The response of the internal standard in all subsequent runs should be within a factor of two (-50% to +100%) of the internal standard response in the opening CCV for each sequence. On days that an initial calibration is performed, the internal standard response should be compared to the internal standard response for the mid-point standard.

9.1.2 If the internal standard response is not within limits, the following are required.

9.1.2.1 Check to be sure that there are no errors in calculations, integrations, or internal standards solutions. If errors are found, recalculate the data accordingly.

9.1.2.2 Check instrument performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample. If the recovery is high due to interfering peaks, it may be possible to get a more accurate recovery by analyzing the sample on a different column type.

9.1.1.3 If no problem is found, prepare a second aliquot of sample and reanalyze the sample. If there is insufficient sample for reanalysis, footnote this on the report.

9.1.1.4 If upon reanalysis, the responses are still not within limits, the problem is considered matrix interference. The sample may need to be diluted or the results qualified.

9.2 Surrogates

9.2.1 Dibromofluoromethane, 1,2-dichloroethane-d_4 and toluene-d_8 may be used as the surrogate standards to monitor the efficiency of the purge-and-trap system.

A known amount of surrogate standard is added to each sample including the QC set prior to purging. The percent recovery for each surrogate is calculated as follows:

% Recovery = (Sample Amount / Amount Spiked) X 100

The percent recovery must fall within the established control limits for all surrogates for the results to be acceptable.

9.2.2 If any surrogate recovery is not within the established control limits, the following are required.

9.2.2.1 Check to be sure that there are no errors in calculations, dilutions, integrations, surrogate solutions or internal standard solutions. If errors are found, recalculate the data accordingly.

9.2.2.2 Check instrument performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample. If the recovery is high due to interfering peaks, it may be possible to get a more accurate recovery by analyzing the sample on a different column type.

9.2.2.3 If no problem is found, reanalyze the sample. **NOTE:** If the recoveries are high and the sample is non-detect, then reanalysis may not be necessary. For any DoD QSM projects, the resulting data must be qualified accordingly. If there is insufficient sample for reanalysis, footnote this on the report.

9.2.2.4 If upon reanalysis, the recovery is still not within control limits, the problem is considered matrix interference. Surrogates from both sets of analysis should be reported on the final report.

9.3 Method Blank

9.3.1 The method blank is de-ionized water or de-ionized water with 5 grams of Teflon chips (depending upon sample matrix) to which the surrogate standard has been added. An appropriate aliquot of methanol should also be added. The method blank is then purged along with the other samples to determine any contamination from the system or ambient sources. The method blank must be free of any analytes of interest or interferences at ½ the required LLOQ level to be acceptable. Common laboratory contaminants such as methylene chloride must be below the LLOQ if present. Samples associated with a contaminated method blank shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples or qualifying the results with a “B” or “V” qualifier.

9.3.2 If the MB is contaminated but the samples are non-detect, then the source of contamination should be investigated and documented. The sample results can be reported without qualification.

9.3.3 If the MB is contaminated but the samples results are > 10 times the contamination level, the source of the contamination should be investigated and documented. The samples results may be reported with the appropriate “B” or “V” qualifier. This must be approved by the department supervisor.

9.3.4 If the MB is contaminated but the samples results are < 10 times the contamination level, the source of the contamination should be investigated and documented. The samples should be reanalyzed for confirmation. If there is insufficient sample to reanalyze, or if the sample is reanalyzed beyond hold time, the appropriate footnote and qualifiers should be added to the results. This must be approved by the department supervisor.

9.4 Blank Spike

9.4.1 The blank spike is de-ionized water or de-ionized water with 5 grams of Teflon chips (depending upon sample matrix) to which the surrogate standard and spike standard have been added. An appropriate aliquot of methanol should also be added. The blank spike is then processed along with the other samples to monitor the efficiency of the purge-and-trap procedure. The percent recovery for each analyte is calculated as follows:

$$\% \text{ Recovery} = (\text{Blank Spike Amount} / \text{Amount Spiked}) \times 100$$

The percent recovery for each analyte of interest should fall within the established control limits for the results to be acceptable.

NOTE: A secondary check against 70-130% limits should be performed for all analytes reported to SC DHEC.

9.4.2 If the blank spike recoveries are not within the established control limits, the following are required.

9.4.2.1 Check to be sure that there are no errors in calculations, dilutions, integrations, spike solutions, or internal standard solutions. If errors are found, recalculate the data accordingly.

9.4.2.2 Check instrument performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample.

9.4.2.3 If the recovery of an analyte in the BS is high and the associated sample is non-detect, the data may be reportable. For any DoD QSM projects, the resulting data must be qualified accordingly.

9.4.2.4 If no problem is found, the department supervisor shall review the data and determine what further corrective action is best for each particular sample. That may include reanalyzing the samples or qualifying the results as estimated.

9.4.2.5 If there is insufficient sample to reanalyze, or if the sample is reanalyzed beyond hold time, the appropriate footnote and qualifiers should be added to the results. This must be approved by the department supervisor.

9.5 Matrix Spike and Matrix Spike Duplicate

9.5.1 Matrix spike and spike duplicates are replicate sample aliquots to which the surrogate standard and spike standard have been added. The matrix spike and spike duplicate are then processed along with the other samples to monitor the precision and accuracy of the purge-and-trap procedure. The percent recovery for each analyte is calculated as follows:

% Recovery = ([Spike Amount – Sample Amount] / Amount Spiked) X 100

The percent recovery for each analyte of interest must fall within the established control limits for the results to be acceptable.

9.5.2 If the matrix spike recoveries are not within the established control limits, the following are required.

9.5.2.1 Check to be sure that there are no errors in calculations, dilutions, integrations, spike solutions, or internal standard solutions. If errors are found, recalculate the data accordingly.

9.5.2.2 Check instrument performance. If an instrument performance problem is identified, correct the problem and reanalyze the sample. If the recovery is high due to interfering peaks, it may be possible to get a more accurate recovery by analyzing the sample on a different column type.

9.5.2.3 If no problem is found, compare the recoveries to those of the blank spike. If the blank spike recoveries indicate that the problem is sample related, document this on the run narrative. Matrix spike recovery failures are not grounds for reanalysis, but are an indication of the sample matrix effects.

9.5.3 Precision

Matrix spike and spike duplicate recoveries for each analyte are used to calculate the relative percent difference (RPD) for each compound.

$$\text{RPD} = (|\text{ MS Result} - \text{MSD Result }| \ / \text{ Average Result}) \times 100$$

The RPD for each analyte should fall within the established control limits. If the RPDs fall outside of the established control limits, the department supervisor shall review the data and determine if any corrective action is necessary. RPD failures are generally not grounds for batch reanalysis.

10.0 CALCULATIONS

The concentration of each target compound in the original sample is calculated as follows:

Water (ug/l) = $(\text{CONC}_{\text{inst}}) \times \text{DF}$

Soil (ug/kg) = $[(\text{CONC}_{\text{inst}}) \times (5 / W_I)] / \%\text{solids}$ (*low level soils)*

Soil (ug/kg) = $[(\text{CONC}_{\text{inst}}) \times (V_F / V_A) \times (5 / W_I) \times \text{DF}] / \%\text{solids}$ (*high level soils)*

$\text{CONC}_{\text{inst}}$ = Instrument concentration calculated from the initial calibration using mean RF or curve fit.
DF = Dilution Factor
V_F = Volume of methanol extract (ul)
V_A = Volume of methanol aliquot (ul)
W_I = Weight of sample (g)
%solids = Dry weight determination in decimal form

For high level soils, V_F is calculated as follows:

$V_F = \{\text{ml of solvent} + [(\%\text{moisture} \times W_I) / 100]\} \times 1000$ ul/ml

11.0 SAFETY AND POLLUTION PREVENTION

11.1 Safety

The analyst should follow normal safety procedures as outlined in the SGS Health and Safety Program, which includes the use of safety glasses, gloves, and lab coats.

The toxicity of each reagent and target analyte has not been precisely defined; however, each reagent and sample should be treated as a potential health hazard. Material Safety Data Sheets (MSDS) or Safety Data Sheets (SDS) are available for all reagents and many of the target analytes. Exposure must be reduced to the lowest possible level. Personal protective equipment should be used by all analysts.

11.2 Pollution Prevention

Waste solvents from the sample analysis, methanol extraction, and standards preparation are collected in waste storage bottles and are eventually transferred to the non-chlorinated waste drum.

Old stock standards are disposed of in the waste vial drum.

Samples are archived and stored for 30 days after analysis. After the storage time has elapsed, the remaining aqueous and soil samples are transferred to the appropriate drums for disposal.

12.0 REFERENCES

SW846 Method 8000D Revision 4, July 2014

SW846 Method 8260B Revision 2, December 1996

TABLE 1

Routine Target Analytes

Benzene	cis-1,3-Dichloropropene
Carbon Tetrachloride	trans-1,3-Dichloropropene
Chloroform	1,4-Dioxane
1,1-Dichloroethane	Methyl Chloride
1,2-Dichloroethane	Methylene Chloride
1,1-Dichloroethylene	Tetrachloroethylene
cis-1,2-Dichloroethylene	1,1,1-Trichloroethane
trans-1,2-Dichloroethylene	Trichloroethylene
1,2-Dichloropropane	Vinyl Chloride

TABLE 2

Characteristic Ions

Analyte	Quant. Ion	Q1	Q2	Q3
Fluorobenzene IS	96	70		
Methyl Chloride	50	52		
Vinyl Chloride	62	64		
1,1-Dichloroethene	61	96	98	63
Methylene Chloride	49	84	86	51
trans-1,2-Dichloroethene	61	96	98	63
1,1-Dichloroethane	63	65		
cis-1,2-Dichloroethene	96	61	98	63
Chloroform	83	85	47	
Dibromofluoromethane Surr	113	111	192	
Carbon Tetrachloride	117	119	121	82
1,1,1-Trichloroethane	97	99	61	
Benzene	78	51		
1,2-Dichloroethane-d4 Surr	65	67	102	
1,2-Dichloroethane	62	49	64	
Trichloroethene	95	130	97	132
1,2-Dichloropropane	63	62	41	76
cis-1,3-Dichloropropene	75	77	39	
Chlorobenzene-d_5 IS	117	82		
Toluene-d_8 Surr	98	100		
trans-1,3-Dichloropropene	75	77	39	49
Tetrachloroethene	166	164	129	131
1,1,2-Trichloroethane	83	97	61	99
1,4-Dioxane-d_8 IS	96	64		
1,4-Dioxane	88	58	43	

METALS BY INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROMETRY (ICP)

Prepared by: David Metzgar III Date: 02/22/2018

Approved by: Svetlana Izosimova Date: 02/22/2018

Annual Review

Reviewed by: ______ Date: ______

Reviewed by: ______ Date: ______

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TITLE: METALS BY INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROMETRY (ICP)

REFERENCES: SW846 6010D, 2014

INSTRUMENT: THERMO 6500, SERIAL # 20100903 SSTRACE 1
INSTRUMENT: THERMO 6500, SERIAL # 20103825 SSTRACE 2
AUTOSAMPLER: CETAC 240 POSITION, SERIAL # 031038A520 SSTRACE 1
AUTOSAMPLER: CETAC 240 POSITION, SERIAL # 041048A520 SSTRACE 2

SUGGESTED WAVELENGTH (S): TABLE 2

REVISED SECTIONS: removed all references to Accutest

1.0 SCOPE AND APPLICATION SUMMARY

SW-846 methods, with the exception of required method use for the analysis of method-defined parameters, are intended to be guidance methods which contain general information on how to perform an analytical procedure or technique which a laboratory can use as a basic starting point for generating its own detailed Standard Operating Procedure (SOP), either for its own general use or for a specific project application. The performance data included in this method are for guidance purposes only, and are not intended to be and must not be used as absolute QC acceptance criteria for purposes of laboratory accreditation.

1.1 This method is applicable for the determination of metals in water, sludges, sediments, and soils. Elements that can be reported by this method include: Aluminum, Antimony, Arsenic, Barium, Beryllium, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Magnesium, Manganese, Molybdenum, Nickel, Potassium, Selenium, Silver, Sodium, Strontium, Titanium, Thallium, Tin, Vanadium, and Zinc.

1.2 Sample matrices are pretreated following SW846 and EPA methods for digestion of soil, sediment, sludge or water samples. Refer to specific metals department digestion SOP's for more information on digestion techniques.

1.3 This inductively coupled argon plasma optical emission spectrometer (s) (ICP-OES) uses an Echelle optical design and a Charge Injection Device (CID) solid-state detector to provide elemental analysis. Control of the spectrometer is provided by PC based iTEVA software. In the instrument, digested samples are introduced into the Thermo 6500 ICP, passed through a nebulizer and transported to a plasma torch. The element-specific emission spectra are produced by a radio frequency inductively coupled plasma. The spectra are dispersed by a spectrometer, and the intensities of the emission lines are monitored with the solid state detector.

1.4 Reporting limits (RL)(LLOQ) are based on the extraction procedure. Reporting limits may vary depending on matrix complications, volumes and by client needs, but the reporting limits must always be verified with a low check which meets the criteria outlined in this SOP. Solid matrices are reported on a dry weight basis. Refer to table 1 of this SOP for SGS - Orlando typical reporting limits. Refer to scheduling sheets and/or project specific QAPP for further information regarding client specific reporting limits.

1.5 MDLs must be established for all analytes, using a solution spiked at approximately 3 to 5 times the estimated detection limit. To determine the MDL values, take seven replicate aliquots of the spiked sample and process through the entire analytical method. The MDL is calculated by multiplying the standard deviation of the replicate analyses by 3.14, which is the student's t value for a 99% confidence level. MDLs must be determined approximately once per year for each matrix and instrument. Please refer to SGS - Orlando QA SOP QA020, current version for further information regarding method performance criteria and experimental method detection limits.

MDLs are generated for each matrix on both ICP instruments. The higher of the two statistically calculated MDL's is entered into LIMS as the MDL. The verified MDLs are stored in the LIMS and must be at least 2 to 3 times lower than the RL. Exceptions may be made on a case by case basis; however, at no point shall the MDL be higher than the reported RL.

1.6 LLOQ verification. LLOQ is the lowest point of quantitation. The LLOQ is initially verified by the analysis of 7 replicate samples, spiked at the LLOQ and processed through all preparation and analysis steps of the method. The mean recovery should be within +/- 35 percent of the true value with an RSD $\leq$ 20 percent.

1.7 Ongoing Lower limit of quantitation (LLOQ) check sample. The lower limit of quantitation check sample should be analyzed on a quarterly basis to demonstrate the desired detection capability. The LLOQ sample is carried through the entire preparation and analytical procedure. The mean recovery should be within +/- 35 percent of the true value with an RSD $\leq$ 20 percent.

1.8 Compounds detected at concentrations between the RL and MDL are quantitated and qualified as estimated values and reported with either a “J” or “I” qualifier. Some program or project specifications may require that no values below the RL be reported.

1.9 Instrument Detection Limits (IDL). It is suggested that IDL's be completed upon initial instrument installation, whenever instrument conditions have significantly changed, or at a minimum annually. Instrument detection limits can be estimated as the mean of the blank results plus 3 times the standard deviation of 10 replicate analyses of the reagent blank solution. (use zero for the mean if the mean is negative) Each IDL measurement shall be performed as though it were a separate analytical sample. IDLs shall be determined and reported for each wavelength used in the analysis of the samples.

2.0 PRESERVATION AND BOTTLEWARE

All samples should be preserved with nitric acid to a pH of <2 at the time of collection. All sample pH are checked in sample receiving and within the metals department. Samples that are received with a pH >2 must be preserved to pH <2 and held for 24 hours prior to metals digestion to dissolve any metals that absorb to the container walls. Refer to SOP SAM101, current revision for further instruction. Final pH of TCLP extracts are checked and recorded in SGS - Orlando Extractions Department. Please refer to TCLP (1311) fluid determination logbook and SPLP (1312) fluid determination logbook for further information. TCLP extracts received from SGS - Orlando Extractions Department are prepared as soon as possible, no longer than 24 hours from time of receipt. If precipitation is observed during the sample preparation process the sample(s) are immediately re-prepped on dilution until no precipitation is observed. Samples received for dissolved metals analysis should be filtered and preserved to pH<2 as soon as possible and held for 24 hours prior to digestion. Refer to SGS - Orlando Sample Filtration Logbook for further information.

All soil samples must be stored in a refrigerator at ≤ 6ºC upon receipt. Refer to SOP SAM101, current revision for further instruction.

All bottleware used by SGS - Orlando is tested for cleanliness prior to shipping to clients. Analysis results must be less than one half the reporting limit (LLOQ) to be acceptable. Refer to SOP SAM104, current revision for further instruction.

3.0 HOLDING TIME AND BATCH SIZE

All samples must be prepared and analyzed within 6 months of the date of collection. Refer to appropriate SGS - Orlando digestion SOP, current revision for batch size criteria.

4.0 INTERFERENCES

Several types of interferences can cause inaccuracies in trace metals determinations by ICP. These interferences are discussed below.

4.1 Spectral interferences are caused by overlap of a spectral line from another element, unresolved overlap of molecular band spectra, background contribution from continuous or recombination phenomena, and background contribution from stray light from the line emission of high concentration elements. Corrections for these interferences can be made by using interfering element corrections, by choosing an alternate analytical line, and/or by applying background correction points. 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 or adequately corrected to reflect the same change in background intensity as occurs at the wavelength peak.

Note: Refer to section 17.0 of this SOP for further instruction regarding interfering element correction factor generation.

4.2 Physical interferences can be caused by changes in sample viscosity or surface tension, by high acid content in a sample, or by high dissolved solids in a sample. These interferences can be reduced by making sample dilutions.

4.3 Matrix interferences in high solid samples can be overcome by using an internal standard. Yttrium/Indium mix is used for the Thermo 6500 ICP. The concentration must be sufficient for optimum precision but not so high as to alter the salt concentration of the matrix. The element intensity is used by the instrument as an internal standard to ratio the analyte intensity signals for both calibration and quantitation.

4.4 Chemical interferences are not pronounced with ICP due to the high temperature of the plasma, however if they are present, they can be reduced by optimizing the analytical conditions (i.e. power level, torch height, etc.).

5.0 APPARATUS

5.1 Currently there are two solid state ICPs available for use in the lab. Both are Thermo 6500 ICP units. These units have been optimized to obtain lower detection limits for a wide range of elements. Since they are solid state systems, different lines may be included for elements to obtain the best analytical results. However, the lines which are normally included in the normal analysis program are shown in Table 2.

5.2 Instrument auto samplers. For random access during sample analysis.

5.3 Class A volumetric glassware and pipettes.

5.4 Polypropylene auto sampler tubes.

5.5 Eppendorf Pipette (s) - Pipette (s) are checked daily for accuracy and to ensure they are in good working condition prior to use. Volumes are checked at 100% of maximum volume (nominal volume). Pipettes are checked within the metals department and results are stored electronically in the “Pipette Calibration Log”. Refer to SOP QA006, current revision for further information regarding pipette calibration. BIAS: mean must be within 2% of nominal volume. Precision: RSD must be $\leq$ 1% of nominal volume based on three replicates.

5.6 Fisher Brand 0.45 micron (um) filter or equivalent. Filter lots are checked for cleanliness through the Method Blank process. All Method Blank analytical results must be less than one half the reporting limit(LLOQ) to be acceptable, if not, the contaminated lot must be identified and removed from laboratory use. Samples filtered through the contaminated filters must be re-filtered through acceptable filters.

5.7 Fisher Brand disposable 10 ml syringes or equivalent. Syringe lots are checked for cleanliness through the Method Blank process. All Method Blank results must be less than one half the reporting limit (LLOQ)to be acceptable, if not, the contaminated lot must be identified and removed from laboratory use. Samples filtered through the contaminated syringes must be re-filtered through acceptable syringes.

5.8 Data System

Microsoft Windows XP Professional Version 2002
Instrument software SST1 – Thermo iTEVA version 2.8.0.89

Instrument software SST2 – Thermo iTEVA version 2.7.0.87

5.8.1 A computer system interfaced to the Thermo 6500 ICP that allows for the continuous acquisition and storage of all data obtained throughout the duration of the analytical run sequence.

5.8.2 Data is archived to a backup server for long term storage.

6.0 REAGENTS

All chemicals listed below are trace metal grade unless otherwise specified. Refer to Acid Certificate of Analysis logbook for Certificates of Analysis and compliance with the specifications of the grade listed. SGS - Orlando produces DI water to the specifications for the ASTM Type II standard designation based on the system manufacturer's performance specifications. The DI water is used exclusively for laboratory purposes. De-ionized (DI) water should be used whenever water is required. Refer to SOP QA037, current revision for more information regarding testing and monitoring. Refer to the Metals Department Standard Prep Logbook for the make-up and concentrations of standards and stock solutions being used within this SOP. Some of the information included in the logbook is as follows: standard name, elements in mix, manufacturer, lot number, parent expiration date, acid matrix, stock concentration, volume of standard added, total volume, final prepared concentration, prep date, initials, MET number, and prepared standard expiration date. Standards and prepared reagents must be prepared every 6 months or before stock standard expiration date, whichever comes first**.** Refer to tables 3 through 7 of this SOP for concentration levels of standards used. Unless otherwise approved, the calibration curve must contain 3 points determined by a blank and a series of standards representing the elements of interest.

6.1 2.5 ppm Yttrium and 10 ppm Indium internal standard, made from ICP quality standard.

6.2 Hydrochloric acid, trace metals grade.

6.3 Nitric Acid, trace metals grade.

6.4 ICP quality standard stock solutions are available from Inorganic Ventures, Spex, Plasma Pure, Ultra, Environmental Express, or equivalent.

6.5 Calibration Standards. These can be made up by diluting the stock solutions to the appropriate concentrations. The calibration standards should be prepared using the same type of acid (s) and at approximately the same concentration as will result in the samples following sample preparation.

6.5.1 For calibration and quantitation an internal standard (Yttrium/Indium) is used to limit nebulization problems. If it is known that the samples contain a significantly different acid matrix, the samples must be diluted so that they are in a similar matrix to the curve. All sample results are referenced to the initial calibration blank (ICB) Internal Standard counts. The criteria is 60-125 percent of the initial calibration blank (ICB) counts. If the internal standard counts fall outside these criteria matrix effects must be suspected and the sample diluted until it meets the criteria or footnoted in LIMS as suspected matrix interference.

6.5.2 Standards must be prepared so that there is minimal spectral interference between analytes.

Note: All Ag stock and intermediate solutions must be stored away from direct sunlight.

6.6 Analytical Quality Control Solutions.

All of the solutions below are prepared by adding either mixed or single element metals solutions to a solution prepared using the same type of acid (s) and at approximately the same concentration as will result in the samples following sample preparation.

6.6.1 Blank (Calibration, ICB, CCB)

This reagent blank contains Nitric Acid at 3 percent and Hydrochloric Acid at 5 percent.

6.6.2 Initial Calibration Verification solution.

This standard solution must be made from a different source than the calibration curve. The concentrations for each element must be within the range of the calibration curve and should be approximately at the midpoint of the curve. This solution is used to verify the accuracy of the initial calibration. Levels for the ICV standard are shown in Table 4.

6.6.3 Continuing Calibration Verification solution.

The metals concentrations for this standard should be at approximately the mid-point of the calibration curve for each element. This standard should be prepared from the same source that is used for the calibration curve. Levels for the CCV standard are shown in Table 5.

6.6.4 Spectral Interference Checks (SIC). Two types of SIC checks are used. Individual element SIC are performed when the instrument is initially set up, and every six months thereafter. The mixed element SIC solution is used daily to check that the instrument is free from interference from elements typically observed in high concentration and to check that interference corrections (IEC) are still valid.

6.6.4.1 Single element interference checks – At a minimum, single element SIC checks should be performed for the following elements: Aluminum 500 mg/l; Barium 4 mg/l; Calcium 500 mg/l; Copper 4 mg/l; Iron 500 mg/l; Magnesium 500 mg/l; Manganese 4 mg/l; Molybdenum 4 mg/l; Sodium 1000 mg/l; Nickel 4 mg/l; Selenium 4 mg/l; Silicon 50 mg/l; Tin 4 mg/l; Vanadium 4 mg/l and Zn 4 mg/l.

Mixed element SIC solution – The mixed element SIC solution is used as an ongoing daily check of freedom from spectral interferences. The mixed element SIC contains the following elements: Aluminum 500 mg/l; Calcium 500 mg/l; Iron 200 mg/l; Magnesium 500 mg/l.

The absolute value of the concentration observed for any unspiked analyte in the single element SIC checks must be less than 2 times the analytes LLOQ. The concentration of the SIC checks are suggested, but become the highest reportable concentration in the sample analysis and cannot be higher than the highest established linear range. Samples with concentrations of elements higher than the SIC check must be diluted until the concentration is less than the SIC check solution. Reanalysis of a diluted sample is required even if the high concentration element is not required to be reported for the specific sample, since the function of the SIC check is to evaluate spectral interferences on other elements. The daily mixed element SIC solution is analyzed daily after calibration. The concentration measured for any target analytes must be less than +/- the LLOQ. For spiked elements, the analyzed results must be within 20 percent of the true value for SIC check and within 10 percent for linear range check. If this criterion cannot be met then sample analysis may not proceed until the problem is corrected, or the LLOQ is raised to twice the concentration observed in the SIC solution. The only exceptions are those elements that have been demonstrated and documented as contaminants in the SIC solutions. Levels for the SIC and mixed SIC can be found on tables 9 and 10.

6.7 CRIA Standard Solution (Also referred to as LLCCV)

The CRIA standard contains the elements of interest at levels equal to SGS - Orlando quantitation limits (RL). Please refer to Table 6 for list of elements of interest and concentration levels for the CRIA. If special client reporting limits are requested, then low checks corresponding to those reporting limits must also be analyzed.

6.8 Matrix Spike, Matrix Spike duplicate, and Spike Blank Solution.

This solution is prepared by adding either mixed or single element metals solutions to a solution containing 3 percent nitric acid and 5 percent hydrochloric acid and diluting to a fixed final volume with this acid mixture. Spiking solution (s) must be added to the spike blank, matrix spike, and the matrix spike duplicate prior to digestion. Levels for the MS and MSD and Spike Blank standard are shown in Table 7.

6.9 Liquid Argon or Argon Gas. (99.999% purity)

7.0 ANALYTICAL PROCEDURE

Note: Please refer to section 8 of this SOP for further detail on quality control standards. Please refer to scheduling sheets and/or project specific QAPP for further information regarding client specific QC requirements.

7.1 General procedure on how to operate the Thermo 6500 is described below. Refer to the Thermo 6500 operation manual for further details.

7.2 Before starting up the instrument, make sure that the pump tubing is in good condition, the torch assembly, the nebulizer, and the spray chamber are clean, the dehumidifier (if used) is filled with DI water up to the level between Minimum and Maximum, and that there are no leaks in the torch area.

7.3 Turn on the recirculating cooler. Verify that the argon is turned on and there is enough for the entire days analytical run.

7.4 Tighten the pump platens and engage the peristaltic pump. Make sure sample and internal standard solutions are flowing smoothly.

7.5 Put a new solution of acid rinse into the rinse reservoir. The composition of the rinse solution may be periodically changed to minimize sample introduction problems and sample carryover. If internal standard is being used, make sure that sufficient amount of internal standard is prepared for the entire analytical run.

7.6 Start up the instrument following the sequence show below.

7.6.1 Double click the **iTEVA Control Center** Icon on the desktop. Type ***admin*** in User Name field, and then click **OK**.

7.6.2 Once the iTEVA Control Center window is opened, click on **Plasma** Icon at status bar area. Then click on **Instrument Status** to check the interlock indicators (torch compartment, purge gas supply, plasma gas supply, water flow and exhaust should be in green; drain flow and busy should be in gray) and the Optics Temperature. (It should be around 38^{o}C.) Click on the Close box.

7.6.3 Click **Plasma On**. When the plasma is on, click close. Let the instrument warm up for 15 to 20 minutes before starting the analysis. New tubing may take an hour to stabilize.

7.7 Torch Alignment and Auto Peak

7.7.1 If the torch has been cleaned, then the torch alignment procedure must be performed.

7.7.2 Open the method and then click on **Sequence** tab, then click on **List View** Icon until you reach rack display.

7.7.3 Go to S-6 position (you can assign any position in the rack for torch alignment), then right click to select **Go** to empty sample S:6. (Now, the auto sampler tip moves from Rinse to this position).

7.7.4 Click on **Analysis** tab, then select **Torch Alignment** from Instrument drop down menu. There will be a pop up dialog box present. Click **Run**. Then there will be another dialog pop up box (This is a reminder for Torch Alignment Solution (2 ppm Zn)), click **Ok**. Now, the instrument is initializing an automated torch alignment. It takes about 7 minutes to complete this step. Progress is indicated in the progress bar.

7.7.5 After torch alignment is complete, click **Close**. Click on **Sequence** tab, then followed by **List View** Icon.

7.7.6 Go to Rinse position at rack display, right click to select Go to rinse and let it rinse for approximately 5 minutes.

7.7.7 Perform Auto Peak

7.7.8 It is recommended that the Auto Peak Adjust procedure be performed daily prior to calibration. A standard that contains all of the lines of interest is used and the system automatically makes the appropriate fine adjustments. (High standard solution should be used for this process.)

7.7.9 Click **Sequence** tab, then click on **List View** Icon until the rack is displayed.

7.7.10 Go to S-5 position (you can assign any position in the rack for auto peak adjust), then right click to select **Go** to empty sample S:5. (Now, the auto sampler tip moves from the Rinse position to this position). Click on **Analysis** tab. All elements result is shown in the display area. From Instrument drop down menu, select **Perform Auto Peak**. There will be a pop up dialog box present. Highlight “All Elements”, and then click **Run**. Then there will another pop up dialog box (This is a reminder for Auto Peak Solution), click **Ok**. Now, the instrument is performing auto peak adjust. It takes about 5 minutes to complete this process. The Auto Peak dialog box will show a green check mark in front of “All Elements”, which indicates Auto Peak is complete.

7.8 Open the method and start up the run.

7.8.1 Click on **Analyst** Icon at the workspace. Go to the method and choose Open from the drop down menu. Select the method with the latest revision number.

7.8.2 Go to **Method** tab at the bottom of left hand corner to click on **Automated Output** at the workspace area. Type a filename in Filename field in the data display area (i.e. : SA101010M1, starts with SA, then followed by MM-DD-YY, then M1; M1 indicates the first analytical run for that day, then followed by M2, M3 and so on for the second and third runs.) Click on **Apply To All Sample Types**.

7.8.3 Click on **Sequence** tab at the bottom of left hand corner. From Auto Session drop down menu bar, click on **New Auto sampler** to create a sequence. This will pop up a dialog box, then click on **New** and fill in number of samples (i.e.: 100) in the Number of Samples field and the sample I.D. (leave this field empty) in Sample Name field. Type a sequence name (i.e. : SEQ101010M1, starts with SEQ, then MM-DD-YY, then M1; M1 indicates the first analytical run for that day, then followed by M2, M3 and so on for the second and third runs) in the Sequence Name field. Click Ok, then put in “0” as settle time between sequences, and click **Ok**.

7.8.4 Right click on **Untitled** (Cetac ASX-520 Enviro 5 Named Rack is the rack that is currently used) at the workspace area, click on **Auto-Locate All** to locate all sample positions.

7.8.5 Double click on **Untitled** again, then click on the sequence name (i.e. : SEQ101010M1), on the data display area, type the sequence in Samplename column, dilution factor (if needed) in CorrFact column, check the box in front of Check column, and select an appropriate check table.

7.8.6 Once done with creating sequence, go to **Method** drop down menu and save all changes as **Save As**. There will be a Save a Method dialog box present, go to the save option to check on “Overwrite Method and bump revision number” box, and then click **Ok**.

7.8.7 Go to Sequence tab, click on List View Icon from tool bar, then click on Connect Autosampler to PC and Initialize Icon.

7.8.8 See table 8 for a typical run sequence.

7.9 Calibrate the instrument as outlined below. See table 3 for calibration standards concentrations. This calibration procedure is done a minimum of once every 24 hours. The calibration standards may be included in the auto sampler program or they may be run manually from the **Calibrate Instrument (graduated cylinder)** icon located on the Analyst tab. The instrument may be calibrated using a single point standard and a calibration blank or a multipoint calibration. If a multipoint calibration is used a minimum of three standards are required. All curves must be determined from a linear calibration prepared in the normal manner using the established analytical procedure for the instrument. Refer to instrument manual for further detail. Three exposures will be used with a percent relative standard deviation of less than 5 percent. The resulting correlation coefficient must be $\geq$0.995. If the calibration curves do not meet these criteria, analysis must be terminated, the problem corrected, and instrument re-calibrated. Correlation coefficients, slopes, and y-intercepts for each wavelength are printed and included in each analytical data package.

7.10 Initial Calibration Verification Standard (ICV).

After each calibration, a standard from a different source than the calibration standard shall be analyzed. For the ICV, all elements to be reported must be within 10 percent of the true value for 6010D. If the ICV is outside these criteria then the analysis must be terminated, problem corrected, and the instrument re-calibrated.

7.11 After analyzing the ICV, the ICB must be analyzed. The results of the ICB must be less than one half the reporting limit (LLOQ). The instrument blank may be failing the criteria due to contamination or instrument drift. Samples associated with the failing blank shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples bracketed by the failing blank, qualifying the results with a “B” or “V” qualifier, or raising the reporting limit (LLOQ) for all samples to greater than two times the background concentration.

7.12 Before analyzing any real world samples the CRIA (also referred to as LLCCV) must be analyzed. The CRIA contains elements of interest at the reporting limit. The CRIA will be analyzed at the beginning and end of each analytical run. For all elements the results must be within 20 percent of the true value. Refer to scheduling sheets and/or project specific QAPP for further information regarding client specific reporting limits (CRIA Requirement). If the initial CRIA fails no samples associated with the failing CRIA can be reported, and the CRIA should be reanalyzed for the failing elements. If the closing CRIA fails the criteria, the samples associated with the CRIA shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples associated with the CRIA, or qualifying the results in LIMS.

7.13 Before analyzing any real world samples, the Mixed element SIC solution must be analyzed. The mixed element SIC solution is used as an ongoing daily check of freedom from spectral interferences. The mixed element SIC contains the following elements: Aluminum 500 mg/l; Calcium 500 mg/l; Iron 500 mg/l; Magnesium 500 mg/l.

The daily mixed element SIC solution is analyzed daily after calibration. The concentration measured for any target analytes must be less than +/- the LLOQ. For spiked elements, the analyzed results must be within 20 percent of the true value for SIC check and within 10 percent for linear range check. If this criterion cannot be met then sample analysis may not proceed until the problem is corrected, or the LLOQ is raised to twice the concentration observed in the SIC solution. The only exceptions are those elements that have been demonstrated and documented as contaminants in the SIC solutions. Refer to section 17.0 of this SOP for Interfering Element Correction (IEC) procedure.

7.14 After the initial analytical quality control has been analyzed, the samples and the preparation batch matrix quality control shall be analyzed. Each sample analysis must be a minimum of 3 readings using at least a 5 second integration time. Between each sample, flush the nebulizer and the solution uptake system with a blank rinse solution for at least 60 seconds or for the required period of time to ensure that analyte memory effects are not occurring.

7.15 Analyze the continuing calibration verification solution and the continuing calibration blank after every tenth sample and at the end of the sample run. If the CCV solution is not within 10 percent of the true value for method 6010D, the CCV shall be reanalyzed to confirm the initial value. If the CCV is not within criteria after the reanalysis, no samples can be reported in the area bracketed by the failing CCV. Immediately following the analysis of the CCV the CCB shall be analyzed. The results of the CCB must be less than one half the reporting limit (LLOQ) for all elements. The instrument blank may be failing the criteria due to contamination or instrument drift. Samples associated with the failing blank shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples bracketed by the failing blank, qualifying the results with a “B” or “V” qualifier, or raising the reporting limit (LLOQ) for all samples to greater than two times the background concentration.

7.16 One sample per preparation batch, or whenever matrix interferences are suspected for a batch of samples, a serial dilution (SDL) must be prepared. For the serial dilution, a 1:5

dilution must be made on the sample. The results of the 1:5 dilution shall agree within 20 percent of the true value as long as the analyte concentration is within the linear range of the instrument and sufficiently high (minimally, a factor of 25 times greater than the LLOQ). If the results are outside these criteria then matrix interference should be suspected and the proper footnote entered into LIMS. A post digestion spike (PDS) must be performed if the SDL fails. The PDS must recover within ± 25 percent for method SW846-6010D. If the PDS is outside these limits then matrix interference must be suspected and the proper footnote entered into LIMS.

7.17 The upper limit of quantitation may exceed the highest concentration calibration point and can be defined as the “linear range”. Sample results above the linear range shall be diluted under the linear range and reanalyzed. Following calibration, the laboratory may choose to analyze a standard (or mixed standard solution) at a higher concentration than the high standard used in the calibration curve. The standard must recover within 10 percent of the true value, and if successful, establishes the linear range. The linear range standards must be analyzed in the same instrument run as the calibration they are associated with, but may be analyzed anywhere in the run. Samples following a sample with high concentrations of analyte (s) must be examined for possible carryover. Verification may be done by rinsing the lines with an acid solution and then reanalyzing the sample. A limit check table is built into the autosampler file so that samples exceeding the standardization range are flagged on the raw data.

7.18 After the instrument is optimized and all initial QC has been run, click on **Run Auto-Session** Icon to start the analytical run sequence.

7.18.1 If you need to add or delete samples once the run is started, follow the steps shown below.

7.18.2 Click on **Sequence** tab, then click on **List View** Icon at the tool bar. There is the sequence table shown on the display area.

7.18.3 Click on **Add Samples** Icon. This will pop up a dialog box, and then fill in number of samples that need to be added. Click **Ok**. By doing this, samples will be added to the end of the current sequence without a rack location.

7.18.4 On the Samplename column type in the sample I.D., correction factors, and check tables. **Click on Auto Locate All.**

7.18.5 The added samples will be analyzed at the end of the original sequence run order unless they are assigned a different run order.

7.18.6 Deleting Samples

7.18.7 Click on **Sequence** tab, and then click on **List View** Icon under the sequence display area.

7.18.8 Highlight all samples that need to be deleted and then click on the **Delete Samples** icon.

7.19 When the analysis is completed export the data to LIMS following the procedure outlined below.

7.19.1 Double click on **ePrint** Icon on desktop. There will be a **LEADTOOLS ePRINT** pop up box, click on **Finish Jobs** and **OK** boxes.

7.19.2 Double click the **PDF** Icon on the desktop; the PDF file will be present as Document_#. Right click on that file, select **rename** to change the filename to an assigned analytical run I.D. (i.e.: MA9000). This is the raw data file for MA9000.

7.19.3 Drop the raw data to the **LIMS Data Drop** icon located on the desktop.

7.19.4 By completing the above steps, the raw data (i.e.: MA9000) can be viewed and/or printed from the Raw Data Search function.

7.19.5 Go to **Analysis** tab, right click on sample header, and select export all samples.
A pop up dialog box will come up, type in the analytical run I.D. (i.e.: SA101010M1) and click **Ok**. Go to **Lims Export** folder located on the desktop, right click on analytical run and change extension from .TXT to .ICP. Open the analytical file and make any necessary changes, such as deleting any samples that need to be re-run on dilution. **Save** the file. Drop the data file to the **LIMS Data Drop** icon located on the desktop. This will then send the export file to LIMS for review.

7.20 The data can be evaluated by running an automated data evaluation program, which will help to generate quality control summary pages. Each run must be evaluated as quickly as possible to make sure that all required quality control has been analyzed. With each data package include: cover sheet, copies of all prep sheets, autosampler run sequence, dilution sheets, and raw data. Label each folder with MA#, instrument run I.D., instrument used, and date.

7.21 At the end of the analysis day the ICP must be shutdown using the following sequence.

7.21.1 Place the auto sampler tip in the rinse cup and rinse in a mixed solution of approximately 5 percent nitric acid and 5 percent hydrochloric acid for 10 minutes and then in DI water for 20 minutes.

7.21.2 Turn off the plasma by clicking on the **Plasma** Icon and then by clicking **Plasma Off.**

7.21.3 Close all iTeva programs/windows.

7.21.4 Release the tension on the sample pump platens.

7.21.5 Turn off recirculating chiller.

8.0 QUALITY CONTROL

This section outlines the QA/QC operations necessary to satisfy the analytical requirements for method SW846 6010D. Please refer to scheduling sheets and/or project specific QAPP for further information regarding client specific QC requirements. Check with the area supervisor or lab manager for any non-compliant quality control for further information.

8.1 Initial Calibration Verification Standard (ICV).

After each calibration, a standard from a different source than the calibration standard shall be analyzed. For the ICV, all elements to be reported must be within 10 percent of the true value for 6010D. If the ICV is outside these criteria then the analysis must be terminated, problem corrected, and the instrument re-calibrated.

8.2 Continuing Calibration Blank/Initial Calibration Blank.

Analyze the Initial calibration blank solution at the beginning of each run and the continuing calibration blank after every tenth sample and at the end of the sample run. The ICB/CCB must be less than one half the reporting limit (LLOQ) for each element. The instrument blank may be failing the criteria due to contamination or instrument drift. Samples associated with the failing blank shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples bracketed by the failing blank, qualifying the results with a “B” or “V” qualifier, or raising the reporting limit (LLOQ) for all samples to greater than two times the background concentration.

8.3 Low Standard Check (CRIA or LLCCV).

Before analyzing any real world samples the CRIA (also referred to as LLCCV) must be analyzed. The CRIA contains elements of interest at the reporting limit. The CRIA will be analyzed at the beginning and end of each analytical run. For all elements the results must be within 20 percent of the true value. Refer to scheduling sheets and/or project specific QAPP for further information regarding client specific reporting limits (CRIA Requirement). If the initial CRIA fails no samples associated with the failing CRIA can be reported, and the CRIA should be reanalyzed for the failing elements. If the closing CRIA fails the criteria, the samples associated with the CRIA shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples associated with the CRIA, or qualifying the results in LIMS.

8.4 ICSA (Mixed SIC Solution)

Before analyzing any real world samples, the Mixed element SIC solution must be analyzed. The mixed element SIC solution is used as an ongoing daily check of freedom from spectral interferences. The mixed element SIC contains the following elements: Aluminum 500 mg/l; Calcium 500 mg/l; Iron 500 mg/l; Magnesium 500 mg/l.

The daily mixed element SIC solution is analyzed daily after calibration. The concentration measured for any target analytes must be less than +/- the LLOQ. For spiked elements, the analyzed results must be within 20 percent of the true value for SIC check and within 10 percent for linear range check. If this criterion cannot be met then sample analysis may not proceed until the problem is corrected, or the LLOQ is raised to twice the concentration observed in the SIC solution. The only exceptions are those elements that have been demonstrated and documented as contaminants in the SIC solutions. Refer to section 17.0 of this SOP for Interfering Element Correction (IEC) procedure.

8.5 Continuing Calibration Verification.

Analyze the continuing calibration verification solution and the continuing calibration blank after every tenth sample and at the end of the sample run. If the CCV solution is not within 10 percent of the true value for method 6010D the CCV must be reanalyzed to confirm the initial value. If the CCV is not within criteria after reanalysis no samples can be reported in the area bracketed by the failing CCV.

8.6 Method Blank.

The laboratory must digest and analyze a method blank with each batch of samples. The method blank must contain elements at less than one half the reporting limit (LLOQ) for each element. The exception to this rule is when the samples to be reported contain greater than 10 times the method blank level. In addition, if all the samples are less than a client required limit and the method blank is also less than that limit, then the results can be reported as less than that limit. Samples associated with the contaminated blank shall be evaluated as to the best corrective action for each particular sample. This may include reanalyzing the samples, re-digesting and reanalyzing the samples, qualifying the results with a “B” or “V” qualifier, or raising the reporting limit (LLOQ) to greater than two times the background concentration,

8.7 Blank Spike Sample.

The laboratory must digest and analyze a spike blank sample with each batch of samples. Blank Spikes must be within 20 percent of the true value for method SW846-6010D. If the lab control is outside of the control limits for a reportable element, all samples must be re-digested and reanalyzed for that element. The exception is if the lab control recovery is high and the results of the samples to be reported are less than the reporting limit (LLOQ). In that case, the sample results may be reported with no flag. For solid standard reference materials (SRMs) ± 20 percent accuracy may not be achievable and the manufacturer’s established acceptance criterion should be used for all soil SRMs.

8.8 Matrix Spike and Matrix Spike Duplicate Recovery.

The laboratory must digest and analyze a matrix spike and matrix spike duplicate with each batch of samples. The matrix spike recovery is calculated as shown below and must be within 20 percent of the true value for method SW846-6010D. If a matrix spike is out of control, then the results must be flagged with the appropriate footnote. If the matrix spike amount is less than one fourth of the sample amount, then the sample cannot be assessed against the control limits and must be footnoted to that effect.

Note: Both the matrix spike amount and the sample amount are calculated to the IDL for any given element. Any value less than the IDL is treated as zero.

$$\frac{\textbf{(Spiked Sample Result - Sample Result)}}{\textbf{Amount Spiked}} \times 100 = \textbf{matrix spike recovery}$$

8.9 Matrix Duplicate/Matrix Spike Duplicate Relative Percent Difference.

The laboratory must digest a duplicate with each batch of samples. The relative percent difference (RPD) between the duplicate and the sample must be ≤ 20 percent for sample results at or above the reporting limit (LLOQ). If the RPD is outside the 20 percent criteria the results must be qualified in LIMS. RPD's are also calculated in LIMS for sample results below the reporting limit (LLOQ). RPD's outside the 20 percent criteria are not considered failing and LIMS automatically footnotes these as "RPD acceptable due to low duplicate and sample concentrations."

Note: Both the duplicate amount and the sample amount are calculated to the IDL for any given element. Any value less than the IDL is treated as zero.

$$\frac{(|\text{Sample Result - Duplicate Result}|) \times 100}{(\text{Sample Result + Duplicate Result})/2} = \text{Duplicate RPD}$$

8.10 Serial Dilution Analysis and Post Digestion Spike.

One sample per preparation batch, or whenever matrix interferences are suspected for a batch of samples, a serial dilution (SDL) must be prepared. For the serial dilution, a 1:5 dilution must be made on the sample. The results of the 1:5 dilution shall agree within 20 percent of the true value as long as the analyte concentration is within the linear range of the instrument and sufficiently high (minimally, a factor of 25 times greater than the LLOQ). If the results are outside these criteria then matrix interference should be suspected and the proper footnote entered into LIMS. A post digestion spike (PDS) must be performed if the SDL fails. The PDS must recover within ± 25 percent for method SW846-6010D. If the PDS is outside these limits then matrix interference must be suspected and the proper footnote entered into LIMS.

$$\frac{(\text{Sample Result - Serial Dil. Result})}{\text{Sample Result}} \times 100 = \text{Serial Dilution RPD}$$

8.11 Linear Calibration ranges.

The upper limit of quantitation may exceed the highest concentration calibration point and can be defined as the "linear range". Sample results above the linear range shall be diluted under the linear range and reanalyzed. Following calibration, the laboratory may choose to analyze a standard (or mixed standard solution) at a higher concentration than the high standard used in the calibration curve. The standard must recover within 10 percent of the true value, and if successful, establishes the linear range. The linear range standards must be analyzed in the same instrument run as the calibration they are associated with, but may be analyzed anywhere in the run. Samples following a sample with high concentrations of analyte (s) must be examined for possible carryover. Verification may be done by rinsing the lines with an acid solution and then reanalyzing the sample. A limit check table is built into the autosampler file so that samples exceeding the standardization range are flagged on the raw data.

8.12 Sample RSD

For samples containing levels of elements greater than five times the reporting limits (LLOQ), the relative standard deviation for the replicates should be less than 5%. If not, reanalyze the sample. If upon reanalysis, the RSD's are acceptable then report the data from the reanalysis. If RSD's are not acceptable upon reanalysis, then the results for that element should be footnoted that there are possible analytical problems and/or matrix interference indicated by a high RSD between replicates.

8.13 Interelement Spectral Interference Correction Validity

For the interelement spectral interference corrections to remain valid during sample analysis, the interferent concentration must not exceed its linear range. If the interferent concentration exceeds its linear range or its correction factor is big enough to affect the element of interest even at lower concentrations, sample dilution with reagent blank and reanalysis is required. In these circumstances, analyte dilution limits are raised by an amount equivalent to the dilution factor.

8.14 Internal Standard (Yttrium/Indium)

For any readings where the internal standard is outside of the range 60-125 percent of the internal standard level in the reference standard (Initial Calibration Blank), then the sample must be diluted until the internal standard is within range and all sample results must be footnoted in LIMS.

8.15 MSA (Method of Standard Additions)

SGS - Orlando uses the internal standard technique as an alternative to the MSA per SW846-6010D section 4.4.2. However, in certain circumstances MSA may be needed by some project specific requirements. SGS - Orlando may perform an MSA when sample matrix interference is confirmed through the post digestion spike process or may qualify the results in LIMS. SGS - Orlando will use a single addition method as described in SW846-7000B.

9.0 GLASSWARE CLEANING

All glassware must be washed with soap and tap water and then rinsed with 5 percent nitric acid. It must then be rinsed at least 3 times with DI water. Refer to SOP GN196, current revision for further information regarding glassware cleaning.

10.0 DOCUMENTATION REQUIREMENTS

Refer to the Laboratory Quality Assurance Manual for documentation requirements. All raw data is printed to .PDF format and archived to a backup server for long term storage.

11.0 SAFETY

The analyst must follow normal safety procedures as outlined in the SGS - Orlando Safety Manual which includes the use of safety glasses and lab coats. In addition, all acids are corrosive and must be handled with care. Flush spills with plenty of water. If acids contact any part of the body, flush with water and contact the supervisor. Follow proper safety precautions when working with gas cylinders.

12.0 CALCULATIONS

For water samples, the following calculations must be used. Refer to the QC section for the calculations to be used for the QC samples.

Original sample concentration of metal (ug/l) =

$$\frac{\text{(conc. in the digestate (ug/l)) x (final digestate volume (ml))}}{\text{(initial sample volume (ml))}}$$

For soil samples, the following calculations must be used.

Concentration of the metal in the dry sample (mg/kg) =

$$\frac{\text{(conc. in the digestate (mg/l) x final digestate volume(L))}}{\text{(sample wt. (kg)) x (\% solids/100)}}$$

13.0 INSTRUMENT MAINTENANCE

Recommended periodic maintenance includes the items outlined below. All maintenance must be recorded in the instrument maintenance log.

13.1 Change the pump tubing as needed.

13.2 Clean the filter on the recirculating pump approximately once a month and dust off the power supply vents as needed.

13.3 Clean or replace the nebulizer, torch assembly, and injector tube as needed.

13.4 Change the sampler tip as needed.

13.5 Clean the recirculating pump lines and internal sock filter every 3 months or as needed.

13.6 Clean the radial view quartz surface weekly or more often if needed.

14.0 POLLUTION PREVENTION AND WASTE MANAGEMENT

14.1 Pollution Prevention

Users of this method must perform all procedural steps in a manner that controls the creation and/or escape of wastes or hazardous materials to the environment. The amounts of standards, reagents and solvents must be limited to the amounts specified in this SOP. All safety practices designed to limit the escape of vapors, liquids or solids must be followed. All method users must be familiar with the waste management practices described in Section 14.2.

14.2 Waste Management

Individuals performing this method must follow established waste management procedures as described in the Sample and Laboratory Waste Disposal SOP SAM108, current revision. This document describes the proper disposal of all waste materials generated during the testing of samples.

15.0 GENERIC DEFINITIONS

15.1 Batch: A group of samples which are similar with respect to matrix and the testing procedures being employed and which are processed as a unit. A sample batch is limited to a maximum of 20 samples or 24 hours whichever comes first.

15.2 Blank Spike (BS): An analyte-free matrix spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. Blank Spike Recoveries are used to document laboratory performance for a given method. This may also be called a Laboratory Control Sample (LCS).

15.3 Continuing Calibration Verification (CCV): A check standard used to verify instrument calibration throughout an analytical run. A CCV must be analyzed at the beginning of the analytical run, after every 10 samples, and at the end of the run.

15.4 Holding Time: The maximum times that samples may be held prior to preparation and/or analysis and still be considered valid.

15.5 Initial Calibration (ICAL): A series of standards used to establish the working range of a particular instrument and detector. The low point must be at a level equal to or below the reporting level.

15.6 Initial Calibration Verification (ICV): A standard from a source different than that used for the initial calibration. A different vendor must be used whenever possible. The ICV is used to verify the validity of an Initial Calibration. This may also be called a QC check standard.

15.7 Matrix Spike (MS): A sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike recoveries are used to document the performance of a method in a given sample matrix.

15.8 Matrix Spike Duplicate (MSD): A replicate sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike recoveries are used to document the precision and performance of a method in a given sample matrix.

15.9 Method Blank (MB): An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is processed simultaneously with the samples through all the steps of the analytical procedure. The method blank is used to document contamination resulting from the analytical process.

15.10 Sample Duplicate (DUP): A replicate sample which is used to document the precision of a method in a given sample matrix.

15.11 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical integrity of the sample.

16.0 METHOD PERFORMANCE

Method performance is monitored through the routine analysis of negative and positive control samples. These control samples include method blanks (MB), blank spikes (BS), matrix spikes (MS), and matrix spike duplicates (MSD). The MB and BS are used to monitor overall method performance, while the MS and MSD are used to evaluate the method performance in a specific sample matrix.

Blank spike, matrix spike, and matrix spike duplicate samples are compared to method defined control limits. Statistical control limits are stored in the LIMS for QA purposes only. Additionally, blank spike accuracy is regularly evaluated for statistical trends that may be indicative of systematic analytical errors.

17.0 GENERATION OF INTERFERING ELEMENT CORRECTION FACTORS

17.1 It is recommended that all IEC's be verified and updated approximately every 6 months or whenever instrument conditions change significantly. It is also recommended that elements with frequent high concentrations or with large IEC's should be checked more frequently.

17.2 Calculate the IEC correction factors and enter them into the method (refer to Thermo 6500 instrument manual). Calculate the correction factor using the equation shown below. This correction factor must be added to the correction factor already in place in the method for a given element.

$$\text{IEC} = \frac{\text{Concentration Result of the element with the interference}}{\text{Concentration result of the interfering element}}$$

17.3 Verify the new correction factors by reanalyzing the ICSA/ICSAB solutions and/or the SIC solutions or by reloading and recalculating the previously stored results. If the reanalysis is not within QC limits, make additional changes to the IEC factors and then re-verify both the individual and combined solution values.

17.4 Save and update the method.

17.5 Interfering element correction factors are saved as raw data along with the run printouts on a daily basis so that the IEC's for a given run are traceable.

TABLE 1: REPORTING LIMIT BY ELEMENT

Analyte	Water Reporting Limit(LLOQ) (ug/L)	Soil Reporting Limit(LLOQ)(mg/kg)	TCLP Reporting Limit(LLOQ) (mg/L)/MCL
Tin	50	5	
Aluminum	200	20	
Antimony	5	1	
Arsenic	10	0.5	0.10 / 5.0
Barium	200	20	10 / 100
Beryllium	4	0.5	
Cadmium	5	0.4	0.05 / 1.0
Calcium	1000	500	
Chromium	10	1	0.10 / 5.0
Cobalt	50	5	
Copper	25	2.5	
Iron	300	10	
Lead	5	1	0.5 / 5.0
Magnesium	5000	500	
Manganese	15	1.5	
Nickel	40	4.0	
Potassium	5000	500	
Selenium	10	1	0.5 / 1.0
Silver	10	1	0.10 / 5.0
Sodium	5000	500	
Thallium	10	1	
Vanadium	50	5	
Zinc	20	2	
Molybdenum	50	2.5	
Strontium	10	0.5	
Titanium	10	0.5	

TABLE 2. THERMO 6500 ANALYSIS LINES

Element	Wavelength
Al	396.1
As	189.042
Ca	317.933
Fe	259.9
Mg	279.078
Mn	257.610
Pb	220.353
Se	196.026
Tl	190.864
V	292.402
Ag	328.068
Ba	455.4
Be	313.042
Cd	226.502
Co	228.616
Cr	267.716
Cu	324.753
K	766.491
Na	589.5
Ni	231.604
Sb	206.838
Zn	206.2
Mo	202.030
Sn	189.900
Sr	407.7
Ti	334.9

TABLE 3: LOW, MID AND HIGH STANDARD LEVELS
Single Point Calibration (blank and high standard) may be used

Element	Low	Mid	High
	ug/l	ug/l	ug/l
Al	10000	40000	80000
As	500	2000	4000
Ca	10000	40000	80000
Fe	10000	40000	80000
Mg	10000	40000	80000
Mn	500	2000	4000
Pb	500	2000	4000
Se	500	2000	4000
Tl	500	2000	4000
V	500	2000	4000
Ag	62.5	250	500
Ba	500	2000	4000
Be	500	2000	4000
Cd	500	2000	4000
Co	500	2000	4000
Cr	500	2000	4000
Cu	500	2000	4000
K	10000	40000	80000
Na	10000	40000	80000
Ni	500	2000	4000
Sb	500	2000	4000
Zn	500	2000	4000
Mo	500	2000	4000
Sn	500	2000	4000
Sr	500	2000	4000
Ti	500	2000	4000

TABLE 4: ICV STANDARD LEVELS

Element	Concentration
	ug/l
Al	40000
As	2000
Ca	40000
Fe	40000
Mg	40000
Mn	2000
Pb	2000
Se	2000
Tl	2000
V	2000
Ag	250
Ba	2000
Be	2000
Cd	2000
Co	2000
Cr	2000
Cu	2000
K	40000
Na	40000
Ni	2000
Sb	2000
Zn	2000
Mo	2000
Sn	2000
Sr	2000
Ti	2000

TABLE 5: CCV STANDARD LEVELS

Element	Concentration ug/l
Al	40000
As	2000
Ca	40000
Fe	40000
Mg	40000
Mn	2000
Pb	2000
Se	2000
Tl	2000
V	2000
Ag	250
Ba	2000
Be	2000
Cd	2000
Co	2000
Cr	2000
Cu	2000
K	40000
Na	40000
Ni	2000
Sb	2000
Zn	2000
Mo	2000
Sn	2000
Sr	2000
Ti	2000

TABLE 6: CRIA(LLCCV) STANDARD LEVELS

Element	CRIA ug/l
Al	200
As	10
Ca	1000
Fe	300
Mg	5000
Mn	15
Pb	5
Se	5
Tl	10
V	50
Ag	10
Ba	200
Be	5
Cd	5
Co	50
Cr	10
Cu	25
K	5000
Na	5000
Ni	40
Sb	5
Zn	20
Mo	50
Sn	50
Sr	10
Ti	10

TABLE 7: BLANK SPIKE, MATRIX SPIKE AND MATRIX SPIKE DUPLICATE LEVELS

Element	Concentration
	ug/l
Al	27000
As	2000
Ca	25000
Fe	26000
Mg	25000
Mn	500
Pb	500
Se	2000
Tl	2000
V	500
Ag	50
Ba	2000
Be	50
Cd	50
Co	500
Cr	200
Cu	250
K	25000
Na	25000
Ni	500
Sb	500
Zn	500
Mo	500
Sn	500
Sr	500
Ti	500

TABLE 8: TYPICAL RUN SEQUENCE

BLANK
LOW
MID
HIGH
HIGH STD
ICV
ICB
CRIA
ICSA
ICSAB
CCV
CCB
MB
SB
SAMPLE1
DUPLICATE
SERIAL DILUTION
MATRIX SPIKE
MATRIX SPIKE DUPLICATE
POST DIGESTION SPIKE
SAMPLE2
SAMPLE3
CCV
CCB
SAMPLE4
SAMPLE5
SAMPLE6
SAMPLE7
SAMPLE8
SAMPLE9
SAMPLE10
SAMPLE11
SAMPLE12
SAMPLE13
CRIA CLOSING
ICSA CLOSING
ICSAB CLOSING
CCV
CCB

TABLE 9: ICSA (Mixed SIC) SOLUTION LEVELS

Element	Concentration
	mg/l
Al	500
As	0
Ca	500
Fe	500
Mg	500
Mn	0
Pb	0
Se	0
Tl	0
V	0
Ag	0
Ba	0
Be	0
Cd	0
Co	0
Cr	0
Cu	0
K	0
Na	0
Ni	0
Sb	0
Zn	0
Mo	0
Sn	0
Sr	0
Ti	0

TABLE 10: SINGLE ELEMENT INTERFERENCE CHECK SOLUTION (SIC) LEVELS

Element	Concentration
	mg/l
Al	500
As	0
Ca	500
Fe	500
Mg	500
Mn	4
Pb	0
Se	4
Tl	0
V	4
Ag	0
Ba	4
Be	0
Cd	0
Co	0
Cr	0
Cu	4
K	0
Na	1000
Ni	4
Sb	0
Zn	4
Mo	4
Sn	4
Si	50
Sr	0
Ti	0

DETERMINATION OF INORGANIC ANIONS BY ION CHROMATOGRAPHY

Prepared by: Jenna Kravitz Date: 11/28/2017

Approved by: Svetlana Izosimova Date: 04/04/2018

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TITLE: DETERMINATION OF INORGANIC ANIONS BY ION CHROMATOGRAPHY

REFERENCES: EPA 300.0, Revision 2.1, 1993; SW846 9056A;
40CFR, part 136, App. B – MDL procedure

REVISED SECTIONS: Apparatus and Reagents sections 7 and 8 are revised to accommodate transition to carbonate-bicarbonate eluent; updated references sec. 17.

1.0 SCOPE AND APPLICATION

1.1 This method is for the measurement of anions such as bromide, chloride, fluoride, nitrate, nitrite and sulfate by ion chromatography. The method is applicable to potable and non-potable water, solids after extractions, and neutral leachates.

2.0 SUMMARY OF METHOD

2.1 A small volume of sample is introduced into an ion chromatograph. The anions of interest are separated and measured, using a system comprised of a guard column, and analytical column, a suppressor, and a conductivity detector.

2.2 Detection limits vary with the instrument conditions and calibration levels used.

REPORTING LIMIT AND METHOD DETECTION LIMIT

3.1 Reporting Limit. The normal reporting limit for this method is normally established at or above the lowest non-zero concentration standard in the calibration curve. Detected concentrations below this concentration are not reported unless MDL reporting is being done. Reporting limits were set as follows:

ANALYTE	REPORTING LIMIT
Bromide	0.50 mg/l
Chloride	2.00 mg/l
Fluoride	0.20 mg/l
Nitrate	0.10 mg/l
Nitrite	0.10 mg/l
Sulfate	2.00 mg/l

3.2 Method Detection Limit. Experimentally determine MDLs using the procedure specified in 40 CFR, Part 136, Appendix B. This value represents the lowest reportable concentration of an individual compound that meets the method qualitative identification criteria.

Experimental MDLs must be determined semiannually for this method, as outlined in EPA 300.0. Refer to SOP QA020, current revision, for further details.

4.0 DEFINITIONS

4.1 Batch: A group of samples which are similar with respect to matrix and the testing procedures being employed and which are processed as a unit. A sample batch is limited to a maximum of 20 samples or samples loaded on an instrument within the same 12-hour shift, whichever comes first.

4.2 Blank Spike (BS): An analyte-free matrix spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. Blank Spike Recoveries are used to document laboratory performance for a given method. This may also be called a Laboratory Control Sample (LCS).

4.3 Continuing Calibration Verification (CCV): A check standard used to verify instrument calibration throughout an analytical run. CCV must be analyzed at the beginning of the analytical run, after every 10 samples, and at the end of the run.

4.4 Holding Time: The maximum times that samples may be held prior to preparation and/or analysis and still be considered valid.

4.5 Initial Calibration (ICAL): A series of standards used to establish the working range of a particular instrument and detector. The low point should be at a level equal to or below the reporting level.

4.6 Initial Calibration Verification (ICV): A standard from a source different than that used for the initial calibration. A different vendor should be used whenever possible. The ICV is used to verify the validity of an Initial Calibration. This may also be called a QC check standard.

4.7 Matrix Spike (MS): A sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike recoveries are used to document the bias of a method in a given sample matrix.

4.8 Matrix Spike Duplicate (MSD): A replicate sample aliquot spiked with a known amount of analyte(s), processed simultaneously with the samples through all the steps of the analytical procedure. The matrix spike duplicate recoveries are used to document the precision and bias of a method in a given sample matrix.

4.9 Method Blank (MB): An analyte-free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank is processed simultaneously with the samples through all the steps of the analytical procedure. The method blank is used to document contamination resulting from the analytical process.

4.10 Method Detection Limits (MDLs) MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte. This definition is qualitative in nature and does not evaluate an acceptable quantitative limit for method performance. MDLs should be determined semiannually for every matrix in this method. Refer to SOP QA020, current revision.

4.11 Reagent Blank: The reagent blank is a blank that has the same matrix as the samples, i.e., all added reagents, but did not go through sample preparation procedures. The reagent blank is an indicator for contamination introduced during the analytical procedure. For methods requiring no preparation step, the reagent blank is equivalent to the method blank.

4.12 Reagent Grade: Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents, which conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.

4.13 Reagent Water: Water that has been generated by any method, which would achieve the performance specifications for ASTM Type II water.

4.14 Reference Material: A material containing known quantities of target analytes in solution or in a homogeneous matrix. It is used to document the bias of the analytical process.

4.15 Sample Duplicate (DUP): A replicate sample which is used to document the precision of a method in a given sample matrix.

4.16 Preservation: Refrigeration and/or reagents added at the time of sample collection (or later) to maintain the chemical integrity of the sample.

5.0 HEALTH & SAFETY

5.1 The analyst should follow normal safety procedures as outlined in the SGS Accutest Health and Safety Program which includes the use of safety glasses and lab coats. In addition, all acids are corrosive and should be handled with care. Flush spills with plenty of water. If acids contact any part of the body, flush with water and contact the supervisor.

5.2 The toxicity or carcinogenicity of each reagent used in this method has not been precisely determined; however, each chemical should be treated as a potential health hazard. Exposure to these reagents should be reduced to the lowest possible level. The laboratory is responsible for maintaining a current awareness file of OSHA regulations regarding the safe handling of the chemicals specified in this method. A reference file of data handling sheets should be made available to all personnel involved in these analyses.

6.0 COLLECTION, PRESERVATION, AND HOLDING TIME

6.1 Samples must be cooled to <6°C at the time of collection.

6.2 Bromide, chloride, fluoride, and sulfate must all be analyzed within 28 days. Nitrite and nitrate must be analyzed within 48 hours for aqueous samples. For solids, the same hold time applies, after the samples are prepared (see section 10.1.)

Note: State of West Virginia requires 48 hours from collection to completion for NO2/NO3, regardless of matrix.

7.0 APPARATUS AND MATERIALS

7.1 Ion Chromatograph with a guard column, an analytical column, a suppressor column, and a conductivity detector. This SOP is written for the use with the Dionex ICS-2000 or ICS-2100 instrument. The ICS-2000 is run using prepared eluent. The columns used are listed below. Alternate columns may be used if all method requirements can be met.

Maintenance and troubleshooting procedures are described in detail in operation manual. Most basic procedures include checking connections for leaks, cleaning and/or replacing tubing, monitoring and recording the pressure. See Sec.12.0.

7.1.1 Suppressor, AERS 500 Carbonate 4mm. Dionex part number 085029

7.1.2 Guard Column, IONPAC AG22 4 mm. Dionex part number 064139

7.1.3 Analytical Column, IONPAC AS22. Dionex part number 064141

7.1.4 Data System **Chromeleon 6.80 SR 10, build 2818**. Data system's revisions will be updated during annual SOP revisions. Data system changes prior to the date of revision are to be recorded in Maintenance log.

7.2 Top loading balance, capable of weighing to 0.01g. Calibrated and serviced annually by outside vendor and verified daily with Class 1 weights.

7.3 Analytical balance capable of accurately weighing to the nearest 0.0001 g.

7.4 Centrifuge Centra CL2, or equivalent

7.5 Class 1 weights

7.6 Volumetric glassware, class A.

7.7 IC vials and caps

7.8 Volumetric pipettes, class A or autopipetters. Note: If autopipetters are used, make sure that the calibration is checked before use as specified in the autopipetter SOP QA006, current revision.

7.9 Helium tank and regulator. On the ICS-2000 and ICS-2100 instruments, helium is used only for head pressure on the water reservoirs. The pressure should be set at approximately 6 psi.

7.10 Nylon 0.45µm membrane filters or equivalent.

7.11 Disposable syringes, for sample filtering.

7.12 Conductivity meter to pre-determine dilutions for possible interferences.

8.0 REAGENTS

All chemicals listed below are reagent grade unless otherwise specified. Deionized water must be used whenever water is required.

8.1 Stock Standard Solutions, custom mix standards that contain all target anions with a concentration range from 500mg/L to 10000mg/L: This custom standard can be purchased from various manufacturers such as High Purity Standard cat. # SM-205-001 and Inorganic Ventures cat.# acuttest-19.

Note: Levels shown below are suggested levels and may be changed to meet different reporting limit requirements.

8.1.1 The final concentrations of suggested standards are shown in the table below. All units are in mg/L.

Anion	STD A	STD B	STD C	STD D	STD E	STD F	STD G
F	.1	.5	1.5	2.5	5	7.5	10
CHL	2	10	30	50	100	150	200
NO2	.1	.5	1.5	2.5	5	7.5	10
BRO	.5	2.5	7.5	12.5	25	37.5	50
SO4	2	10	30	50	100	150	200
NO3	.1	.5	1.5	2.5	50	7.5	10

8.1.2 The volume of stock added to 100mL volumetric flask are shown in the table below. All volume units are in mL.

Anion	STD A	STD B	STD C	STD D	STD E	STD F	STD G
Custom mix	0.02	0.10	0.30	0.50	1.00	1.50	2.00

8.2 CCV. Same concentration as standard D.

8.3 ICV (External Check Solution.) The ICV can be made in the same manner as the standard D from a separate source than the ICAL standards. It must be within the range of the curve. Alternatively, it can be purchased from an outside supplier.

8.4 Stock Eluent (450mM Na2CO3, 140mM NaHCO3): In a 1000mL flask, add approximately 300mL of DI H20. Using oven dried reagent, dried at 105˚C, (temperature should not exceed 110 ˚C) weigh 47.6955g of Na2CO3 and 11.7614g of NaHCO3, and add to flask. Bring this solution to volume. This solution is stable for 6 months stored refrigerated.

8.5 Eluent Solution (4.5mM Na2CO3, 1.4mM NaHCO3): Dilute Stock Eluent –Sec. 8.4 using 20mL of stock in a 2000mL flask and bring up to volume. This solution is stable for a week stored refrigerated.

8.6 0.2N H_2SO_4 for suppressor regeneration: Pipet 1.0 mL of concentrated H_2SO_4 into 100 mL DI and dilute to final volume of 200mL with DI.

8.7 0.1M Oxalic Acid for metals column clean-up: Dissolve 6.3g of oxalic acid into approx. 300mL of DI water. Bring to final volume of 500mL with DI water.

8.8 10X eluent concentrate for hydrophilic ionic contamination clean-up.

8.9 Acetonitrile, reagent grade

8.10 1M HCl: Add 8.3 mL of concentrated hydrochloric acid to approximately 70 mL of deionized water. Dilute to a final volume of 100 mL and mix well.

9.0 INTERFERENCES

9.1 Interferences can be caused by substances with retention times that are similar to and overlap those of the anion of interest. This interference is especially important at low concentrations.

9.2 The acetate anion elutes early during the chromatographic run and can cause elution times of other anions to vary when large amounts of acetate are present. High levels of acetate also can cause interference with the fluoride peak. Therefore, this method is not recommended for leachates containing acetic acid.

9.3 Large amounts of an anion can interfere with the peak resolution of an adjacent anion. High concentrations of an anion can also cause the peak to be misidentified on the chromatograph due to the large width of the peak. Sample dilution and fortification can be used to correct most interference problems connected with peak resolution.

9.4 Samples that contain particles greater than 0.45μm and reagents with particles larger than 0.2μm must be filtered to prevent damage to instrument columns and flow systems.

10.0 SAMPLE PREPARATION PROCEDURE

10.1 For soil samples, follow the preparation outlined below.

10.1.1 Mix the sample well and remove any artifacts as discussed in SOP QA034, current revision. Weigh approximately 5g of sample and add 50mL of DI water. Mix or shake the resulting slurry for 10 minutes. Record the weight to the nearest 0.01g on preparation log.

10.1.2 For matrix spikes, make sure to spike the aliquot of the sample directly and then add the volume of DI water needed to make the volume of liquid being added to the soil sample equal to 50 mL including the volume of the spike solutions. In most cases this will be 49.75 mL of DI.

10.1.3 Prepare blank QC (Method Blank and Blank Spike) using a clean solid matrix, using approximately 5g aliquot and 50mL of DI water. Record the weight to nearest 0.01g.

10.1.4 Check with the lab supervisor if there is insufficient sample to use a 5g aliquot. Smaller aliquots may be used if a homogeneous portion of the sample can be obtained. The sample must always be extracted with 10 times the sample weight of DI water.

10.1.5 Centrifuge samples and QC for 10 minutes at 2000 RPM, then pre-filter through 0.45µm filters before analysis.

10.2 For aqueous samples, pre-filter water samples through 0.45µm filters only if they contain sediment or appear cloudy before analysis. Matrix spikes must be spiked before filtration. Pre-filter method blanks and blank spikes to act as QC check of the filters, only if there are samples in the batch that have been filtered. Record which samples have been filtered and the lot number of the filters in the run log. An unfiltered Method Blank and unfiltered Blank Spike are required for every batch of samples.

11.0 ION CHROMATOGRAPHY ANALYSIS PROCEDURE

11.1 Check to make sure that the helium tank pressure is > 100 PSI and the pressure gauge by the eluent bottles is set at 6 PSI.

11.2 Fill the eluent generation bottle(s) that are to be used with Eluent Solution- Sec. 8.5, making sure that they are pressurized with helium. On the instrument panel (or in the software) set the water volume at the level in the bottles and adjust the flow rate up to 1.0 mL/min.

11.3 Check the lines coming out of the suppressor for air bubbles. Bubbles should be present. If not, then check to make sure the current is on and the suppressor is working properly.

11.4 Check the pump waste line and see if bubbles are present. If they are present, then prime the pump using the procedure described below.

11.4.1 Verify that the priming valve on the primary pump head (right side) is closed. Hit the prime button on the front panel.

11.4.2 Follow the screen prompts. When prompted, open the waste valve by turning the knob ¼ to ½ turn counter-clockwise.

11.4.3 Check for air bubbles on the pump waste line. Continue priming until no air bubbles are exiting the waste line. Turn the pump off and then close the waste valve.

11.4.4 Allow the instrument conditions to settle and then check the pressure and check for air bubbles. If there is still a problem, the priming procedure may be repeated.

11.5 In the software, go to the browser and go to the correct instrument panel (1 or 2). Then connect the instrument. Monitor the baseline until it is stable.

11.6 Go to the template sequences and edit a sequence for the samples in the run. If a calibration is being used from an earlier run, make sure to copy the calibration into the front of the sequence. After the sequence is generated, then save it using the file name (instrument, date, run). Refer to the instrument manuals or help screens in the program for help in using the software. A summary of the instrument conditions required for the analysis of anions is shown below. Note: the retention time for each anion must not exceed ±10% of that anions retention time from the calibration. Refer to section 14.7 for more discussion of the proper application of retention time.

Column: IonPac AG22, AS22
Eluent: 4.5mM Na2CO3, 1.4mM NaHCO3
Suppressor setting: approximately 30mAmps. This setting will be autogenerated.
Flow Rate: 1.0mL/min
Inj. Volume: 12.5µl
Pump pressure – should be around 1600 psi
Detection: Suppressed conductivity, SRS Ultra II, external water mode

11.7 Check sample conductivity with a conductivity meter to determine if dilutions are needed. Refer to spreadsheet of possible dilutions stored on LAN in GenChem directory.

11.8 Load the autosampler and turn it on. The autosampler should then move to the first sample. A print-out of the autosampler table should be generated showing the order that the samples are loaded into the autosampler.

11.9 Start the run. Monitor the results as the run is going to make sure that problems are identified quickly. Note: the initial demonstration of capability, including instrument MDL's and linear calibration ranges, must be completed before samples can be run.

11.9.1 Data files should be saved using the naming scheme of instrument, year (last 2 digits), month, day, run number followed by the extension of .txt. For example, the first IC run on instrument 2 on May 20, 2005 would be named 205052001.txt. This name should always be used in the workgroup description in the LIMS system.

11.9.2 It is recommended that a new calibration be run a minimum of once per month. (It is required that a calibration be run once per quarter.) Calibrations standards may be varied from the one stated in this SOP depending on the levels of each anion that are to be reported. A minimum of 5 standards and a blank are required and a low standard must be at or below the reporting limit for each anion. A correlation coefficient of 0.995 or greater is required. If this correlation coefficient is not met, than the instrument must be recalibrated. Force to Origin (aka Force to Zero) is not permitted.

11.9.2.1 Using weighed regression 1/concentration is also acceptable. Same correlation coefficient of 0.995 or better is required for this calibration model. *For greater details refer to SOP QA042, current revision.*

11.9.3 After the calibration, a low check at the reporting limit must be run. This low check must have the levels in standard A or at the reporting limit for the calibration outlined in this SOP and recoveries must be in the range of 50–150%. On a daily basis, it is recommended that an external check is analyzed and recoveries must be within a range of 90-110%. (This check must be analyzed at a minimum with each new calibration.) Continuing calibration checks and continuing calibration blanks must be run every 10 samples. The continuing calibration checks must have recoveries in the range of 90-110%. Refer to the quality control section of this SOP for more detail on these quality control samples.

11.10 After the run is completed, review all of the chromatograms and check for overlapping peaks, dilutions, etc.

11.10.1 If the retention time of any anion in the ICV or CCV check standards has shifted more than 10% from the original calibration curve retention time, then no results can be reported for that anion. The column should be reconditioned, if necessary, and the instrument recalibrated before any more samples are reported for that anion. Affected samples are reanalyzed after the problem has been corrected.

11.10.2 If a sample peak has shifted significantly from the original retention time (and the ICV and CCV check standards are within the 10% retention time window), then verify the reported result using post-digest spike on that sample. Do not report results from peaks where the retention time has shifted more than 10 percent unless the peak can be verified using a post-digest spike.

11.10.3 For large or overlapping peaks, make dilutions. If at all possible, make dilutions and reruns on the same run as the original sample.

11.10.4 Refer to section 14.7 for information on how to determine the appropriate retention time window.

11.11 Review all data and update the appropriate tests in the LIMS system. A write-up including a run log, a calibration summary, batch quality control summary, and copies of all chromatograms should be turned into the area supervisor for each batch.

11.11.1 If edits are needed in the calibration after the data has been calculated, the run can be reprocessed using the batch function in the software. Refer to the instrument manuals or on-screen help for addition information.

12.0 INSTRUMENT MAINTENANCE

12.1 Whenever a new suppressor is put in place or when the baseline is unstable or very high, the suppressor should be regenerated. The procedure below is for the Ultra 4mm suppressor.

12.1.1 Using a disposable plastic syringe, push approximately 3mL if 0.2(200mN) H_2SO_4 through the ELUENT OUT port and 5mL of 0.2N H_2SO_4 through the REGIN IN port respectively.

12.1.2 Allow the suppressor to sit for approximately 20 minutes to fully hydrate the suppressor screens and membranes.

12.1.3 Re-connect the suppressor to the system in the recycle mode.

12.2 Periodically, due to the matrix of samples, both guard and analytical columns become degraded and cleaning them becomes necessary. This is evidenced in changing retention times, round-shaped peaks, tailing peaks and overall poor integration. The metals cleanup should be done a minimum of once per month, while the others should be done a minimum of once per quarter.

12.2.1 There are 3 recommended cleanup solutions for the AS22 and AG22 columns.

12.2.2 Metal contamination column clean-up: Use 500mL of 0.2M oxalic acid solution.

12.2.3 Low valency hydrophilic ionic contamination column clean-up. Use 500mL of 10X eluent concentrate (300 mM KOH).

12.2.4 High valency hydrophobic ion 200mM HCl in 80% acetonitrile: The acetonitrile solution is stored in a separate eluent bottle because acetonitrile slowly breaks down in acidic aqueous solutions. Prepare 2 bottles (E1 and E2) with the following 500-mL solutions: E1: 100% Acetonitrile and E2: 1M HCl using DI water.

12.3 Column Clean-up Procedure.

12.3.1 Prepare 500mL solution of the appropriate cleanup solution from 12.2.1

12.3.2 Disconnect the suppressor from the IonPac AS22 Analytical column. **Make sure to reverse the order of the guard and analytical column in the eluent flow path.** Contaminants that have accumulated on the guard column can be eluted onto the analytical column and irreversibly damage it. Cleaning each column separately is recommended. Double check that the eluent flows in the direction designated on each of the column labels.

12.3.3 Set the pump flow rate to 1.0mL/min for an AS22 4-mm analytical or guard column.

12.3.4 Rinse the column for 15 minutes with DI water before pumping the chosen cleanup solution over the columns.

12.3.5 Pump the cleanup solution through the column for at least 60 minutes.

12.3.6 Rinse the column for 15 minutes with DI water before pumping eluent over the column.

12.3.7 Equilibrate the columns with eluent before resuming normal operation for at least 30 minutes.

12.3.8 Reconnect the suppressor and place the guard column in line between the injection valve and the analytical column.

13.0 METHOD PERFORMANCE

Method performance (accuracy and precision) is monitored through the routine analysis of negative and positive control samples. These control samples include method blanks (MB), blank spikes (BS), matrix spikes (MS), and matrix spike duplicates (MSD). The MB and BS are used to monitor overall method performance, while the MS and MSD are used to evaluate the method performance in a specific sample matrix.

Blank spike, matrix spike, and matrix spike duplicate samples are compared to method defined control limits. Control limits are stored in the LIMS. Additionally, blank spike accuracy is regularly evaluated for statistical trends that may be indicative of systematic analytical errors.

Filtered method blanks and blank spikes to act as QC check of the filters. Unfiltered method blanks and blank spikes are used to monitor overall method performance.

14.0 QC REQUIREMENTS

14.1 A method detection limit study must be done semiannually, or when new operator begins work, or whenever there is a significant change in the background or instrument response. The MDL study is done following the procedure outlined in the SGS Accutest - Orlando SOP QA020, current revision. A minimum of seven replicates spiked at 3 to 5 times the MDL must be taken through the procedure for each anion. If instrument conditions (columns, etc.) are modified, then a new MDL must be done.

14.2 A method blank and a spike blank are required to be run with every batch of 20 samples. Additionally a matrix spike and a matrix duplicate are required for every 10 samples. In some cases a matrix spike duplicate may be required in place of a duplicate.

14.2.1 The method blank must contain <½ RL of each anion that is reported and this sample must be run with each set of samples in a batch. If the blank contains more than the reporting level, then all samples must be reanalyzed. If no sample volume remains to be reanalyzed, then the data must be flagged. (The exception is if the sample results are less than the reporting limit.)

Note: West Virginia state specific requirement for method blank must contain analyte at <MDL

14.2.1.1 Although the method states that values greater than the MDL should be suspect, this is not appropriate for the concentration levels being applied for this analysis. MDL's are generally up to 10 times lower than reporting limits for all analytes and values over the MDL do not impact data usability.

14.2.2 The recovery of the spike blank must be within the limits of 90-110% recovery for each anion that is reported and this sample must be run with each set of samples in a batch. If the recoveries are outside of this range, then all associated samples must be reanalyzed. If no sample volume remains to be reanalyzed, then the data must be flagged.

14.2.3 The matrix spike is spiked with all anions of interest. Method limits of 90 -110 % recovery must be applied. Control limits must be generated from laboratory data to support method limits. If the recoveries are outside of this range, and all other method quality control is within limits, then matrix interference should be suspected.

14.2.4 For matrix duplicates control limits of 10% RPD must be applied for all sample values within the calibration range (up to 10 times the reporting limit). If the RPD values are outside of this range, and all other method quality control is within limits, then sample non-homogeneity should be suspected.

14.3 An external source standard (ICV) must be analyzed after every new calibration and its recovery must be within 10% of the true value. If the ICV is not within ±10%, a second ICV should be prepared and analyzed. If the ICV is still outside of the limits, sample analysis must be discontinued and the cause determined (preparation of ICV from third source, instrument recalibration, etc)

14.4 It is recommended that a new calibration be run a minimum of once per month. (It is required that a calibration be run once per quarter.) Calibrations standards may be varied from the one stated in this SOP depending on the levels of each anion that are to be reported. A minimum of 5 standards and a blank are required and a low standard must be at or below the reporting limit for each anion. A correlation coefficient of 0.995 is required.

14.4.1 A new calibration is required when standard retention times shift by more than 10% from the original calibration.

14.5 A low check at the reporting limit (CCV2) for each anion must be run after each calibration. Acceptance criteria is 50–150%.

14.6 Continuing Calibration Verification (CCV) Checks at or near the mid-level of the curve must be run at the beginning and the end of the run and after every 10 samples throughout the run. Every CCV must be followed by a continuing calibration blank (CCB). The CCV must have results within 90-110% of the true value. If the CCV results are outside of the acceptance criteria range, analyst must demonstrate acceptable performance with two CCVs analyzed immediately (started within 1 hour), with no samples between failing CCV and the two additional CCVs. The results for the CCB must be <1/2 RL for an analyte. If they are not, then all bracketed samples for that analyte must be reanalyzed.

14.7 Retention time windows must be established whenever a new column/guard column is installed in an instrument or whenever a major change has been made to an instrument. Retention time shift is checked weekly with a CCV to ensure it does not exceed 10%, and the data is stored on LAN in GenChem directory.

Retention time windows are established by injecting standard mix three times over the course of 24 hours and calculating the standard deviation of the retention times of each analyte. Plus or minus three times the standard deviation of the retention times is defined as the retention time window of that compound.

Peak identification is based on the retention time of an analyte in the standard (initial or continuing) being used as the mid-point of the retention time window. The retention time windows should be used as a guide for identifying compounds; however, the experience of the analyst should weigh heavily in the interpretation of the chromatograms. The analyst should monitor the retention times of known standard peaks throughout an instrument run as an indication of instrument performance.

Because calculated retention time windows are generally very tight (less than ± 0.10 minutes), the retention time windows for the data processing method are generally set wider than the calculated window. This is done to ensure that the software does not miss any potential “hits”. The analyst will then review these “hits” and determine if the retention times are close enough to the retention time of the target analyte to positively identify the peak or to require confirmation.

14.8 The Linear Calibration Range (LCR) is the concentration range the instrument response is linear and must be initially determined and verified every 6 months or whenever a significant change in the instrument is observed or expected. Initially, enough standards must be used to insure the curve is linear. The linearity verification must use at a minimum, a blank and 3 standards. The verification data must be within ±10% of the assigned values. If the data falls outside of this range, then the linearity of the instrument must be reestablished. If any portion of the curve is nonlinear, then sufficient standards must be used to clearly delineate the nonlinear portion of the curve.

NOTE: Samples with detections within 10% of highest calibration standard must be diluted.

14.9 ***Contingencies for handling out-of-control QC***. Upon certain circumstances data can be reported from batches with QC non-conformances. Such samples are to be qualified accordingly. Examples include:

- If the MB is contaminated but the samples are non-detect, then the source of contamination should be investigated and documented. The sample results reported with appropriate qualifiers and footnotes. If the MB is contaminated but the samples results are > 10 times the contamination level, the source of the contamination should be investigated and documented. The samples results may be reported with the appropriate “B” or “V” qualifier. *This must be approved by the department supervisor.* Samples with hits <10 times contamination are reprepped and reanalyzed. If there is insufficient sample to reanalyze, or if the sample is re-analyzed beyond hold time, the appropriate footnote and qualifiers should be added to the results. *This must be approved by the department supervisor*
- Similarly, if the recovery of LCS or CCV is high and the associated sample is non-detect, the data may be reportable with appropriate qualifiers and footnotes. If the recovery of LCS or CCV is below lower acceptance limit, the department supervisor shall review the data and determine what further corrective action is best for each particular sample. That may include reanalyzing the samples, reprepping and/or reanalyzing the samples, or qualifying the results as estimated. *This must be approved by the department supervisor.* If there is insufficient sample to reanalyze, or if the sample is re-analyzed beyond hold time, the appropriate footnote and qualifiers should be added to the results. *This must be approved by the department supervisor.*

If the matrix spike recoveries are not within the established control limits, compare the recoveries to those of the LCS to assess method performance in clean QC matrix. Matrix spike recovery failures are not grounds for reanalysis but are an indication of the sample matrix effects

15.0 DOCUMENTATION REQUIREMENTS

15.1 All reagents must be recorded in a reagent logbook with manufacturers, lot numbers, and expiration dates. All reagent information must be cross referenced on the sample worksheet.

15.2 All instrument data must be exported to the LIMS system and a copy of the run log must be included in the logbook by the instrument.

15.3 A data package consisting of a manual run log, a LIMS run log, a calibration summary, batch quality control summary, and copies of all chromatograms must be turned into the area supervisor for each batch. The analyst should also complete the preliminary review in the LIMS system.

15.4 Refer to SOP QA029, current revision, for procedures and documentation that must be followed when peaks are manually integrated.

16.0 POLLUTION PREVENTION & WASTE MANAGEMENT

16.1 Users of this method must perform all procedural steps in a manner that controls the creation and/or escape of wastes or hazardous materials to the environment. The amounts of standards, reagents, and solvents must be limited to the amounts specified in this SOP. All safety practices designed to limit the escape of vapors, liquids or solids to the environment must be followed. All method users must be familiar with the waste management practices described in section 16.2.

16.2 Waste Management. Individuals performing this method must follow established waste management procedures as described in the waste management SOP, SAM108, current revision. This document describes the proper disposal of all waste materials generated during the testing of samples.

17.0 ADDITIONAL REFERENCES

17.1 Dionex Instrument and column manuals

17.2 QA020 Method performance SOP, current revision

17.3 QA029 Manual Integration SOP, current revision.

17.4 QA042, General Chemistry Calculations, current revision

17.5 TNI 2009 standards.

17.6 DoD QSM, Rev. 5.1, 2017

Table 1 QC Criteria

Quality Control	Frequency	Acceptance Criteria	Corrective Action
Initial Calibration: r = coefficient of correlation	At least quarterly	≥0.995	Rerun calibration standards, and/or prepare new calibration standards and recalibrate the instrument, or document why the data are acceptable. See 11.9.2.
Initial Calibration Verification standard (ICV)	One per calibration	90-110% of the standard's true value	Rerun standard, and/or prepare new standard, and/or recalibrate instrument, or document why the data are acceptable. See 14.3
Continuing Calibration Verification standard (CCV)	Every tenth sample	90-110% of the standard's true value	Rerun standard, and/or recalibrate instrument and reanalyze all samples run since the last acceptable CCV, or document why the data are acceptable. See 14.6
Low-level Standard	One per calibration	50-150% of the standard's true value	Rerun standards, and/or recalibrate instrument and reanalyze all samples run since the last acceptable CCV, or document why the data are acceptable.
Method blank (MB) and Calibration Blank (CCB)	MB: One per batch CCB: Every tenth sample	< ½ RL **Note**: West Virginia state specific requirement for method blank must contain analyte at <MDL	Reanalyze, and/or stop the run and determine the source of contamination, or document why the data are acceptable.
Retention time	Checked weekly	90-110% of the standard's true value	Rerun standard, and/or recalibrate instrument and reanalyze all samples run since the last acceptable CCV, or document why the data are acceptable.
Blank Spike (BS or LCS)	One per batch	90-110%	Determine and correct the problem, reanalyze samples, if necessary, or document why data are acceptable.
MS/MSD	10% of matrix	90-110%	Determine and correct the problem, reanalyze samples and MS/MSD, or document why data are acceptable
Linear Calibration Range (LCR)	Bi-annually	± 10% of the standard's true value	Rerun and/or prepare new series of standard, and/or recalibrate instrument

SAMPLE RECEIPT AND STORAGE

Prepared by: Svetlana Izosimova Date: 10/25/2018

Approved by: Heather Wandrey Date: 10/29/2018

Annual Review

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TITLE: SAMPLE RECEIPT AND STORAGE

REFERENCES: TNI Standards 2009 and 2016, State of Florida DEP SOPs, 40 CFR Part 136, DoD QSM 5.1 and 5.1.1

REVISED SECTIONS: Removed Accutest references throughout the document; Added Access Receipt program throughout the document; added verification of correction factors to 2.2.2; discussed recording temperature to first decimal place in 2.2.3; added section 2.4.8; added green labels to 2.11.2; removed 2.5 as redundant to 2.2.4; edited 2.10;

1.0 SCOPE AND APPLICATION

To maintain documentation of custody of all bottle sets, samples (domestic and foreign), digestates, distillates, and extracts that fall under the responsibility of SGS North America, Inc. - Orlando.

2.0 EXTERNAL CHAIN-OF-CUSTODY PROCEDURE

2.1 Samples are received via commercial carrier, client delivery, or are picked up by SGS - Orlando employees. Upon receipt, sample management inspects the outside of the container for signs of tampering, such as a torn or missing custody seal. The staff reviews Chain Of Custody (CoC) document for the following information:

2.1.1 Client Information- Name / Address, Phone and Fax contact numbers

2.1.2 Facility Information- Project name, Location, Project Number.

2.1.3 Field ID / Point of Collection- Date- Time- (HOLD TIMES) Samplers Initials- # of containers Shipped, Preservative types.

2.1.4 Matrix of samples: WW- water, GW-ground water, SW-surface water, DW-drinking water, SO-Soil, SOL-other solid, LIQ-other liquid, OI- Oil, AIR-air, WP- Wipe, FB-field blank, TB-trip blank.

2.1.5 Analytical Information- Samples with hold times of 72 hrs or less remaining on analyses upon receipt are considered Short Hold Samples and are listed on Short Hold Notification form in order of hold times, from ASAP to 7 days with less than 3 days left. These samples are processed immediately. Job Numbers are assigned, and the samples are given directly to the appropriate lab. Copy of CoC and completed Short Hold Notification Form are relinquished to the appropriate lab by the sample receiving technician. Laboratory personnel accept the samples, time of transfer is recorded, both parties sign SHNF and a copy of the SHNF is attached to CoC. (See Attachment I, Short Hold Notification Form)

2.1.5.1 VOC soil sample vials must be frozen within 48 hours of collection. Receiving technicians review sample times and deliver samples with a

SHNF if sufficient hold-time remains to process the samples. If samples are close to expiring the samples are immediately placed in the freezer with a card notating the time they were placed in the freezer.

2.1.6 TURN AROUND TIME- Samples with a 6 day or less TAT are processed as soon as possible, depending on samples with short hold status.

2.1.7 Sample custody documentation signatures – relinquished/received in Client – Carrier – Laboratory sequence. Per FL DEP SOPs signature shall consist of full signature – no initials allowed – and business affiliation.

2.1.8 Special Requirements and or comments - Compositing, filtering or preservation of samples, Extended sample storage etc.

2.2 Samples are processed by a two-technician team, The sample custodian(s) accepts sample custody upon receipt of samples and verifies that the custody document is correct. Sample conditions, sample temperature, and other observations, including custody seal condition, are documented in detail on the electronic Sample Receipt Confirmation form (p-note).

2.2.1 Temperature is measured using IR thermometer against white label on temperature blank, or on the sample container, if temperature blank is absent. **NOTE: For jobs originated in West Virginia every sample container must be checked.** This thermometer is calibrated measuring the temperature off of white sample label against NIST-traceable liquid-in-glass thermometer – see SOP QA002, current revision. When recording the cooler temperature with the use of an IR gun the following needs to be documented on Sample Receipt Confirmation Form:

2.2.1.1 IR gun used.
2.2.1.2 Correction factor.
2.2.1.3 Observed cooler temperature.
2.2.1.4 Corrected cooler temperature.

2.2.2 Verify IR thermometer correction factor gains Correction factor recorded in Receipt utility to make sure it is correct in both locations. Notify QA/Department Manager if these values are not the same. Apply temperature correction factor for a face value – positive number to be added to direct reading temperature, negative correction factor to be subtracted.

2.2.3 **Samples must remain in coolers full of ice until it is time to process the job for login. Coolers received out of temperature range have initial temperature recorded and are then placed into a Walk-In cooler until resolution from client is received.** 40 CFR part 136, TNI Standards 2009, 2016 revision and DoD QSM 5.1 all designate acceptable temperature as “above freezing and below 6°C”. Temperature is measured and recorded to first decimal place due to state-specific and client-specific requirements.

2.2.4 Any discrepancies or non-compliant situations are documented on the Sample Receipt Confirmation Form (p-note) which is automatically e-mailed to the SGS - Orlando Project Manager (PM) team. PM assigned to the particular client contacts the client for resolution. Major issues require the client to be contacted before the samples can be logged in, such as but not limited to missing COC's, samples being out of hold, insufficient sample volume, bottles received not on COC or out of temperature range. If resolution of the problem is taking time, the samples are labeled as is and placed into refrigerated storage until the problems are resolved. Samples are then removed and processed according to client's instructions. Minor issues identify discrepancies that do not interfere with log-in and/or analysis of the samples, such as 1 of 2 PAH bottles received broken or supplied. The resolution is documented and communicated to sample management for execution.

2.2.5 Once the sample custodian(s) is (are) satisfied with the information on the chain of custody document, the job number is generated from Receipt access-based utility with the next available SGS - Orlando sequential job ID in FXXXXXX convention.

2.2.6 First technician arranges samples on the counter in the order of CoC. Every different point of collection must have a different fraction number, i.e. -1, -2, etc. The assigned fraction number must be written on the chain of custody, to the left of the line identifying the point of collection (Client ID) unless there is insufficient space. The custodian then assigns a unique sample identifier to each sample container, i.e. FAXXXXX-1.4, where 4 is a unique container designation.

2.2.7 The same technician enters samples in the sample location database and prints the labels for the samples. A second technician then attaches the labels to the samples and re-verifies sample client ID and Lab fraction number against CoC. After all the steps in Sec. 3 are completed, first technician closes the Sample Receipt Confirmation Form and second technician reviews it for completeness and accuracy of recorded information.

2.2.7.1 Wherever samples are designated to be put on hold by the client, labels on these samples are highlighted in bright pink and additional bright pink **"HOLD – Do Not Dispose"** label is attached to the individual containers

2.2.8 **After Hours Delivery Procedure**. Upon return to the lab SGS - Orlando-employed couriers will visually inspect the coolers and add ice if needed. Coolers will then be placed into Refrigerated storage until Sample Receiving Technicians can process the coolers. Sample Receiving technicians will arrive first thing in the morning to verify Short Holds, Rushes etc as per sec. 3.1.5 and 3.1.6.

2.3 When assigning a job number, the following information from the chain of custody is entered in the Access Receipt utility:

2.3.1 SGS - Orlando Assigned Job #
2.3.2 Client Name
2.3.3 Project Name
2.3.4 Date and Time Samples Received.
2.3.5 # of coolers Received.

2.3.6 Courier Information
2.3.7 Skif # (Sample Kit Information Sheet)
2.3.8 Technician Initials

2.4 The sample custodian then checks the samples' preservation, except for the volatile samples, which are checked by the analyst after the sample is analyzed. Should a sample be received preserved incorrectly the following actions are taken:

2.4.1 pH and residual chlorine: For samples requiring preservation (HNO3, H2SO4, NAOH and NAOH/Zn Acetate) each container is tested by applying the sample with disposable capillary to narrow-range pH paper. Residual chlorine presence/absence is measured using potassium iodide/starch paper in samples for all EPA 600 series and samples originated in North Carolina (one bottle per well). 45-ml VOC vials are exempt from this procedure and are being tested in the lab after the requested tests are completed (purge-and-trap GC and GC/MS, TOC/TC and EPA 504/8011).

2.4.2 Organochlorine pesticides and PCBs by EPA 608 - samples that are not extracted within 72 hours of collection need to have pH checked and adjusted, if necessary, to a pH within 5.0-9.0 using H2SO4 or NaOH. Coordinate with Extraction department.

2.4.3 Pesticides/PCB's/Semivolatile Organic aqueous samples with residual chlorine present: Add 1 ml of 8% sodium thiosulfate solution per 1liter (0.008%) to all containers except VOA. Record event on Sample Receipt Confirmation Form and in preservative adjustment log.

2.4.4 Cyanide is preserved to pH $\geq$ 12 using 10N NaOH, prepared by WetChem personnel.

2.4.5 Sulfide is preserved to pH $\geq$ 9 using 10N NaOH and Zn acetate, prepared by WetChem personnel.

2.4.6 Aqueous samples for metals are preserved to pH $\leq$ 2 with nitric acid, prepared by WetChem Personnel. These samples are marked with colored label "**Metals Sample Received Unpreserved. Preserved Date_____Time_____ Analyze after 24 hours".** For correctly preserved aqueous metals sampling date and time from COC is recorded as date and time of preservation.

2.4.7 Aqueous samples for TRPH and some WetChem parameters are preserved to a pH of $\leq$2 with H2SO4, prepared by WetChem Personnel.

2.4.8 To avoid using expired preservatives, in the beginning of the calendar month obtain no more than 100 ml of currently used preservative reagents from Shipping area, appropriately label the container with reagent identity and expiration date and discontinue its use at the end of the month. Turn unused portion to the Waste room for further disposal.

2.5 .

2.6 Incorrectly preserved samples have the proper amount of preservative added, upon confirmation from PM or client, volume added is recorded on the Sample Receipt Confirmation form and in preservative adjustment log. The same volume and type of preservative is then added to the Equipment Blank and/or Field Blank, regardless of pH reading. Volume added is recorded on the Sample Receipt Confirmation form and in the preservative adjustment log. Also see Sec. 3.4.5.

Job Number, Sample ID, Bottle Number, Parameter, Preservative Type, Preservative Lot, and Amount of Preservative Added, Date/Time Added and the technician's initials.

2.7 All bottles must be labeled. Each bottle will be labeled both on the cap and on the bottle. VOA vials have the label wrapped around the top of the vial, just below the cap. The labels are generated by the electronic sample receipt log. The following information is entered into the electronic log:

2.7.1 Job #:
2.7.2 Client Name and Project
2.7.3 Date and time samples were received.
2.7.4 The number of coolers received
2.7.5 The temperature of each cooler
2.7.6 Initials of custodian logging in the job
2.7.7 Number of samples
2.7.8 Number of bottles
2.7.9 Bottle type
2.7.10 Preservative by code. Preservatives codes are:

"1" = preservative is checked by analyst
"2" = not applicable
"3" = correctly preserved for the analysis requested

2.7.11 Bottle storage location
2.7.12 Department to do the analysis
2.7.13 The information is saved and labels can be printed.

2.8 The following information must be on the bottle:

2.8.1 The sample number and bottle number
2.8.2 Storage location
2.8.3 The preservative used during sampling as indicated on the chain
2.8.4 Any hazard the Sample Custodian may be aware of

2.9 The samples must be placed in their assigned locations and kept at above freezing and below 6.0°C until preparation and/or analysis. Water samples preserved with HNO_3 for metals analyses are stored at room temperature. Access to the area is limited.

2.10 The original chain of custody and any additional documented information relative to the job is handed to Log-in technician for further processing as described in SOP QA048, current revision, for entry in LIMS.

2.11 **Foreign samples** are referred to samples originated outside of continental United States. These samples must be segregated from domestic samples in storage, processing and disposal. Objective of such segregation is to keep agricultural pests and pathogens from entering continental US territory and interfering with animal and plant health.

2.11.1 Foreign Samples shall be shipped in securely closed watertight containers and free of debris and macro organisms (insects, mollusks, worms, ticks and mites).

2.11.2 Foreign samples are stored in lockable cage in WI#3 to prevent accidental disposal. This cage is clearly marked *for foreign samples only*. Sample labels are colored green to stand out in the lab departments.

2.11.3 Keep lids tightly closed while in storage.

2.11.4 All unconsumed samples and containers must be separately collected for disposal. SGS - Orlando employs outside contractor to sterilize and dispose of foreign samples – see SOPs SAM108 and SAM109, current revision.

3.0 SAMPLE STORAGE TEMPERATURE AND CROSS-CONTAMINATION MONITORING

3.1 While in the laboratory, samples shall be stored in limited-access, temperature –controlled areas. Refrigerators shall be monitored for temperature daily. Acceptance criteria for the temperature of refrigerator is 0.5 to 6.0 °C * and is listed in the refrigerator log. Thermometers that have been calibrated with a NIST traceable thermometer monitor all cold storage areas. As indicated by the finding of the calibration, a correction factor is applied to each thermometer for a face value. Records that include acceptance criteria shall be maintained.

*According to TNI 2009 and 2016, V1M2, sec. 5.8.9.a.i) temperature should be above freezing point and below 6.0°C, when specified storage temperature is 4°C. Lowest temperature that can be practically read above freezing point is 0.5°C.

3.2 Samples for volatile organics determination shall be stored separately from other samples, standards, and sample extracts. Acceptance criteria for the temperature of a volatile refrigerator is 0.5 to 6.0 °C and is listed in the refrigerator's log. VOC Soil freezers are maintained between –10.0°C and -20.0°C per SW-846 5035A. For further details refer to SOP QA004, current revision.

3.3 Sample storage area for volatile organics shall be monitored for cross contamination using refrigerator blanks. Refrigerator blanks shall be analyzed every other week.

3.3.1 If contamination of the refrigerator is confirmed, the samples must be removed from the refrigerator and placed in coolers with ice, or in alternate refrigerated storage.

3.3.2 All samples received after the date of the last clean refrigerator blank must be checked for the same contaminants. If present, they must be reported and flagged with a qualifier indicating possible lab contamination.

3.3.3 The source of the contamination must be located and removed.

3.3.4 A new refrigerator blank is then placed in the refrigerator and analyzed after 24 hours.

3.3.5 Samples may be returned to the refrigerator when all contaminants are removed as indicated by the analysis of a refrigerator blank without contamination.

4.0 DOCUMENTATION

All samples received by SGS - Orlando must come with a chain-of-custody (COC). Special attention shall be paid to client-specific COCs.

SGS - Orlando personnel MUST record dates and time in **mm/dd/yy 24:00** format, and both observed and corrected temperatures.

Current revisions of forms and label templates used in sample receipt process are maintained as controlled documents in limited access directory on LAN.

Attachment I

SHORT HOLD NOTIFICATION FORM **JOB #________________**

HOLD TIME	ANALYTE	CHECK COC	COMMENTS
ASAP	RedOx		
	Bacteria- Total Coliform/Fecal Coliform		
24 hrs	XCr / Hexachrome / Cr +6		
	Dissolved/Filtered Metals		
	Odor		
	Salinity (SCON+ Field Temp & Presure)		
48 hrs	BOD		
	CBOD		
	MBAS		
	Turbidity		
	Color		
	Nitrate (NO3)		
	Nitrite (NO2)		
	TN (NO2/NO3)		
	OPO4 / Orthophos		
	SS (Settleable Solids)		
	Chlorophyl A (Subcontract)		
72 hrs	Acrolein/Acrylonitrile (VOA from Alaska)		
	Formaldehyde (Subcontract)		
7 days Only for samples received after 5 days	Unpreserved Voa Vials		
	TDS/TSS/TS		
	Sulfide		
	8141 pesticides in soil		
	All the Water extractables		
	Soils		
48 Hours	5035 Field Kit (DI vials)		
	Encore Sampler VOA/VPH/GRO		
	Soil Jar (Bulk Sample) VOA/VPH/GRO		
	NO2/NO3 from WV (IC analysis)		

Relinquished by:______________________Date/Time relinquished:_______________

Received by:__________________________Date/Time received:__________________

SAMPLE AND LABORATORY WASTE DISPOSAL

Prepared by: Svetlana Izosimova Date: 12/30/2015

Approved by: Randy Shields Date: 01/21/2016

Annual Review

Reviewed by: ____________________ Date: __________

Reviewed by: ____________________ Date: __________

Reviewed by: ____________________ Date: __________

Document Control

Issued to: QA Department Date: 01/21/2016

Issued to: Sample Management (Shipping) Date: * 01/21/2016

Issued to: ____________________ Date: __________

Issued to: ____________________ Date: __________

Issued to: ____________________ Date: __________

Issued to: ____________________ Date: __________

Effective 7 days after "*" date

CONTROLLED COPY
DO NOT DUPLICATE

TITLE: SAMPLE AND LABORATORY WASTE DISPOSAL

REFERENCES: Florida DEP Hazardous Waste; 40 CFR, Part 261

REVISED SECTIONS: Segregation of Foreign soils – see 4.2.6; Storage and Disposal of samples in “HOLD” status – sec. 4.7 (new), corrected facility name throughout the document.

1.0 SCOPE AND APPLICATION

The disposal of samples and lab waste adhering to Florida State and Federal Regulations.

2.0 SUMMARY

This SOP describes the procedures used by SGS Accutest - Orlando to properly and safely dispose of samples and laboratory wastes; hazardous and non-hazardous; domestic and foreign.

3.0 DEFINITIONS

3.1 Foreign sample: Samples from sites that are outside the continental United States.

3.2 Hazardous Sample or Waste: A material is considered hazardous if it is listed in the Code of Federal Regulations, 40 CFR, Part 261 or it demonstrates any of the hazardous characteristics including, ignitability, corrosivity, reactivity, or has demonstrated toxicity.

4.0 PROCEDURE

Sample Disposal: Samples are kept in appropriate storage for a minimum of 30 days after the report is sent to the client unless otherwise specified by client. The samples are divided into three categories: Aqueous, Soil, and Non-aqueous liquid.

4.1 Aqueous Samples

4.1.1 A disposal list is generated by computer, based on either reporting dates or sample number range (see attached).

4.1.2 Samples are then removed from the refrigerators and/or cabinets, and are separated as non-hazardous (non-detected or normal) and hazardous (positive result) samples.

4.1.3 Non-hazardous samples are emptied into a drum. Once full, the drum is sampled and screened for metals. If screening results are within TCLP limits, the drum is then pumped into a large holding tank. If TCLP limits are exceeded, the drum should be disposed of via the contracted waste disposal company. Once the large holding tank is full, the contracted waste disposal is contacted to arrange for an on-site transfer. The contents are profiled annually unless a major change to the waste stream occurs.

4.1.4 VOA vials are processed through a glass crusher and into an open-top drum. The solid material (glass, plastic, and septa) is separated from the liquid and is drummed separately. The liquid drum, when full, is then handled in the same way as described in section 4.1.3. The crushed glass drum is handled as described in section 4.2.2.

4.1.5 SGS Accutest - Orlando contract Disposal Company segregates hazardous aqueous samples into the appropriate waste drums for disposal.

4.1.6 Samples containing PCB in excess of 50 ppm are automatically flagged by LIMS on disposal list. These samples are labeled with distinct PCB label and segregated from the rest of waste samples to be disposed of in LabPak.

4.1.7 Some samples, on a case by case basis, are returned to the client for disposal.

4.2 Soil Samples

4.2.1 Domestic Soil Samples (DSS) are placed in drums after the storage period, either in a hazardous or non-hazardous drum per the samples’ status on the disposal sheets.

4.2.2 When the drums are full, they are then sampled and analyzed to determine their hazardous constituents (Full TCLP, RCI, and PCBs).

4.2.3 Based on the results of analysis, the drums are then either disposed of as hazardous or non-hazardous by our contract disposal company.

4.2.4 Samples containing PCB in excess of 50 ppm are automatically flagged by LIMS on disposal list. These samples are labeled with distinct PCB label and segregated from the rest of waste samples to be disposed of in LabPak.

4.2.5 Some samples, on a case by case basis, will be returned to the client for disposal.

4.2.6 Foreign soil samples (FSS) come in vials (volatile organic analysis) or jars. These soils are segregated in WI#3 in lockable cage (see also SAM101 and SAM109, current revisions)

4.2.7 After minimum 60-day hold period, but not to exceed 6 months, these FSS are disposed of in the following manner.

4.2.7.1 FSS vials: Vial samples are preserved either with methanol or DI water. Vials with water are uncapped and placed into a drum labeled specifically for foreign soils. No more than six months may elapse form the accumulation start date on the drum before the drum must be disposed. The contracted disposal company must be certified to handle and dispose of foreign soils. Vials with methanol must be filtered. The filtrate (methanol) is disposed of in the non-chlorinated solvent waste drum. The soil is then drummed per the hazard status on the disposal sheets.

4.2.7.2 FSS Solids: FSS in jars are emptied into drum labeled specifically for foreign soils. Once full, the drum is disposed of via the contracted disposal company. No more than six months may elapse from the accumulation start date on the drum to disposal.

4.3 Non-aqueous liquid samples

4.3.1 Non-aqueous samples are placed in drums after the hold period.

4.3.2 When the drums are full, they are then sampled and analyzed to determine their hazardous constituents (PCBs). Drums have a 6 month expiration time. If the drum is not full by then it is analyzed and picked up by our contract disposal company.

4.3.3 Based on the results of analysis, the drums are then either disposed of as hazardous or non-hazardous by our contract disposal company.

4.3.4 Samples, on a case by case basis, will be returned to the client for disposal.

4.4 Sample Containers

4.4.1 Containers from samples deemed Non-Hazardous are immediately disposed of into a waste container provided by waste management services specifically for SGS Accutest - Orlando direct use. A lock and key has been installed to keep the containers use limited to Accutest only.

4.4.2 Containers from samples deemed hazardous are disposed of into the Hazardous waste solids drum.

4.4.3 Waste Management services picks the container up on a weekly basis and brings to the local sort facility where contents are destroyed -recycled.

4.5 Laboratory Waste Disposal:

4.5.1 All materials determined to be hazardous are containerized in appropriate vessels (i.e. drums). A waste is considered hazardous if it is listed in the Code of Federal Regulations, 40 CFR, Part 261 or it demonstrates any of the hazardous characteristics including, ignitability, corrosivity, reactivity, or has demonstrated toxicity. Our contract disposal company disposes of the drums.

4.5.2 WASTE DRUMS are separated by type:

Chlorinated Waste (Closed Top Steel) - Methylene Chloride

Non-Chlorinated Waste (Closed Top Steel) - Hexane, Methanol, and mixed solvents

Sodium Sulfate/Used Charcoal (Open Top Steel) - Charcoal and paper filters used in the filtering of samples.

Non Hazardous Aqueous Vials (Open Top Poly) - Primarily Acid Vials.

Hazardous Flammable Vials (Open Top Poly) - Methylene Chloride, Hexane.

Hazardous Aqueous waste (Closed Top Poly) - High Odor Samples, Lachat Waste.

Non Hazardous Soil (Open Top Steel)- Soils.

Hazardous Solid Waste - (Open Top Steel).

Non-Aqueous/Oil Samples- (Closed Top Steel)

Difference between Open and Closed type of drums is whether it is possible to remove entire lid or just threaded stopper. Drums are closed at all times while in storage.

4.5.3 Disposal is done as conscientiously as possible following guidelines set forth by both the State of Florida and our contract disposal company. Management and proper handling is necessary to avoid any violation. The guidelines change depending on how much waste is generated on a monthly basis:

4.5.3.1 Less than 220 pounds (100 kilograms or about half a drum) is a “Conditionally Exempt Small Quantity Generator”.

4.5.3.2 A “Small Quantity Generator” generates 220-2,200 pounds (100-1,000 kilograms or about half a drum to 5 drums)

4.5.3.3 More than 2,200 pounds (100-1,000 kilograms or more than about 5 drums) is a “Large quantity Generator”.

4.5.3.4 SGS Accutest - Orlando is considered a “Small Quantity Generator”.

4.6 Waste Containers and Storage

4.6.1 Containers must be maintained in good condition at all times. Care must be taken to prevent leaks, ruptures, and the accumulation of rainwater on tops of the drums.

4.6.2 Waste containers must be kept closed at all times, except when waste is being transferred to drum.

4.6.3 The containers must be compatible with the waste being stored (i.e. acids should not be stored in metal drums). Never store incompatible wastes in the same container (i.e. acids and bases). Containers must be stored in such a way to accommodate inspection for leaks and damage from all sides

4.6.4 Each waste container must be labeled with the following information.

4.6.4.1 Type and nature of waste (soil, oil, hazardous, non-hazardous)

4.6.4.2 Waste generator's name and address

4.6.4.3 Manifest document number

4.6.4.4 Proper DOT shipping name and identification number

4.6.4.5 Accumulation start date (change to storage date when container is full)

4.6.4.6 In addition, a hazardous waste must have the words "HAZARDOUS WASTE. FEDERAL LAW PROHIBITS IMPROPER DISPOSAL. IF FOUND, PLEASE CONTACT THE NEAREST POLICE OR PUBLIC SAFETY AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY" prominently displayed on the container.

4.6.5 Inspection and Records

4.6.5.1 Containers must be inspected weekly. All records must be kept on file for three years. The records, which must be kept on file, include:

4.6.5.1.1 A written log of the inspections
4.6.5.1.2 Manifests and shipping receipts
4.6.5.1.3 Results of laboratory analyses of the wastes
4.6.5.1.4 Land Disposal Restriction form

4.7 Samples in "HOLD" status

4.7.1 Wherever samples are designated to be put on hold by the client, labels on these samples are highlighted in bright pink and additional bright pink **"HOLD – Do Not Dispose"** label is attached to the individual containers.

4.7.2 Additionally, all Foreign Soils are kept in lockable cage in WI#3 regardless of status (see 4.2.6).

4.7.3 When samples are removed from the temperature controlled storage and boxed for extended storage these boxes also receive same bright pink label as individual containers.

4.7.4 Samples are segregated into a designated quarantine area with clear signs to the nature of the stored samples.

4.7.5 Prior to removal and disposal from this area, written permission should be obtained from the Project Manager, addressed to Sample Management Supervisor and CC'd to the Laboratory Director.

4.7.5.1 Due to 6-months storage restriction on Foreign soils samples (see 4.2.7.1) Project Manager's input must be requested by Sample Management department in a timely manner.

5.0 HEALTH AND SAFETY

5.1 All employees who handle waste materials should wear full protective clothing including safety glasses &/or face shield, gloves, boots, lab coat or a Tyvek suit, and air-purifying respirator. Direct skin contact with waste materials should be avoided.

5.2 If an employee has accidentally been exposed to a hazardous waste, the individual should rinse the affected areas thoroughly under a safety shower for at least 15 minutes. If the individual begins to exhibit any adverse effects from the exposure, he should be immediately transported to the nearest hospital emergency room. Employees are referred to the Material Safety Data Sheets for specific instructions on exposure to hazardous substances.

ATTACHMENT B

Resumes

Holly Dillon

Environmental Scientist/SSHO

EDUCATION

MS, Coastal and Watershed Science and Policy (watershed emphasis), 2010, California State University

BA, Environmental Science (Public Policy Minor), 2005, Mills College

CERTIFICATIONS, LICENSES, TRAINING

Safety, Health, and Environmental Program (SHEP), 2015

Leading Cultural Change, 2014

Management Conference, 2014

Biennial American Red Cross CPR / First Aid

Confined Spaces for Construction, 2009 / Respiratory Protection, 2009

HAZWOPER 40-Hour, 2005 / Annual 8-Hour Refresher

Hazardous Waste Management, 2004 / Hazard Communication, 2005

OSHA 30-Hour Construction Safety, 2009

HAZWOPER Supervisor, 2009 / Health and Safety Leadership, 2009

DOT Hazmat, 2013

Laboratory, 2008 / Compressed Gas, 2008 / Fire Extinguisher, 2010 / Defensive Driving Safety, 2014

U.S. Army Corps of Engineers Construction Quality Management for Contractors, 2011

US Army AKO READ and ERIS, 2013

Incident Management and Reporting Procedures, 2012

EXPERIENCE SUMMARY

- Over 11 years of experience as an Environmental Scientist supporting federal/DoD environmental remediation projects through data management, sampling and analysis, site safety and quality control, and the development of work plans and reports
- Over 6 years of SSHO experience and specialized safety training in field and office workplace environments including USACE environmental remediation projects throughout California; ensure quality health and safety reporting, safety training; develop APPs and AHAs, perform safety inspections, conduct daily toolbox meetings and administer best safety practices; experience at sites where EPA Level C PPE was required
- Over 8 years of quality control (QC) experience including QC inspections and reporting of field and office work performance, equipment, and reports
- 2 years of experience implementing Stormwater Pollution Prevention Plan (SWPPP) Best Management Practices

PROJECT EXPERIENCE

Environmental Scientist and SSHO, Ahtna, 2009-Present

Maintain safety training records and schedule training. Assist with production of safety plans including Business Response Plans, Site Specific Health and Safety Plans (SSHPs), Activity Hazard Analyses (AHAs), Accident Prevention Plans (APPs), Emergency Action Plan (EAP), and Hazard Communication Program (HCP). Provide training to coworkers and subcontractors for safety related topics and conduct safety meetings. Maintain Safety Data Sheets (SDSs) for all onsite hazardous substances, inventories of materials, and update site plans and maps accordingly. Support the development of quarterly and annual monitoring reports, work plans, construction completion reports, and project-specific reports. Manage environmental data for various projects including tracking sample information, data validation, and data upload to project specific databases. Analyze environmental data by creating and updating site maps, plume and water elevation contours, tracking data trends, creating data tables, and assisting with project decisions based on data analyses. Completed all work to date with zero lost-time safety incidents.

Environmental Scientist/SSHO, Groundwater Treatment Plant O&M – Former Fort Ord, USACE Sacramento, Marina, CA, 2008-present, $10M

Prepare Quarterly and Annual Groundwater Treatment System and Groundwater Monitoring reports, and project APP and AHAs as well as Quality Assurance Project Plans (QAPPs). Provide technical support, handouts, and minutes for client and agency monthly and semi-annual meetings. Perform groundwater treatment plant sampling, data management, data analysis, and data validation in support of O&M of two GWTPs consisting of a network of 28 extraction and 6 injection wells and infiltration galleries. Provide field supervision and support, oversee QC, and health and safety during the quarterly sampling of over 200 groundwater monitoring wells, as well as water level measurements at over 300 wells. Support project optimization

Behavior Based Safety, 2012

Terrorism Awareness, 2013

Annual Medical Clearance and Respirator Fit Test

Globally Harmonized System, 2013

Munitions Response, 2012

Qualified SWPPP Practitioner (QSP) training, 2012 (not licensed)

WORK HISTORY

Ahtna Environmental Inc., Environmental Scientist/Site Safety & Health Officer, 2015-present

Ahtna Engineering Services, LLC, Environmental Scientist/Site Safety & Health Officer, 2009-2015

Volt Workforce Inc. (California American Water), Laboratory Technician, 2008-2009

Student Intern, California State University Monterey Bay, 2007-2010

MACTEC Engineering & Consulting, Environmental Scientist, 2005-2007

City of Menlo Park, Engineering Intern, 2004-2005

Yoh Scientific/ICF Consulting (USEPA Contractor), Laboratory Assistant, 2002-2004

PTRL West, Laboratory Assistant, 2001

and expansion strategies for remedial systems at three sites in six groundwater aquifers.

Environmental Scientist/SSHO, Operable Unit Carbon Tetrachloride Plume (OUCTP) Evaluation, Injection, and Bioremediation, Former Fort Ord, USACE Sacramento, Marina, CA, 2014-present, $2.5M

Write APP and AHAs and provide SSHO support for field work involving the evaluation and remediation of the OUCTP A-Aquifer CT groundwater plume, including installation and sampling of eight new groundwater monitoring wells, and installation and operation of an injection and bioremediation system (summer 2016).

Environmental Scientist/SSHO, Sites 2/12 Remedial Investigation/Feasibility Study (RI/FS) Addendum, Former Fort Ord, USACE Sacramento, Marina, CA, 2013-2015, $1.2M

Executed fieldwork as part of a four-person team to perform drilling and sampling work to investigate plume delineation of groundwater and soil gas, as well as potential for soil vapor intrusion in commercial buildings. Directed the installation and sampling of 167 soil gas probes and 17 monitoring wells, and provided support for 25 sub-slab soil gas samples and 25 indoor air samples. Provided technical input into the RI/FS Work Plan and Addendum report. Prepared Cinema Work Plan and SSHP. Provided technical support for client, agency, and land owner meetings. Performed data management and analyses. Performed onsite field QC inspections, safety meetings. Oversaw field activities including monitoring well and soil boring drilling, overnight drilling, soil gas probe and monitoring well installation, geologic logging, soil gas sampling, soil sampling, groundwater sampling, laboratory and subcontractor oversight. Completed the installation and operation of a Soil Vapor Extraction Pilot Study. Produced the RI/FS report and additional Indoor Investigation Technical Memorandum. Supported preparation to expand the groundwater remedy to include additional groundwater extraction and a full-scale soil vapor extraction treatment system at Sites 2/12.

Environmental Scientist/SSHO, Multiple Environmental Government Acquisition (MEGA) ID/IQ Environmental Services, USACE Sacramento, Hawthorne Army Depot, NV, 2014-2015, $97.7K

Prepared APP in support of groundwater assessment work at three solid waste management units. Provided safety support during field execution. Implemented corrective actions as needed to maximize safe execution of work.

Environmental Scientist/SSHO, Greely Hall, East Range Mine Shaft and South Range Landfill, Fort Huachuca, USACE Los Angeles, Fort Huachuca, AZ, 2013-2014, $1.3M

Prepared APP for all three sites that involve environmental services to achieve site closure including the installation of groundwater monitoring wells, groundwater monitoring, and development of a Response Complete Decision Document. Provided safety support during field execution. Implemented corrective actions as needed to maximize safe execution of work.

Environmental Scientist/SSHO, POM/OMC Stormwater Compliance,

USACE Sacramento, Former Fort Ord, CA, 2013-2014, $21K

Prepared the SWPPP Implementation Plan to guide the Presidio of Monterey/Ord Military Community in ensuring compliance with the new municipal storm water permit by researching new permit requirements, organizing requirements into an annual list of requirements, and researching available resources of nearby storm water organizations.

Environmental Scientist, Building 258 Source Area Remediation (SAR) Excavation, USACE Los Angeles, Fort Hunter Liggett, CA, 2012-2013, $5M

Prepared a SWPPP for the Building 258 Source Area Remediation (SAR) land farm. Implemented and provided staff training for the SWPPP including land farm BMP inspections, daily weather reports, Rain Event Action Plans, reporting on SMARTS including annual reports and the Notice of Termination (site closeout). Created gINT boring logs for the new monitoring wells installed.

Environmental Scientist/SSHO, O&M - Riverbank Army Ammunition Plant, USACE Sacramento, Riverbank, CA, 2009-present, $1.2M

Perform QC document editing of monthly and quarterly progress reports, SDS records, training records, safety oversight of site personnel in support of the O&M of the GWTP.

Environmental Scientist/SSHO, Building 258 Monitoring Well Installation, UVOST, MIP, HPT profiling, USACE Sacramento, Fort Hunter Liggett, CA, 2011-2012, $5.8M

Supported the installation of new monitoring wells at Building 258. Drilled soil borings to perform Ultraviolet Optical Screening Tool (UVOST), Membrane Interface Probe (MIP), and Hydro Punch Tool (HPT) subsurface vertical profiling for site plume and remediation analysis. Performed HPT profiling, monitoring well installation. Prepared Work Plan and Construction Completion reports. Conducted data management and analyses. Created gINT boring logs for the new monitoring wells. Observed MIPS and UVOST field work. Presented HPT results to the Army. Provided safety oversight and QC inspections of field work.

Environmental Scientist/SSHO, FAA Anchorage, FAA Release Investigation, McGrath, AK, 2011, $760K

Provided field support during a UVOST subsurface investigation of 13 former Federal Aviation Administration (FAA) underground storage tank (UST) and aboveground storage tank (AST) and conveyance pipeline sites in remote McGrath, Alaska. Performed Geoprobe direct-push drilling oversight, UVOST data analysis, monitoring well installation oversight, soil sampling, geologic logging, monitoring well development with pump and bailer, groundwater sampling with micro-purge, shipping and receiving samples, created gINT boring logs, and survey monitoring wells. Performed QC and safety oversight of subcontractors.

Environmental Scientist/SSHO, Fort Hunter Liggett Building 194 Chemical Injections, USACE Sacramento, Fort Hunter Liggett, CA, 2011-2012, $360K

Provided oversight of fieldwork and technical support during in situ chemical injections at the Building 194 area using direct push technology as well as groundwater sampling and analysis to monitor the groundwater post-injection. Ensured all field work was executed in accordance with approved work plans and schedule. Conducted safety vapor monitoring of worker breathing zone. Coordinated sampling and laboratory work. Prepared Chemical Injection Completion Report. Performed safety oversight and QC inspections of field work.

Environmental Scientist/SSHO, Building 258 Groundwater Monitoring and Reporting, USACE Sacramento, Fort Hunter Liggett, CA, 2010-2013, $750K

Provided technical expertise for groundwater monitoring and reporting of the monitoring well network at Building 258. Conducted groundwater sampling, safety oversight and QC inspections of field work. Prepared quarterly and annual progress reports, and data management and analysis.

Environmental Scientist/SSHO, OUCTP Monitoring Well Installation, USACE Sacramento, Former Fort Ord, CA, 2010-2011, $1.6M

Conducted safety meetings and safety oversight of field activities, and QC inspections during the installation of monitoring wells. Prepared Work Plan and Construction Completion report. Monitored well drilling and installation executed by a four-person crew, including geologic logging, well development, well surveying, groundwater sampling, Westbay multi-port well installation, and overnight drilling operations. Created gINT boring logs for the installed wells.

Environmental Scientist/SSHO, Landfill Post-Closure Monitoring, USACE Sacramento, Fort Hunter Liggett, CA, 2010-2011, $750K

Provided technical guidance during the inspection and monitoring of the closed FHL Landfill. The FHL Landfill includes 32 landfill gas vents, 7 landfill gas probes, and 28 wells. Prepared semi-annual reports, and performed data management, safety and QC oversight of field activities, landfill inspections, and micro-purge groundwater sampling.

Environmental Scientist/SSHO, Building 258 Soil Vapor Extraction System (SVE) Operation and Maintenance, USACE Sacramento, Fort Hunter Liggett, CA, 2009-2011, $750K

Provided technical expertise during the construction and operation of an SVE treatment system including five SVE wells. Installed, maintained and sampled the SVE system. Performed micro-purge groundwater sampling and data management. Oversaw safety and QC for field activities. Prepared monthly and quarterly progress reports.

Environmental Scientist/SSHO, Building 194 Groundwater Monitoring and Reporting, USACE Sacramento, Fort Hunter Liggett, CA, 2009-2011, $207K

Supported groundwater monitoring and reporting of the monitoring well network at Building 194. Completed groundwater sampling with a bladder pump and micro-purge, and oversaw safety and QC inspections of field work. Prepared quarterly and annual monitoring reports, and performed data management and analyses.

Environmental Scientist/SSHO, Del Monte Shopping Center Groundwater Monitoring, USACE Sacramento, Monterey, CA, 2009-2010, $6.7K

Performed groundwater monitoring and reporting of the monitoring well network of approximately 15 wells at the Del Monte Shopping Center in Monterey, CA. Recorded groundwater elevation measurements. Completed groundwater sampling of monitoring wells, pump station, and creek surface water sampling. Communicated with shopping center personnel to coordinate sampling. Oversaw safety and QC inspections of field work.

Environmental Scientist/SSHO, Fort Hunter Liggett Building 194 Well Repair, USACE Sacramento, Fort Hunter Liggett, CA, 2009, $7.5K

Conducted safety tailgate meeting and safety oversight of field activities during the relocation of seven monitoring wells in the Building 194 area. Oversaw 2-person field crew.

Other Relevant Work Experience 2001-2009

Laboratory Technician, Volt Workforce Inc. (California American Water), CA, 2008-2009

Performed drinking water sampling at customer homes, businesses, reservoirs, treatment pump stations, and wells. Analyzed drinking water samples and Moss Landing pilot desalination plant samples in a bacteriological laboratory for coliform, total heterotrophic plate count, alkalinity, and general water quality parameters. Operated an autoclave for sterilization of bacteriological waste. Maintained laboratory and prepared biological media. Investigated customer drinking water complaints.

Student Intern, California State University Monterey Bay, CA, 2007-2010

Conducted field and laboratory tests and analyzed data with computer modeling simulation software to predict environmental data with various agricultural settings. Developed predictions of greenhouse gas emissions from application of fertilizer on agricultural fields. Performed stream and watershed analyses of steelhead fish population, diurnal invertebrate cataloging, urea contamination distribution, and impacts of wildfire and rain on stream erosion and meandering.

Environmental Scientist, MACTEC Engineering and Consulting, CA, 2005-2007

Prepared and implemented several phases of remedial investigation to delineate lateral and vertical extent of perchlorate in soil and groundwater for design of an onsite remediation system at the site of a former flare manufacturing facility. Perchlorate was detected in onsite soil and onsite and offsite groundwater extending 10 miles from the site and to depths in excess of 600 feet below ground surface. Supported the identification and implementation of innovative monitoring well installation techniques, in situ aquifer testing procedures, groundwater sampling methods, as well as several monitoring and evaluation programs to save the client additional future costs. Collected drinking water samples for perchlorate analysis at customer homes, businesses, agricultural pumps, and municipal wells. Sampled groundwater from monitoring wells with micro-purge, barcade, bailer, airlift, bladder pump, snap sampler, and waterra hydrolift. Measured water elevation with water level meter and transducer. Inspected and sampled ion-exchange (IX) perchlorate groundwater treatment systems. Received HAZWOPER safety training and supervised QC and safety during field activities including monitoring well drilling, sampling, and surveying activities.

Engineering Intern, City of Menlo Park, CA, 2004-2005

Sampled drinking water at customer residences, water wells, pumps, and reservoirs. Analyzed drinking water for chemical disinfectant and byproducts with a colorimeter and performed data entry and analyses. Identified system maintenance and upgrades to increase water quality within the distribution system. Performed hazardous waste disposal per applicable regulations utilizing the Uniform Hazardous Waste Manifest. Prepared a Hazard Communication Program and an Emergency Preparedness Plan for the office.

Laboratory Assistant, Yoh Scientific/ICF Consulting (USEPA), 2002-2004

Performed laboratory analyses including Total Organic Carbon (TOC), percent moisture, and alkalinity. Performed safety and QC inspections of laboratory equipment, emergency equipment, personnel, and mobile laboratory vehicle. Cleaned laboratory equipment utilizing ovens and acid washers in accordance with SOPs. Maintained SDS records and disposed of and treated hazardous waste IAW laws and regulations. Produced laboratory spiral locked notebooks. Maintained laboratory scales, thermometers, pH meters, refrigerators, and freezers. Prepared an SOP report for calibrating thermometers.

Laboratory Assistant, PTRL West, 2001

Performed laboratory analyses, sample preparation, shipping and receiving including radioactive and biological materials, and hazardous waste operations.

Mark Fisler

Field Supervisor

EDUCATION

BS, Biology, George Mason University

CERTIFICATIONS, LICENSES, TRAINING

40-Hour HAZWOPER and annual 8-Hour refresher

CA. Dept. of Health Services Water Distribution 2 and Water Treatment 2 certifications

USACE Construction Quality Management for Contractors

OSHA Construction and Safety Health

OSHA 30-Hour Construction Safety

First Aid/CPR

WORK HISTORY

Ahtna Environmental, Inc., Field Supervisor, 2015-present

Ahtna Engineering Services, Field Supervisor, 2002-2006, and 2006-2015

Harding Lawson Associates, Plant Operator, 2001-2002

Advanced Biological Testing, VP and Field Manager, 1993-2001

EXPERIENCE SUMMARY

- Environmental: 15+ years of experience on Army/DoD environmental restoration projects with expertise in the O&M of groundwater treatment plants; 3+ years of experience in the O&M of soil vapor extraction systems
- Field Supervisor: 8 years of experience directing field teams during the execution of groundwater monitoring, upgrades and repairs to GWTS at three DoD/Army installations in CA

PROJECT EXPERIENCE

Senior Plant Operator/Field Supervisor, Groundwater Treatment System Operation and Maintenance, USACE Albuquerque and Sacramento, Former Fort Ord, Marina, CA, 2002-present, $16M

Manage daily O&M of OU2 and Sites 2/12 GWTPs consisting of 27 extraction wells, four injection wells, and five infiltration galleries. Perform weekly inspections of mechanical and electrical systems, repairs and preventive maintenance, routine housekeeping, GAC change-outs, GWTS monitoring, flow regulation, and process sampling. Direct the execution of system upgrades in support of optimization. Ensure the effective management of hazardous materials resulting from a 1,000-gal tank of sulphuric acid stored at Sites 2/12. Develop daily reports.

- To-date, maintained a total maximum flow rate of 1,200-gpm for both GWTS, for an average of 95% operability since 2002
- Consistently complete work on schedule and within budget in accordance with contract requirements

Field Supervisor, Groundwater Monitoring, USACE Albuquerque, Former Fort Ord, Marina, CA, 2010-present, $10M

Oversee quarterly groundwater sampling at over 200 wells across 5,000 acres using passive diffusion bag samplers, the Westbay sampling system, and HydraSleeves. Perform routine maintenance on monitoring wells, including replacing broken or worn locks on well covers, repainting and labeling well completions, checking and recording total depth.

Senior Plant Operator, Groundwater Treatment System Operation and Maintenance, sub to Geosyntec Consultants, Hollister, CA, 2013-present, $50K

Perform operations and maintenance of a groundwater extraction system with seven extraction wells at a former explosives facility utilizing a combination of bio-reaction, sand filtration, and granular activated carbon to remove perchlorate, chromium 6+, arsenic, and volatile organic carbons. Perform sampling of all plant constituents to comply with NPDES requirements for discharge. Provide daily reports to the client within 24 hours to confirm work completed in accordance with the task list provided by the prime contractor.

- Recommended and completed four upgrades and optimization strategies within the first three months to increase productivity and reduce long-term O&M costs

- Successfully resolved an unanticipated system shutdown within a few hours of discovery, avoiding significant impact to system functionality

Field Supervisor, Groundwater Treatment System Operation and Maintenance, Riverbank Army Ammunition Plant, USACE Sacramento, Riverbank, CA, 2004-present, $8M

Oversee the operations and maintenance of the GWTP at the former Riverbank Army Ammunition Plant. Perform three phase inspection processes. Review daily field activity reports and monthly O&M reports. Manage hazardous waste streams, including treatment, handling and temporary storage, documentation, transport and disposal. Support the Project Manager in resolving any operation and maintenance issues.

- Successfully completed upgrades to an existing extraction well to increase the extraction capacity to three times the previous rate
- To-date, performed all work with zero safety incidents

Field Supervisor, Site 12 Remedial Investigation/Feasibility Study Addendum, Former Fort Ord, USACE Sacramento, Marina, CA, 2012-present, $1.2M

Manage field team performing soil gas sampling at Site 12 on the Former Fort Ord as part of the RI/FS addendum. Perform USACE three phase inspections. Work with chemistry labs to ensure the timely procurement of supplies. Support the field team in completing fieldwork in accordance with budget and schedule. Develop daily reports.

Senior Plant Operator/Field Supervisor, Soil Vapor Extraction System Operation and Maintenance, USACE Albuquerque and Sacramento, Former Fort Ord, Marina, CA, 2015-present

Manage daily O&M of Site 12 SVE System consisting of 10 vapor extraction wells. Perform daily and weekly inspections of mechanical and electrical systems, repairs and preventive maintenance, routine housekeeping, vapor extraction monitoring, flow regulation, and process sampling. Direct the execution of system upgrades in support of optimization. Develop daily reports.

- To-date, maintained a total maximum flow rate of approximately 800 cfm, for an average of 99% operability since 2015
- Consistently complete work on schedule and within budget in accordance with contract requirements
- Ensure cost efficiencies and productivity by evaluating the chemistry and identifying which of the 10 wells to run at any given time, and reducing sampling events from weekly to monthly to quarterly as appropriate
- Saved money by eliminating ambient air sampling after demonstrating through historical data collected from years working at the site, that the ambient air samples had been non-detect during the entire sampling period.

Field Supervisor, Monitoring Well Installation and Development, USACE Sacramento, Former Fort Ord, Marina, CA, 2010-2011, $1.6M

Executed fieldwork for the installation of 11 monitoring wells including lithologic logging and soil classification during drilling, and groundwater sampling and analysis. Managed IDW, including disposal of drill cuttings/soil core, in accordance with applicable laws and regulations.

- Successfully completed the work three months ahead of schedule and within budget, despite the challenges of working in and around an active airport and residential areas, and habitat reserve

Charles Holman

Vice President, Southwest Environmental Operations

EDUCATION

Graduate, Structural Design, Heald Institute of Engineering, 1978

CERTIFICATIONS, LICENSES, TRAINING

NQA-1 Certified Lead Auditor

40-Hour HAZWOPER and 8-Hour Refresher

USACE Construction Quality Management for Contractors

DOT Certification

WORK HISTORY

Ahtna Environmental, Inc., Environmental Program Manager, 2016-present

Ahtna Engineering Services, LLC, Environmental Program Manager, 2009-2015

Ahtna Government Services Corporation, Environmental Program Manager, 2006-2009

TN&A, Inc., Senior Technical Manager, 2003-2006

Shaw Environmental IT Corporation, Construction and QC Management, 1996-2003

Parsons Brinckerhoff, Nuclear Quality Services, 1986-1996

Kaiser Engineers, Construction Management, 1977-1986

EXPERIENCE SUMMARY

- 38 years of experience including 28 years working for the DoD and DOE on environmental engineering and construction projects located nationwide
- 15 years of program management experience on DoD/Army environmental contracts; managed multiple contracts valued at over $100M to-date; successfully procured $16M in DoD/Army sole source awards in 2013 as a result of outstanding performance and strong client relationships; maintained 100% repeat business with the AEC and USACE SPD, consistently performing quality work at individual sites for over 10 years
- 15 years of project management experience overseeing all technical execution of environmental restoration projects, QA/QC, project controls, and personnel management; managed projects/task orders exceeding $1B in total value
- Received multiple letters of recognition for outstanding work and client service for work performed at the Former Fort Ord and Riverbank Army Ammunition Plant: "…Without exception, Ahtna has provided the Fort Ord BRAC office with the highest degree of expertise and professionalism."
- More than doubled the growth of SWE operations from one office with five employees to three offices and 30 employees, with cumulative revenues of over $150 million

PROJECT EXPERIENCE

Vice President, Southwest Environmental Operations, Pleasant Hill, CA, 2015-present

Direct a team of 30 staff in the development and execution of USACE and USAEC programs across the southwest U.S. (CA, NV, NM, AZ) with an annual budget of $25M. Oversee the development of cost bids for negotiated and sole source contracts. Develop and maintain client relationships within the USACE SPD and USAEC, achieving 100% repeat business rate to-date. Manage staff resources in multiple locations to maintain an average of 89% utilization.

Program Manager, Two MESA IDIQs, USACE Los Angeles, AZ and CA, 9/2013-present, $20M

Direct the planning and execution of 12 environmental and engineering support services task orders (to-date) varying in size and complexity from a $30K geophysical survey to a $4.5M major auger excavation and a $5.8M soil removal at a high profile FUDS. Manage client relations. Review and approve work plans. Identify and allocate resources to meet project requirements. Ensure contractual, safety, and quality requirements and expectations are exceeded on all task orders.

Program Manager, Environmental Remediation Services IDIQ, USACE Sacramento, Multiple Locations, CA, 2006-present, $23M

Oversaw 40 TOs under four consecutive contracts to provide environmental services at multiple Army installations including O&M/optimization of GWTPs, groundwater sampling and analysis/monitoring, and the development of SWMPs. Direct the development of project estimates. Perform resource allocation and client communications. Oversee project teams for the timely and cost-effective completion of all work including project reports in accordance with plans. Develop and maintain relationships with regulators and ensure compliance with all requirements.

- Commended by Robert Smith, BRAC Environmental Coordinator: "I would like to congratulate and thank you for the exceptional professionalism and customer service I have received from Ahtna for the last three years…[I] look forward to working with [Ahtna] in the future."

Program Manager, Environmental Services IDIQ – Former Fort Ord, USACE Albuquerque, Marina, CA, 2010-present, $10M

Oversee the execution of FFP environmental quality and restoration projects at the Former Fort Ord, including development of hazardous materials management storage plans at the GWTP, O&M, remedial system construction, and document production. Manage government client and stakeholder relations with the USAEC, USACE, and US Army/FFO. Ensure the delivery of all work in accordance with quality, safety, and performance standards and expectations.

- Consistently complete work on schedule and within budget and in accordance with contract requirements
- Performed all work to-date with zero recordable or reportable injuries to-date

Ahtna Government Services Corporation/Ahtna Engineering Services, LLC (Ahtna), Environmental Program Manager

As the senior cost center manager for nationwide environmental operations, managed identification of opportunities, evaluated teaming options, developed proposals, and managed program start up through reporting and turnover. Achieved significant departmental growth, development of an employee mentoring plan, and consistent high evaluations from clients. Worked as an integral part of the company senior management team helping to keep this small disadvantaged business on the leading edge of technological and managerial excellence. Projects include the development and implementation of SWPPPs, groundwater treatment systems, construction, operations and maintenance (O&M), demolition, soil removal actions, and groundwater monitoring, reporting, and analysis. Specific Ahtna projects include the following:

Program/Project Manager, Pacific Gas and Electric Company Storm Water Pollution Prevention Services and Support, Various Locations, CA, 2009-2011, $2.6M

Directed multiple T&M, not-to-exceed projects to prepare, install, monitor and inspect a variety of SWPPPs. Managed 14-person team to perform full services from determination of BMPs, SWPPP development/approval, BMP implementation, and preparation and processing of NOTs. Interfaced daily with client. Monitored cost/schedule. Executed 29 projects at sites across California, with an average of 10 projects managed concurrently.

- Completed all work in compliance with 1 and 2 Risk/Type Levels for General Construction and Linear Underground/Aboveground Projects in accordance with permitting requirements

BMPs have included erosion control, sediment control, tracking control, wind erosion control, non-storm water management, and materials and waste management controls. The SWPPPs also featured appropriate BMP “cut-sheets” identifying installation, inspection, and maintenance requirements. Provided water pollution control drawings showing the recommended temporary BMPs. The SWPPPs included sampling and analysis plans for construction storm water monitoring for non-visible pollutants, sediment, siltation, and/or turbidity pollutants.

Program/Project Manager, Performance-Based Multiple Award Contract (PERMAC) for Environmental Remediation Services at Naval and Marine Corps Installations in California, Arizona, Nevada, New Mexico, and Utah, NAVFAC Southwest (Sub to AMEC), 2008-2009, $13M

- Camp Pendleton, Pesticides Soil Treatment/Removal, 400,000 cy, 370-acre soil removal. Mobilization and startup had to be accomplished in a very short time frame to support federal reconstruction funding requirements. Successfully mobilized including 14 pieces of heavy equipment and all operators and engineers and began operations within 2 weeks of NTP
- Moffett Naval Air Station, Hangar 1 Demolition Engineering Support, PCB contaminated Hangar Demolition
- Alameda Naval Air Station, Sites 1 and 2 Soil Remediation, landfill excavation, waste management and backfill immediately adjacent to the SF Bay

Nuclear Quality Services Director, Parsons Brinckerhoff, California

As Quality Services Director for the nuclear services division on DOE Projects, planned, budgeted, staffed, and assessed performance of QA/QC functions for all 4 high-level nuclear waste programs. Performed contract reviews, developed QA and PM procedures, completed audits and surveillance, and kept senior management advised of project performance. Developed and ensured implementation of all NQA-1 based quality programs, companywide.

- Successfully procured $500M project to perform QA/QC and engineering support for the exploratory tunnel construction at Yucca Mountain including repository design and exploratory studies facilities construction, construction of all radioactive waste conveyance systems and facilities, and ensuring that the disposal facilities met regulatory requirements
- Basalt waste isolation project, exploratory studies facilities (ESF), and repository design, including the assessment of radiological waste migration prevention measures and background surveys for naturally occurring radioactive constituents
- Salt project, ESF design, including designs for all radioactive waste isolation systems
- Waste isolation pilot project, sealing systems design, including performance monitoring of the test sealing and containment systems for radioactive leaks

Senior Technical Manager, TN and Associates Inc.,

Senior Technical Manager, Hunters Point Shipyard, Tetra Tech ECI, San Francisco, CA, $4M

Managed radiological remediation project including the production of high quality planning documents responsive to radiological and environmental regulatory standards, construction of SWPPP and BMPs for the excavation, regrading, and site restoration for $70M of cleanup activities.

- Successfully obtained approvals for HPS documents involving a complex set of regulations, working collaboratively and proactively with the EPA, DTSC, Water Board, Fish and Wildlife
- Completed all work on time and on budget

Shaw (IT) Environmental

Site Manager, Environmental Compliance, Alameda Naval Air Station, Alameda, CA

Manage environmental compliance and restoration work. Developed work plans, including SWPPP, QC, and Health & Safety Plans. Ensured NPDES SWPPP field compliance, and managed field construction, subcontractors, sampling, QC, Health and Safety, T&D of the soil and groundwater. Obtained Navy and regulatory (EPA, DTSC, and Water Board) approval of the plans governing construction and remediation operations for the groundwater analysis, design, and construction of dual-vapor extraction systems for removal of free hydrocarbon products.

- Successfully led the completion of more than $23M in remedial actions at Alameda and received commendations from the Navy

Construction Manager, Sulphur Bank Mercury Mine Superfund Site, USEPA, Clear Lake, CA

Managed the construction of a 36” diameter, mile-long storm water diversion pipeline at an abandoned mercury mine. The construction was completed in hazardous conditions on time and within budget.

Senior QC Manager, Fort Ord, Monterey, CA, $50M

Managed a support staff of more than 20 people during the execution of a $50M project. Oversaw SWPPP compliance inspection, chemistry, sampling, and document control. Worked extensively with client, regulators (EPA and DTSC), and responsible parties to facilitate cost-effective land transfer. Completed base-wide SWPPP compliance; installation, testing, and startup of a base-wide groundwater pump and treat system; consolidation of existing US Army landfills into a single facility; completion of a 28-acre landfill cap; removal, transportation, screening, and recycling of more than 285,000 cy of lead soils from the beach ranges.

- Successfully addressed all management and technical concerns of the client and was commended by the USACE Program Manager, Mr. Steve Lightner, for contributions to the successful turnaround of this major environmental undertaking

QC Manager, Presidio of San Francisco, San Francisco, CA

Managed the development and implementation of plans for both field and technical activities, ensuring balance between client needs and regulators (DHS, EPA and DTSC) in a highly charged political atmosphere. Managed the field technical staff, technicians, document control staff, and sampling groups. This project involved planning, field activities, and preparation of closure reports necessary to receive regulatory approval for turnover of multiple properties including the Crissy Field soil remediation, the fuel distribution systems pipeline removal and soil remediation, the Nike Missile Silos lead abatement and water treatment, and the Fill Site 7 soil and groundwater remediation.

- Successfully completed the remedial actions to allow the base to be turned over to the Presidio Trust

QC Manager, Hamilton Army Airfield, Novato, CA

Managed the review and approval of site closure documents including Work Plans, Sampling and Analysis Plans, Risk Assessment Reports, and Closure Reports.

Field Supervisor, Kaiser Engineers, CA

Supervised mechanical systems design, construction supervision, and QA/QC. Successfully performed the following:

- Basalt nuclear waste isolation project, ESF design/construction, including all natural and engineered high-level radioactive waste barriers
- ICBM basing research, construction
- VALCO aluminum smelter, construction and capital improvements
- Mechanical design, various industrial facilities

Sylvester Kosowski

Project Manager/Senior Environmental Scientist

EDUCATION

MS, Civil & Environmental Engineering, University of Wroclaw Poland

MS, Hydrogeology, University of Wroclaw Poland

BS, Geotechnical Engineering, University of Wroclaw Poland

CERTIFICATIONS, LICENSES, TRAINING

24-Hour Hazardous Waste Generator Training and 8-Hour Annual Refresher Training

40-Hour HAZWOPER & 8-Hour Refresher

OSHA 30-Hr Construction Safety Training

WORK HISTORY

Ahtna Environmental, Inc. Project Manager/Senior Environmental Scientist, 2016-present

T3W Business Solutions, Inc., Senior Project Manager, 2011-2016

Jacobs Technology, Inc./Jacobs Engineering, Inc. Senior Project Manager, 2008-2011

General Dynamics Information Technology (GDIT)

Remedial project Manager, 2006-2008

Tybrin Corporation, Senior Remediation Project Manager, 2000-2006

Laidlaw Environmental/Safety-Kleen, (California), Inc.

Project Manager, 1997-2000

Remedial Management Corporation,

Vice President Engineering

EXPERIENCE SUMMARY

- 30 years in environmental consulting including 16 years in program management with expertise in all phases of the environmental assessment and remediation in the United States within different EPA regions.
- Well-qualified Environmental Program and Project Management Leader with extensive experience in the development and execution of domestic and international remediation and compliance programs and projects that have significantly improved productivity and environmental quality while reducing operating costs for major domestic and international private companies and government agencies.
- Assists in negotiating cleanup and remediation strategies and technical approaches with regulators to secure cost-effective remediation and accelerated, risk based site remediation and closures.
- Oversees field teams including multiple subcontractors conducting soil/groundwater assessments, groundwater monitoring/sampling, SVE O&M, groundwater extraction system O&M, post-closure landfill O&M, in situ chemical injection, demolition, bioremediation, bio augmentation, land farming, and remedial landfill cap installations.
- Manages CERCLA remediation program and project-specific activities and oversees performance of the remediation project and program specific activities including technical document deliverables. Reviews remedy specific operations and monitoring to optimize remedies performances.

PROJECT EXPERIENCE

Project Manager/Senior Environmental Scientist, Sharp Army Depot Groundwater and Soil Remediation, USACE Sacramento, Lathrop, CA 5/2016-present, $ 10 M

Manages CERCLA remediation program and project-specific activities and oversees performance of the remediation project and program specific activities including technical document deliverables.

- Reviews remedy specific operations and monitoring to optimize remedies performances. Manages and supervises program and project specific staff and contractor personnel.

- Assists in negotiating cleanup and remediation strategies and technical approaches with regulators to secure cost-effective remediation and accelerated, 1993-1997

Canonie Environmental Corporation

Project Engineer/Project Manager 1989-1993

International Technology Corporation (IT)

Staff Engineer/Hydrogeologist 1986-1989

risk based site remediation and closures.

- Ensures remediation and remedy performance and monitoring activities are performed in accordance with applicable laws, guidelines and regulations. Recommends optimization approaches to remedial process and remedy operations and long term monitoring.
- Performs business development activities and assists in proposal preparations.
- Oversees personnel during field remediation and monitoring activities.

Senior Project Manager, RCRA Hazardous Waste Facility Management and IRP Program Support, NAF El Centro CA, NAVFAC SW San Diego, CA, 2011–2016,
$ 6.0 M

Directed program and project-specific activities and oversaw performance of the compliance and restoration program activities. Oversaw and participated in business development activities, including meetings, presentations and proposal preparation and oversight. Managed and supervised program and project staff and contractor personnel. Negotiated cleanup and remediation strategies and technical approaches with regulators to secure cost-effective remediation and accelerated, risk based site closures. Ensured compliance and remediation activities are performed in accordance with applicable laws, guidelines and regulations.

- Prepared and implemented Environmental Assessment, Remediation, Compliance, Solid and Hazardous Waste Management Plans, and Storm Water Pollution Prevention and Spill Prevention, Control and Countermeasure (SPPCC) Plans. Prepared water quality, surface water and treated groundwater discharge monitoring plans. Ensured compliance with all Federal (US EPA), State and Local environmental regulations pertaining to soil, storm water, air emissions and water quality.
- Provided support to project management, field remediation, compliance and construction personnel. Ensured storm water is managed and discharged in accordance with the General Permit to Discharge under the National Pollutant Discharge Elimination System (NPDES), State Pollutant Discharge Elimination System, and County

requirements.

- Ensured compliance and remediation systems at installations are managed with state and county specific air emissions permits and discharge requirements. Interacted with regulatory agencies to negotiate cleanup strategies based on risk based and cost-effective cleanup goals and objectives. Supported the client(s) at the meetings with regulatory agencies negotiations. Advised clients and supporting contractors on changes to compliance and restoration program approaches and strategies in order to optimize programs performance. Provided recommendations on how to implement new approaches, strategies, and technological advances to minimize waste generation activities at the installations.

Senior Project Manager, Site 25 OU8 and Multiple Sites in OU5, OU 10 and OU 8 RI/FS, PP, ROD, IRAs RD, RA, RAO and LTM, AFCEE/AFCEC San Antonio, TX, Edwards Air Force Base, Edwards, CA, 2008-2011,

$ 10 M

Maintained client relationships, directed and oversaw environmental remediation program and project work to maintain high technical and high quality control standards. Managed, mentored and supervised program and project specific personnel. Participated in business development activities, including meetings, presentations, proposal preparation, and oversight. Directed and oversaw preparation of budgets, and monthly status reports. Conducted due diligence activities, contaminated site investigation, remediation, regulatory compliance, permitting, and storm water management. Directed, performed and oversaw work in regulatory compliance for landfills and other solid waste projects.

- At Edwards Air Force Base (EAFB) in California, worked with Environmental Restoration operations, including program and project specific components. Performed the Environmental Restoration Program, Planning, Budgeting and Execution. Assisted in developing cleanup strategies and participated in cleanup strategies negotiations with regulatory agencies. Developed engineering cost estimates and scope of works (SOW).

- Provided program and project management, engineering support, and technical assistance for the Operable Units (OUs), on complex, Comprehensive

Environmental Response, Compensation, and Liability Act (CERCLA), Resource Conservation Recovery Act (RCRA), Military Munitions Response Program (MMRP), Underground Storage Tank (UST) investigation, assessment, and remediation projects. Oversaw and performed technical reviews of Environmental Restoration documents.

- Reviewed new restoration and compliance mitigation technologies, and provided recommendations on how to implement restoration Research and Development (R&D) activities at Edwards AFB. Provided sub-consultants and subcontractors management and oversaw their performance via field surveillance activities. Served as a senior remedial project manager for OUs 5, 10 and OU8.

Remedial Project Manager, Multiple Sites in Multiple OUs RI/FS, PP, ROD, IRAs RD, RA, IRAs, RAO and LTM, NAVFAC SW and BRAC PMO West San Diego, CA, NWS Seal Beach Detachment Concord, CA, 2006-2008, $ 10 M

Served as client manager to direct and oversee environmental services program and project work to maintain high technical and high quality control standards. Participated in business development activities, including meetings, presentations, proposal preparation, and oversight. Managed and supervised program and project-specific staff personnel. Directed and oversaw preparation of budgets, and monthly status reports. Managed and mentored contract and task specific personnel and client(s). Interacted with regulators and clients to negotiate cleanup strategies and associated cleanup goals and objectives. Conducted due diligence assessments, contaminated site investigation, remediation, regulatory compliance, permitting, and storm water management. Directed, performed and oversaw work in regulatory compliance for landfills and other solid waste projects.

- Provided vision and direction as the Remedial Project Manager (RPM) at Naval Weapons Station Seal Beach Detachment Concord (NWSSB) Tidal and Inland Areas, in Concord, California.

- Assisted at Base Realignment and Closure Program Management Office (BRAC PMO West) in San Diego with the Installation Restoration Program/Environmental Restoration Program (IRP/ERP) Division operations by providing program and project management, engineering advisory support, and technical assistance on complex Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Resource Conservation Recovery Act (RCRA), Military Munitions Response Program (MMRP), and Underground Storage Tank (UST) investigation, assessment and remediation projects.

- Directed, oversaw, and performed technical reviews of IRP/ERP Remedial Investigation (RI), Feasibility Study (FS), Proposed Plan (PP), Record of Decision (ROD), Remedial Design (RD), Remedial Action (RA), Operations and Maintenance (O&M), Remedial Process Optimization (RPO), and Long Term Monitoring/Management (LTM) documents. Managed and provided oversight of the IRP/ERP contractors during the performance of field investigations, treatability and/or feasibility studies, remediation design and system optimization, remedial action, and long term management activities under CERCLA, RCRA, MMRP, and LUFT programs.

- Interacted with the regulatory Remedial Project Managers (RPMs), Restoration Advisory Board (RAB) members and other stakeholders during the program and project management planning and execution meetings and activities. Developed engineering cost estimates and scope of works (SOW).

Senior Remediation Project Manager, OU4 and OU 9 AFRL RI/FS, PP, ROD, IRAs RD, RA, RAO and LTM, AFCEE/AFCEC San, AFCCE San Antonio, TX, Edwards AFB, Edwards, CA, 2000-2006, $ 30 M

Worked with Environmental Restoration Division (ERD) operations by providing program and project management, engineering support, and technical assistance for the Operable Units (OUs 4 & 9), on complex Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Resource Conservation Recovery Act (RCRA), Munitions Response Program (MRP), and Underground Storage Tank (UST) investigation and remediation projects. Reviewed new restoration technologies, and provided recommendations on how to implement restoration Research and Development (R & D) at Edwards AFB. Developed engineering scope of works and cost estimates.

- Advised ERD on changes to technical documents to avoid receiving similar comments from the regulatory agencies and other reviewers. Provided surveillance of ERP contractors during the performance of field investigations, treatability and/or feasibility studies, remediation systems implementation, maintenance, operation, remedial systems optimization, and long term monitoring activities.

- Assisted ERD team in developing multiple risk based cleanup strategies leading to multi million dollars in remediation cost avoidance. Maintained and assimilated detailed technical information for tracking progress and efficiency of ERP projects. Performed remedial action (RACER) cost estimates. Prepared OU4 and 9 project funding narratives and associated cost estimates.

Project Manager, Multiple Private and Government Clients, Los Angeles, CA, 1997 – 2000, $ 12 M

Responsible for project management, client relations, and interaction with Federal, State, and local regulatory agencies to meet all requirements associated with hazardous waste removal, treatment, and remediation. Assisted with business development activities, proposal preparation, estimates, bids and maintained cost controls, community and client relations. Won multiple bids and contributed to a company gross revenue increase. Served as project manager and task (TO) and/or DO manager on a variety of private and government projects. Met with clients on a regular basis to provide updates regarding status of the projects and discuss scope of work of the projects.

- Directed, oversaw and performed technical review of documents that involved site investigations (RI/FS), remedial design and implementation (RD/RA), and Long Term Operation/Long Term Monitoring (LTO/LTM) associated with soil and groundwater remediation systems. Managed and oversaw development of work plans, remedial investigations, engineering design and remediation to comply with CERCLA, RCRA and LUFT laws, guidelines and regulations. Supervised, trained and mentored staff geologists, engineers and technicians.

Vice President Engineering, Multiple Private and Government Clients and Projects, Schaumburg IL, and Newport Beach, CA, 1993-1997, $ 10 M

Acted in charge of P&L and overall financial performance of the RMC

Schaumburg, Illinois office. Involved in development and implementation of strategic plans to establish and grow the business in Midwest and Europe. Directed and conducted marketing and business development activities to identify new domestic and international opportunities. Oversaw and participated in domestic and international contract, teaming and joint venture partnering activities and negotiations. Established an office for the environmental services consulting company in Midwest.

- Managed, mentored and supervised program and project specific RMC personnel in Schaumburg, Illinois office. Participated in business development activities. Acted as program account manager and client(s) representative/liaison during program and project execution activities, and negotiations with regulatory agencies.
- Managed and prepared business development proposals and cost estimates for the removal and treatment of contaminated soil and groundwater. Managed and oversaw the assessment of contaminant extent and design of soil and groundwater remediation systems. Directed and oversaw preparation of hydrogeological and engineering reports to ensure technical quality and thoroughness.

Project Engineer/Project Manager, Multiple Private and Government Clients and Projects San Mateo, CA, 1989 – 1993,

$ 5.0 M

Served as project engineer and project manager and worked on private sector NPL, CERCLA and RCRA investigation and remediation projects such as industrial and landfill facilities. Prepared hydrogeological, design and remediation engineering reports. Reviewed and prepared applications for the NPDES permits. Planned and performed hazardous waste investigations, design and remediation under CERCLA, RCRA and LUFT regulations. Prepared landfill cap and liner design, closure and post closure reports. Participated and assisted in business development activities including meetings, presentations and proposal preparation. Evaluated NPL site investigation and remediation decision documents (RI/FS) to identify data gaps relating to selection, design and implementation of future potential remedies.

- Directed and prepared conceptual remedial and corrective action plans (RAPs and CAPs), engineering design, and construction plans and specifications. Investigated, selected and implemented RCRA corrective action programs associated with hazardous waste management facilities.

- Investigated and designed Class I surface impoundments and landfills meeting RCRA minimum standards. Developed surface impoundments and landfill cap and liner design and implemented closure and post closure plans.

Staff Engineer/Hydrogeologist, NPL Site Former Firestone Plant Salinas, CA, 1986-1989, $ 2.0 M

Worked as staff engineer and hydrogeologist on a National Priority List (NPL) site in Salinas, CA. The site was a former Firestone Site (Superfund Project). The project included additional site assessment, remedial design, remediation construction and site remediation, O&M, and LTO/LTM associated with a large full scale pump and treat system (800 gpm).

- Conducted pump tests for different types of aquifers, data analysis due to pumping tests and evaluation of hydrogeological characteristics for shallow and deep aquifers. Prepared technical hydrogeological and engineering reports.

- Performed data analysis of hydrological, hydrogeological and geotechnical parameters of the aquifers affecting groundwater and well hydraulics, their planning, design and construction. Evaluated groundwater flow directions, shallow and deep aquifers contour maps. Performed soil, treatment plant, surface and groundwater sampling.

Derek Lieberman, PE

Senior Project Manager/Regulatory Specialist

EDUCATION

MA, Science, Technology, and Public Policy, The George Washington University Elliott School of International Affairs, 2002

Master of Environmental Management, Yale University, School of Forestry and Environmental Studies, 2000

BS, Engineering (Geological Engineering), Purdue University, 1989

REGISTRATIONS

Professional Engineer, Civil Engineering, California #C57417

Qualified SWPPP Developer/Practitioner (QSD/QSP) CA#20527

CERTIFICATIONS, LICENSES, TRAINING

40-Hour HAZWOPER

8-Hour HAZWOPER Refresher

Supervisory Hazardous Substances/Waste Health and Safety, 1994

Health and Safety Training and Field Experience for Hazardous Materials Operations, 1994

U.S. Army CHPPM Advanced Health Risk Communication Training, 2004

Defensive Driving Techniques, 2010

Confined Spaces, 1992

OSHA 30-hour Construction Safety, 2013

DOT Hazmat Employee, 2013

USACE Construction Quality Management for Contractors, 2011

WORK HISTORY

Ahtna Environmental Inc., Senior Project Manager, 2015 – present

Ahtna Engineering Services, LLC, Senior Project Manager,

EXPERIENCE SUMMARY

- 23 years of engineering experience in environmental remediation services (ERS), including soil, soil gas and groundwater remediation, CERCLA (as amended by SARA)/RCRA/BRAC sites, and geotechnical investigation, design and construction oversight
- 13 years of experience managing the preparation of analytical and descriptive reports and property transfer documentation
- 12 years of experience in Community Relations, delivering presentations on behalf of the U.S. Army regarding the status of the groundwater remediation program at the former Fort Ord at the U.S. Army's Community Involvement Workshops, Technical Review Committee meetings, Open House events
- 10 years of experience managing operations and maintenance (O&M) of full scale groundwater treatment systems (GWTS) and soil vapor extraction and treatment systems (SVETS), including system optimization and QC oversight of construction, documentation and environmental sampling
- In-depth experience with the CERCLA process, including development of Decision Documents and use of EPA's Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents
- Commended by Gail Youngblood, BRAC Environmental Coordinator: "No listing of Ahtna's personnel would be complete without Derek Lieberman, whose breadth of knowledge about remediation systems, Fort Ord history, and the ins-and-outs of transferring property have helped Fort Ord reach the point of having transferred the vast majority of property available for redevelopment."

PROJECT EXPERIENCE

Director, Environmental Services, Former Fort Ord, Multiple Consecutive USACE Sacramento and Albuquerque Districts, Marina, CA, 2008-present, $10M

Manage seven environmental technical onsite staff performing FFP ERS, including development of hazardous materials business plans (HMBP), remedial system construction and O&M, reporting, preparation of CERCLA documents and UFP-QAPPs. Provide expertise on CERCLA/RCRA issues. Update the HMBP describing procedures for emergency response for hazardous materials (sulfuric acid and compressed helium) stored at the groundwater treatment plants (GWTP) in accordance with the requirements of the local California Certified Unified Program Agency. Maintain hazmat storage facilities in compliance with laws/regulations and received no notices of violation (NOVs). Participate in regular meetings with the U.S. Army Environmental Command (AEC), USACE, regulatory agencies and the public to provide technical and regulatory expertise on ERS in accordance with CERCLA/RCRA.

Project Manager, O&M of GWTS and SVETS, Former Fort Ord, Multiple Consecutive USACE Sacramento, Marina, CA, 2007-present, $20M (multiple consecutive awards)

2007 – 2015

J.M. Waller Associates, Inc., Senior Environmental Compliance Specialist, 2003 – 2007

U.S. Department of Agriculture, Economist, 2001 – 2003

The Tahoe-Baikal Institute, Environmental Exchange Participant, 2000

Harding Lawson Associates (now Amec Foster Wheeler), Project Engineer, 1991 – 1999

Herzog Associates (now defunct), Assistant Engineer, 1989 – 1991

Direct O&M of two GWTS, which include 32 extraction wells, 4 injection wells and 4 infiltration galleries, and one SVETS, which includes 10 extraction wells. All three systems use granular activated carbon (GAC) as the primary treatment technology for VOCs. Prepare and review programmatic documents, including project management plan, O&M manuals, project schedule, UFP-QAPPs, and site-specific Accident Prevention Plan (APP). Directed construction and commissioning of automated sampling and analytical platforms, including integration w/SCADA system to allow real-time automated decision-making for GWTS operations. Develop all work plans, QC/safety plans. Monitor productivity, cost/schedule and provide progress reports. Oversee implementation of USACE three-phase inspection process for ERS and remedial system construction. Perform data validation, database management, and reporting, which includes quarterly O&M status and monitoring summary reports, and an annual effectiveness evaluation report. Manage accumulation, manifesting and shipment of wastes in the form of spent GAC.

- Successfully operated both GWTS at over 99% cumulative operability since 2007
- As of December 2015, treated over 8.5 billion gallons of contaminated groundwater while maintaining plume capture; discharged treated water per CWA requirements with no NOVs
- Successfully operated the SVETS at over 99% cumulative operability since startup in September 2015
- Discharged treated air per CAA requirements with no NOVs

Project Manager, O&M of Landfills and Landfill Gas Extraction and Treatment System, Former Fort Ord, USACE Sacramento, Marina, CA, 2015-present

Direct O&M of five landfill areas and a landfill gas (LFG) extraction and treatment system, which includes 35 extraction wells, LFG collector pipes, and a thermal treatment unit (TTU) as the primary treatment technology for methane and VOCs. Prepare and review programmatic documents, including O&M manual, project schedule, UFP-QAPP, and site-specific APP. Develop all work plans, QC/safety plans. Monitor productivity, cost/schedule and provide progress reports. Oversee implementation of USACE three-phase inspection process for O&M activities. Perform data validation, database management, and reporting, which includes monthly O&M status and LFG monitoring reports, and an annual O&M and regulatory compliance monitoring report.

- Successfully operated the TTU at over 99% cumulative operability since September 2015
- Discharged treated LFG per CAA requirements with no NOVs
- Successfully managed LFG in compliance with California Code of Regulations Title 27

Senior Environmental Engineer, Optimization of GWTS and SVETS, Former Fort Ord, Multiple Consecutive USACE Sacramento Environmental Services Contracts, Marina, CA, 2007-present

Provide engineering and regulatory expertise to identify cost-saving measures to be implemented at the GWTS (e.g., waste minimization and waste management). Evaluate quarterly analytical and operational data and modify GWTS and SVETS operational parameters accordingly (e.g., extraction wells were operated based on specific decision rule criteria). Employ groundwater modeling to evaluate GWTS effectiveness and capture analysis to optimize the operation of extraction and injection wells. Evaluate new technologies for potential application to the GWTS and SVETS. Present optimization recommendations to the USACE for implementation with regulatory agency approval.

- Optimized GWTS operations through decision rules that maximize GAC lifecycle, confirm plume capture and remediation progress, and significantly reduce sampling frequency
- When an air stripper was installed as a polishing step after GAC treatment at the Sites 2 and 12 (2/12) GWTP, determined the air stripper effectively treated specific contaminants that were not efficiently treated by GAC. This allows for continuous operation until the GAC capacity is maximized for trichloroethene (TCE), the primary chemical of concern at Sites 2/12, reducing the need for GAC change-outs from once every 8-12 weeks to once every 19-23 months; decision rules were approved by regulatory agencies and subsequently modified and applied by other contractors at the former Fort Ord
- Performed a cost benefit analysis to determine the feasibility of relocating the Operable Unit 2 (OU2) GWTP to an area with the highest concentrations of contaminants in groundwater; determined that moving the GWTP in combination with installing new extraction wells and groundwater recharge structures would reduce the time to achieve remedial action objectives by 10 years, thereby reducing costs by almost 50% over the life of the project; based on these findings, the Army is proceeding with the project

Project Manager/Environmental Engineer, Installation of Monitoring Wells, Former Fort Ord, USACE Sacramento, Marina, CA, 2010-2011, $1.6M

Designed and executed the installation of 11 monitoring wells up to 450 feet deep in support of a monitored natural attenuation groundwater remedy in a deep aquifer. Developed a well installation work plan that included a SAP and an Environmental Protection Plan to address well installation in protected habitat areas that include several federally listed species and species of concern. Implemented a high level of quality control through all phases of well construction, including determining well locations, borehole logging, well design by a registered professional hydrogeologist, well casing and screen installation, well development, and installation of the Westbay sampling system. Coordinated all work with multiple stakeholders including: the Fort Ord BRAC Office Biologist to minimize impact to protected habitat; the Army to avoid impact to residential neighborhoods, and the municipality, airport staff, and the Federal Aviation Administration to avoid impact to airport operations.

- Completed the project three months ahead of schedule, and with no impact to residents, airport operations, or critical habitat

(of the 11 wells, two are located in the habitat area, four in residential areas, and one at an airport)

- Successfully worked with the Army, regulatory agencies and University of California (habitat reserve managers) to complete the work plans and obtain the necessary permits to allow work to start the first week of December, complying with the Army's request to start drilling no later than December to avoid impact to protected plant species (the growing season for sand gilia and Monterey spine flower is approximately December through May)

Project Manager, Groundwater Monitoring Program, Former Fort Ord, USACE Sacramento, Marina, CA, 2010-present, $900K

Manage quarterly groundwater sampling at over 150 wells on the former Fort Ord using passive diffusion bag samplers (PDS), the Westbay sampling system, and HydraSleeves. Analyze groundwater samples for organic and inorganic compounds in accordance with the approved Quality Assurance Project Plan (QAPP). Measure and record water level elevations with respect to established survey control points. Use data to optimize GWTS operations.

Project Manager, Soil Gas Investigation and Vapor Intrusion Analysis, Former Fort Ord, USACE Sacramento, Marina, CA, 2008-2009, $30K

Developed a work plan, SAP, and Activity Hazard Analysis to conduct a soil gas investigation within an area proposed for residential development at the former Fort Ord. Used the investigation data to perform a screening level assessment of the vapor intrusion pathway using DoD guidance documents (Tri-Services Handbook for the Assessment of the Vapor Intrusion Pathway) and the DTSC Human and Ecological Risk Division (HERD) version of the EPA Vapor Intrusion (Johnson and Ettinger [J&E]) Model (HERD Model), which contains the toxicity criteria acceptable to the DTSC. Based on the analytical and HERD Model results, the site passed a site-specific J&E evaluation; therefore, no further consideration for indoor air risk was necessary and the site continues to meet No Action conditions.

Community Relations Specialist, Former Fort Ord, USACE Sacramento, Marina, CA, 2004-present, $250K (multiple awards)

As a recognized subject matter expert with effective communication skills, provide community relations representation on behalf of the U.S. Army for environmental work at former Fort Ord. Deliver presentations regarding the status of the groundwater remediation program at the former Fort Ord to the public at the Army's Community Involvement Workshops (CIW), Technical Review Committee (TRC) meetings, and Open House events.

Environmental Compliance Manager, Property Transfer, Former Fort Ord, USACE Sacramento, Marina, CA, 2003-present, $450K (multiple awards)

Provide technical support to U.S. Army BRAC Fort Ord Office for property transfer documentation including producing reports and documents, and responding to regulatory agency and public comments concerning property transfer and real estate issues as they relate to the environmental remediation program. Draft deeds for transfer of former Fort Ord property in accordance with the Army's Model Deed and the Department of Defense Instruction Number 4165.72. Provide technical support for USACE legal review of the deeds including preparing or reviewing draft deed revisions and memorandums, coordinating receipt of legal descriptions and other deed exhibits, responding to comments and questions from USACE and property recipients regarding environmental and technical components of the deed, and tracking the progress of deed execution and recordation. With expertise in institutional controls for real estate transactions, prepare and coordinate Covenants to Restrict Use of Property (CRUPs) to be executed by the Army and the State of California for application and enforcement of land use controls on former Fort Ord property. Prepare documentation required to obtain RCRA Corrective Action Complete Determination (CACD) from DTSC for all transferred property where remedial action is complete.

- Completed Findings of Suitability to Transfer (FOST) in accordance with the Army's Model FOST for former Fort Ord property impacted by munitions and explosives of concern (MEC)
- Due to the policy complexities associated with MEC at CERCLA sites, participated in successful negotiations between the Army's Environmental Law Division and Office of General Counsel, EPA and DTSC to resolve issues pertaining to the environmental condition of the property and the appropriate section of CERCLA under which the transfer should occur
- Reviewed and commented on land use control implementation plans (LUCIPs) for munitions response areas (MRAs) at the former Fort Ord, which ensured conformity between the LUCIP and the requirements of the deed under CERCLA
- Established the procedure for issuing the CERCLA Warranty for early transfer property where CERCLA remedial actions are complete

Environmental Compliance Manager, CERCLA Decision Documents, Former Fort Ord, USACE Sacramento, Marina, CA, 2006-2010

Completed two Explanations of Significant Differences (ESDs) to the Operable Unit 1 (OU1) ROD and the OU2 ROD at the former Fort Ord. Successfully coordinated with the regulatory agencies and obtained signatures from all the parties on behalf of the Army. The OU2 ESD was particularly complex and addressed several areas of concern, including MEC, mitigation of landfill gas, Corrective Action Management Unit (CAMU) requirements for a landfill, and use of treated groundwater for construction purposes. Participated in the review process for several RODs and ROD Amendments.

Project Manager, Remedial Investigation/Feasibility Study (RI/FS) Addendum at Sites 2/12, Former Fort Ord, USACE Sacramento, Marina, CA, $1.2M, 2013-2014

Manage $1.2M project to determine the magnitude and extent of PCE and TCE contamination in soil, soil gas, groundwater, and indoor air. Developed and implemented detailed RI/FS work plan to meet the client's aggressive schedule, which included a significant community relations effort to address the concerns of the property owners and 11 retailers located within the project site (Target, Kohl's, Old Navy, Recreational Equipment, Inc., etc.), and to coordinate field work to ensure minimal impact to daily retail operations. Designed and implemented remedial investigation; designed and constructed a soil vapor extraction (SVE) and air sparge (AS) pilot treatability study, and developed a RI/FS Addendum report.

- Eliminated offsite disposal of waste – solid IDW transferred to onsite OU2 Landfills for reuse as landfill cover, liquid IDW treated at the onsite GWTS
- Scheduled the SVE/AS pilot study as "proveout" study ahead of the RI/FS report, based on 10+ years of experience at the former Fort Ord including previous use of SVE at other former Fort Ord locations, thereby completing the project four months ahead of schedule
- Completed extensive indoor air and sub-slab sampling program without disruption to retail operations; received no complaints from property owners, retail managers or customers
- Based on RI results, determined there was no unacceptable risk to human health due to vapor intrusion, but additional remedial action was appropriate to protect groundwater from contaminants found in soil gas

Project Manager, Groundwater Remedy Addendum at Sites 2/12, Former Fort Ord, USACE Sacramento, Marina, CA, 2015, $1.2M

Based on the results of the RI/FS Addendum, prepared an ESD to the Remedial Investigation Sites ROD to include soil vapor extraction and treatment as part of the Sites 2/12 groundwater remedy to prevent partitioning of contaminants between soil gas and groundwater. Managed $1.2M project to construct and operate the SVETS and one additional groundwater extraction well. Developed and implemented detailed remedial action work plan to meet the client's aggressive schedule, which included a significant community relations effort to address the concerns of the property owners and 11 retailers located within the project site (Target, Kohl's, Old Navy, Recreational Equipment, Inc., etc.), and to coordinate field work to ensure minimal impact to daily retail operations. Developed an O&M manual based on construction and start-up/shakedown activities.

Qualified SWPPP Developer (QSD), Multiple federal and commercial clients, Marina, CA

In compliance with CWA requirements, develop storm water pollution prevention plans (SWPPPs) for federal facilities and private utility sites throughout California. QSD of record for over a dozen projects. Select and design Best Management Practices (BMPs). Developed an implementation plan and related cost estimate for the execution of the new storm water management program at the Presidio of Monterey (POM) and Ord Military Community (OMC) in accordance with the Phase II Small Municipal Separate Storm Sewer Systems (MS4) General Permit (California State Water Resources Control Board [SWRCB] Order No. 2013-0001 DWQ) and applicable SWRCB guidance.

Quality Control Engineer, Fort Hunter Liggett Building 194 Groundwater Monitoring and Reporting, USACE Sacramento, Fort

Hunter Liggett, CA, $285K (multiple task orders)

Provide senior level quality control review for quarterly groundwater sampling and analysis, data validation, waste management, well maintenance, quarterly groundwater monitoring reports, and annual groundwater monitoring report. Ensure regulatory compliance and technical accuracy.

Quality Control Engineer, Fort Hunter Liggett Building 258 Soil Vapor Extraction System Operations and Maintenance, USACE Sacramento, Fort Hunter Liggett, CA, 2010-2011, $478K

Provide senior level quality control review, ensuring regulatory compliance and technical accuracy of all documents for a project involving vadose zone hydro-carbon remediation at the Building 258 Area using SVE technology. Reviewed Remedial Action Work Plan detailing the SVE system requirements for installation, start-up, and shakedown, and semi-annual treatment system monitoring reports.

Quality Control Engineer, Operations and Maintenance of Fort Hunter Liggett Landfill, USACE Sacramento, Fort Hunter Liggett, CA, 2010-2012, $109K

Provide senior level quality control review, ensuring regulatory compliance and technical accuracy of all documents for a project involving the O&M of Landfill #1, including semiannual groundwater monitoring, landfill gas monitoring, laboratory analysis, data validation, waste management, reporting, well maintenance, and landfill cover inspections.

Quality Control Engineer, O&M of Riverbank Army Ammunition Plant, USACE Sacramento, Riverbank, CA, 2007-2012, $4M

Support the O&M for the RBAAP GWTP and quarterly groundwater monitoring. Provide QC and technical and regulatory compliance oversight for O&M of groundwater treatment facilities, a closed landfill, and associated reporting and documentation.

Quality Control Engineer and Regulatory Specialist, RCRA Hazardous Waste Facility Permit Closure, Riverbank Army Ammunition Plant, USACE Sacramento, Riverbank, CA, 2011-2013, $4M

Provide QC and technical and regulatory compliance oversight during preparation of closure plans, QAPP, and closure certification reports, and decommissioning activities for 13 hazardous waste management units.

Senior Environmental Compliance Specialist, Fort Ord Office, U.S. Army Base Realignment and Closure, J.M. Waller Associates, Inc., College Park, GA, 2003-2006

Worked with the BRAC Environmental Coordinator (BEC), USACE, contractors, and regulatory agencies to ensure requirements were met for environmental cleanup actions for contaminated soil and groundwater at the former Fort Ord. Monitored and modified project schedules and ensured specifications of the Federal Facility Agreement, CERCLA, RCRA, and applicable or relevant and appropriate requirements (ARARs) were met. Ensured actions were cost-effective and efficient, as well as protective of human health and the environment. Met with and presented information to community groups, local government officials, and others as requested by the BEC.

- Successfully completed and obtained regulatory approval of four FOSTs, two Findings of Suitability for Early Transfer (FOSETs), two Findings of Suitability to Lease (FOSLs), and 24 CRUPs leading to the transfer of more than 8,000 acres of property
- Coordinated with USACE to support production of deeds for transfer of property; reviewed and commented on draft deeds and provided technical support
- Initiated request and compiled all documentation for DTSC RCRA corrective action complete determinations
- Provided technical support for completion of a Covenant Deferral Request (CDR) for early transfer of property
- Initiated development of a land use control (LUC) database for LUCs for use in drafting LUC Implementation Plans
- Coordinated with property recipients to resolve post-transfer issues related to the environmental condition of the property
- Achieved regulatory closure of RCRA hazardous waste facility

Economist, U.S. Department of Agriculture, Foreign Agricultural Service, Commodity and Marketing Programs, Forest and Fishery Products Division, Washington, DC , 2001 - 2003

Assisted industry associations to develop and maintain export markets for U.S. forest and fishery products via a Unified Export Strategy. Analyzed markets for U.S. forest products in North America, Europe, and Oceania. Assessed impact of trade agreements and environmental reviews on U.S. forest products exports. Assessed causes and consequences of illegal logging and timber trade. Analyzed market trends for exports of U.S. forest and fishery products for development of a Global Marketing Strategy. Wrote briefing papers for each of the top 15 states in seafood industry production for use in presentations and speeches by USDA personnel.

Environmental Exchange Participant, Lake Baikal, Russia and Lake Tahoe, United States, Tahoe-Baikal Institute, South Lake Tahoe, CA, 2000

Studied natural and cultural histories and current environmental problems and policies related to the respective limnological systems through contact with government agencies, non-government organizations, and citizens. Performed volunteer work for multiple water quality improvement projects at both lakes:

- Site Restoration in the village of Khuzhir on Olkhon Island in Lake Baikal: Worked on the U.S. Agency for International Development (USAID)-funded restoration of Shaman’s Cape, a Buryat sacred site. Work focused on an area once encompassed by a Soviet-era petroleum fueling and storage facility. Provided manual labor and made recommendations to project leaders for site restoration. Utilized engineering experience to plan and implement interim erosion control measures to mitigate shoreline degradation and migration of contaminated silt and storm runoff to the lake.
- Land-use Planning -- Environmental Assessments on Olkhon

Island: Worked with researcher from the Institute of Geography of Irkutsk, Siberian Branch of the Russian Academy of Sciences to assess anthropogenic impact on wildlife areas. Proposed policies for future land use, management of wildlife protection, recreational activities, and waste disposal to be incorporated into national park zoning plan.

- Stream Restoration: Worked with California Tahoe Conservancy on stream restoration project for Cold Creek, a tributary to Lake Tahoe. Native vegetation was transplanted into areas degraded by livestock activity along a one-mile section of stream.
- Environmental Policy and Natural Resource Management: Evaluated impact of wild horses and domestic livestock grazing in the South Lake Tahoe watershed and Great Basin by observing wild horses and range areas, interviewing experts, including Bureau of Land Management (BLM) officials and ranchers, and performing research regarding wild horses. Completed a report, including policy recommendations, for the Animal Legal Defense Fund, BLM, U.S. Forest Service, and members of U.S. Congress.

Project Engineer, Harding Lawson Associates (now AMEC), Petaluma, CA, 1991 - 1999

Managed field offices, coordinated and supervised trainees, engineering technicians, staff engineers, and scientists in environmental sampling and investigation work. Developed and implemented health & safety and work plans. Conducted QA/QC programs for hazardous materials/waste investigations. Performed feasibility studies and remedial actions on civilian, military and Superfund projects, including: lead abatement in former military small arms ranges in coastal sand dunes; hexavalent chromium abatement in former military pickling and plating facility; decommissioning of sewage treatment plants and tank farms; sampling and analysis of discharge from shoreline storm drain outfalls; monitoring and remediation of contaminated groundwater; sampling and remediation of contaminated dredge material. Performed O&M of remedial systems, including soil vapor extraction, bioremediation, and groundwater treatment facilities utilizing granular activated carbon and ultraviolet light oxidation/reduction. Supervised trainees, engineering technicians, staff engineers, and scientists in the same. Successfully operated systems with minimal down time. Devised and proposed expansion of groundwater treatment system. Supervised general laborers and heavy equipment operators in construction of remedial systems. Consistently completed projects on time and within budget. As site project manager, acted as liaison to clients, regulatory agencies, the public, and the media; interpreted data and wrote project status reports and proposals; and gave presentations to prospective clients. Conducted Phase I and Phase II site assessments; supervised drilling crews for installation of exploratory borings and monitoring and extraction wells; logged and sampled borings; conducted soil gas surveys; developed and sampled wells; and performed construction and remedial action oversight.

Assistant Engineer, Herzog Associates, Petaluma, CA, 1989 - 1991

Observed and tested geotechnical related construction, including earthwork, grading, paving, and foundation installations for commercial and residential projects to confirm conformance to plans and specifications. Wrote proposals, reports, and plan reviews; drafted site plans and detailed specifications; and designed street and parking lot pavements and building foundations. As Radiation Safety Officer, devised and implemented state compliant program for and oversaw use of nuclear testing equipment.

Ahtna

Christopher Ohland

Senior Program Chemist

EDUCATION

BS, Water Chemistry,
University of Wisconsin, 1985

CERTIFICATIONS, LICENSES, TRAINING

40-hour HAZWOPER, 1988

8-Hour HAZWOPER Refresher, 2015

Blood-borne Pathogens, 1998

Confined Spaces, 1996

DOT Hazmat Employee, 2013

RCRA Statistics, 1992

Supervisory Hazardous Substances/Waste Health and Safety, 1988

USACE Construction Quality Management for Contractors, 2015

WORK HISTORY

Ahtna Environmental, Inc.
Senior Program Chemist, 2015 – Present

E-Data, Inc.

Technical Director, 2009 – 2015

Sullivan International, Inc.
Project Manager / Program Chemist, 2007 – 2009

OTIE, Inc.
Project Manager / Program Chemist, 1998 – 2007

Katalyst Analytical Technologies, Inc.
Operations Director, 1996 – 1998

CH2M Hill, Inc.
Senior Project Scientist, 1988 – 1996

Hazleton Laboratory America
Senior Project Scientist, 1985 – 1988

EXPERIENCE SUMMARY

- Over 27 years of experience in environmental investigation and remediation programs for government/DoD, state, and commercial clients
- 19 years of experience as Project Manager directing site assessments; remedial investigations; feasibility studies; risk assessments; long-term operations and management; remedial actions; regulatory agency interaction and negotiations; community involvement programs
- Technical expertise in environmental chemistry, data management, meteorological and perimeter air quality, natural attenuation, soil vapor and indoor air monitoring, multi-media sampling methods, quality assurance, and quality control

WORK EXPERIENCE

Ahtna Environmental Inc. – Pleasant Hill, CA Senior Program Chemist

Oversight of corporate laboratory programs, third-party quality assurance/quality control (QA/QC) reviews, and analytical chemistry consulting services to industrial clients and environmental science and engineering firms.

E-Data Inc. – San Francisco, CA Technical Director

Oversight of corporate laboratory programs, third-party quality assurance/quality control (QA/QC) reviews, and analytical chemistry consulting services to industrial clients and environmental science and engineering firms.

Typical tasks include: develop chemistry programs, perform laboratory data validation, define data quality objectives, complete QA/QC project plans, write SOPs, train employees in proper field sampling protocol and documentation, and perform ongoing QC audits of sample collection and handling activities and contracted laboratory vendors. Used MS Access to import various electronic data (SEDDs, ERPIMS, EQuIS, others), evaluate, report, and export large datasets.

Sullivan – San Francisco, CA Project Manager / Program Chemist
Served as USACE and Navy Program Chemist with firm-wide oversight of task-level associates that wrote sampling and analysis plans, quality assurance plans (UFP-QAPP), performed sampling and chemical testing, managed laboratory vendors, reviewed chemical data, and validated data with ADR.net.

Managed 16 ongoing environmental projects valued at $2.4M that were completed on time and profitable. Projects included: fuel spills investigations, hotspots assessments, sediment/soil/groundwater investigations, skeet debris removal, and soil gas and vapor intrusion studies.

Proposal and deputy program manager for USEPA Region 9 and USACE Sacramento District direct awards. Successful as proposal manager and interim program manager for awards with USEPA

Region 9 ($1M direct award and $3.5M small biz award), USACE-Omaha ($1M MATOC task order); and USEPA Region 2 ($10M Small Business RAC IDIQ). Developed project scope through carefully written specification statements to limit contract liability and establish a fair price. Developed cost and schedule estimates, managed risk registers, wrote technical specifications, and assigned staff resources for projects.

OTIE, Inc. – Project Manager / Program Chemist

Technical lead for environmental chemistry programs and data management using in-house database management tools. Responsible for growing the environmental chemistry practice, maintaining high quality standards and efficient work processes, training and mentoring the team, providing senior technical support, working to create external visibility, while building the client portfolio.

Extensive experience in preparation and peer review of field sampling plans and data quality objectives to ensure effective and appropriate data collection along with other quality-related tasks, including field and laboratory auditing and training, writing technical specifications and standard operating procedures (SOPs), providing QA/QC and health and safety orientation, document preparation, data quality assessments, data validation of analytical laboratory data, data management, technical support, and senior document review. Identified innovative solutions to streamline work flow processes resulting in reduced levels of labor effort, budget and schedule improvements, and increased access to innovative technology.

Project management of more than 30 projects valued between $25K and $1M. In this role, collaborated with project stakeholders, developed scope of work, wrote work plans, established budgets and schedule, staffing plans, QA/QC plans, and risk management plans; monitoring progress of project and providing technical direction and resources to project team, and managing project scope.

Brief list of extraordinary personal accomplishments:

- Knowledge of USEPA terminology and requirements for environmental chemistry programs was a key advantage to winning the firm’s first USEPA Region 9 contract
- Expert testimony led to two successful subcontractor litigations
- Grew the environmental chemistry team from a single office to a nationwide team of highly qualified chemists and data managers
- Collected, chemically tested, and managed data for 900 multimedia samples for off-site chemical analysis and 3,000 soil samples for onsite analysis during a 3 month remedial action
- Developed a perimeter air monitoring program with real-time data acquisition and reporting that allowed sediment remediation work to proceed without a single fence line non-compliance

- Designed a soil bio-pile treatability study resulting in remediation of fuel contaminated soil and onsite reuse at base landfill; successfully eliminating all offsite transportation and disposal costs
- Performed a PA/SA for 91 listed areas at Dare County Bombing Range and successfully negotiated 86 no action determinations and reducing remediation cost by 85%

Katalyst Analytical Laboratory, Inc. - Laboratory Operations Director

Manage the overall financial and technical aspects of the laboratory operations while maintaining corporate profit goals. Responsibilities include all data reported by the laboratory, personnel management, environmental consulting, public relations and financial support and management. Review the operations of each reporting function on a regular basis and support the development and implementation of the quality control program to maintain an excellent reputation in the environmental field.

CH2M Hill, Inc. - Sr. Project Scientist.

Skilled in the sampling of multimedia environmental samples (air, water, soil, waste, unknown material), chain-of-custody documentation, packing and shipping hazardous materials, data interpretation and reporting, and regulatory agency notification. Authored various documents and work plans including activities memorandums, field sampling and analysis plans, quality assurance project plans, health and safety plans, spill containment plans, and sections of investigation reports. Setup and operated mobile laboratories for general chemistry, GC, HPLC, and XRF instrumentation.

Hazleton Laboratory America, Inc. – *Project Scientist*

As a project scientist in the Environmental Fate, Metabolism, and Transport department responsible for laboratory procedures used to quantify pesticide degradation using various pathways such as soil metabolism, soil and aqueous photolysis, hydrolysis, column leaching, and volatility. Trained in the safe use of radiological isotopes.

Eric Schmidt

Chemist

EDUCATION

M.S., Environmental Science and Engineering, Contaminant Hydrology Focus, Oregon Graduate Institute, 1993

B.S., Biochemistry, University of California, Davis, 1986

TRAINING

40-Hour HAZWOPER

ERPIMS Training course, 2013

QSP/QSD Training course, 2012

Microsoft elearning SQL Server 2005 coursework, 2010

Geographic Information Systems, San Francisco State University, 2002

Stream Habitat Restoration Course, CDFG, 1995

Database: MS Access, SSMS, Oracle

Programming: VBA, C, FORTRAN, Javascript, HTML

WORK HISTORY

Ahtna Environmental, Marina, CA, Senior Environmental Project Manager, 2015-Present

Chicago, Bridge, and Iron Federal Services, IMS Analyst III, 2013 – 2015

Shaw Environmental, Scientist III, 2003 – 2013

International Technologies Corporation, Project Chemist, 1997 – 2003

Woodward Clyde Consultants, Project Chemist, 1995 – 1997

Law Crandall Associates, Project Chemist, 1994-1995

Kuparuk Industrial Center Laboratory, Chemist, 1990 – 1992

Chemical and Geological Laboratories of Alaska,

EXPERIENCE SUMMARY

- 21 years of experience as a Project Chemist for multiple environmental investigation and remediation DoD/Army CERCLA sites
- 20 years of experience performing environmental data management, and programming
- 27 years of field sampling of multiple media including soil, ambient air, indoor air, landfill gas, soil vapor, surface water, vernal pools, groundwater, and landfill leachate.
- Document Development: Primary or co-author in documents that include Quality Control Summary Reports, Work Plans, Technical Memorandums and Reports, Quarterly and Annual Reports, Closure Reports, Uniform Federal Policy Quality Assurance Project Plans (UFP-QAPP), Sampling and Analysis Plans, Chemical Data Quality Management Plans, and Environmental Protection Plans

PROJECT EXPERIENCE

Project Chemist/Senior Scientist, Former Fort Ord, Presidio of Monterey, CA, 9/97 - present

Management of subcontracted laboratories and third party data validation using Automated Data Review (ADR) software; Development of project specific ADR libraries; Gas/Soil/Groundwater/Surface water sampling; Familiar with standard test methods, SW846, and other analytical methods in sample analysis; Incorporation of the latest DoD QSM requirements and EPA data quality objectives process in the development of UFP-QAPPs; Implementation of data validation per EPA guidance; Production of Quality Control Summary Reports, Contractor Quality Assurance Reports, and Data Quality Assessments.

Optimization, monitoring of landfill gas (LFG) thermal treatment unit; field measurement of LFG for compliance, LFG Annual reporting, assistance in annual source testing to determine compliance with regulations; groundwater velocity calculations and plume determinations, creation of Environmental Protection Plan which involved detailed review of Fort Ord Wetlands Restoration Plan, and USFWS Biological Opinions.

Programmer, Treasure Island, San Francisco, CA, 2013 – 2014

Performed needs assessment and worked with radiological technicians and program manager in the development of a customized Excel VBA application for radiological field work.

GIS/Database Manager, Former Fort Ord, Presidio of Monterey, CA, 8/2006 – 8/2009

Managed www.fortordcleanup.com and www.fodis.net, and associated databases (MS Access and SQL Server); designed web-based chemistry data loading tool, managed subcontractors performing work for Sacramento Total Environmental Restoration Contract (TERC) I and II project site; and provided cost estimates, schedule updates, accruals, and budget information on a monthly basis.

Supervisor/Chemist, 1988 – 1990

Sebastiani Vineyards, Laboratory Technician, 1987 - 1988

Data Management/Programming, 8/2006 – 8/2009

Creation of customized MS Access databases for data management of chemistry and landfill data; Development of custom MS Excel VBA macros for data conversion, loading, and presentation; Optimization and improvement of existing programming, utilization of data in a multitude of formats (delimited, fixed length); Querying, and updating of SQL and oracle databases; Tortoise SVN SOP development; Development of Migration Plan and QC Test Plan for migration and merger of multiple databases; Google API map development: http://199.255.250.170/parcelmap/; and troubleshooting and QC of applications, and training.

Task Manager, Former Fort Ord, Presidio of Monterey, CA, 2006 – 2007

Task management for offsite drilling operations, and fence construction; Liaison with local land owners to address their concerns and provide information; installed passive diffusion bags, and profiled aquifer for TCE contamination; provided technical evaluations of data to the client and to the agencies, wrote statements of work and procured subcontractors; and tracked costs/invoices and performed monthly accruals.

MEC Removal Database Manager, Former Fort Ord, Presidio of Monterey, CA, 8/2005 – 9/2008

Data management for MEC removal action; imported data into an offsite SQL server database that was collected using handheld PDAs, resolved data issues with field staff, queried SQL server database (using MS Access as a front end) for daily reporting, presented updates at weekly meetings with USACE, made grid assignments working with task management and UXO supervisors, worked with UXO QC, lead Geophysicist;

Senior Staff Scientist, Hamilton Army Airbase, Novato, CA, 8/1995 – 9/1997

Applied statistical analysis on analytical data to characterize remediation stockpiled soils; created SAPs, QAPPs, work plans, and Data Quality Assessment reports for the USACE; developed database for analytical data; generated data quality assessment for inclusion in Remedial Investigation report; and directed preparatory phase inspections.

Supervisor/Chemist, AK, 10/1988 – 8/1992

Worked at two laboratories, one of which was on remote camp in the Arctic; Developed and produced Standard Operating Procedures to ensure uniformity in sample analysis; implemented QA/QC procedures for inorganic sample analysis and field work done at Kuparuk Field, Alaska; gathered soil samples at petroleum spill site; Supervised Inorganic Chemical Analysis section; and developed extraction procedure for soil petroleum hydrocarbons analyses. **Field work**: Kenai, Alaska, screened for petroleum hydrocarbons at oil company cleanup site; Kodiak, Alaska, screened for petroleum hydrocarbons on bore samples, to determine location of leaking underground fuel tank; and Soldotna, Alaska, samples monitoring wells at Kenai and Soldotna landfills.

Zachary T. Carroll - ***Staff Database Analyst II***
13 total years of experience

EDUCATION

Bachelor of Art, History (Social Science Program), 1999, California State University, Sonoma

BIOSKETCH

Mr. Carroll is a Data Management Specialist and Data Validation Technician who has been maintaining data integrity and production of scheduled reports in a timely manner since 2000. He has reviewed all aspects of program databases for accuracy, advised on future database design needs, performed data validation, wrote and presented reports, and answered questions regarding analysis.

PROJECT EXPERIENCE

Data Validation Technician: Casmalia Resources Superfund Site Maintenance, Remedial Investigation/Feasibility Study (RI/FS), Groundwater Monitoring, Casmalia, California. Responsible for providing quality assurance (QA) and quality control (QC) review relative to analytical laboratory data. Performed Level III and Level IV data review in accordance with the project work plan, the project field sampling plan, and the principals presented in the *USEPA National Functional Guidelines for Superfund Organics Data Review* and the *USEPA National Functional Guidelines for Laboratory Data Review, Inorganics*. Scope: Work performed in support of site maintenance and management, RI/FS, regulatory compliance and support of investigation at a 252-acre, former Class I Superfund, Hazardous Waste Management Facility comprising five separate landfills and which included approximately 40,000 tons of industrial waste on site (with acids, caustics, solvents, pesticides, and metals). Implemented 24-hour operating leachate collection and contaminated groundwater treatment system, and over 300 monitoring wells.

Data Validation Technician: Universal Paragon Corporation / BP PLT-1, LLC Former Schlage Lock and Southern Pacific Brisbane Rail Yard Operable Units (OUs) Brownfield Soil and Groundwater Remediation Services, San Francisco, California. Responsible for providing data review summary reports describing analytical performance expressed in terms of precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS). Scope: Engineering efforts in development of a strategic roadmap to help close the real estate deal and transfer of environmental liability to BP/MACTEC Team for redevelopment. Brownfield site is scheduled to be redeveloped into a $450 million mixed-use development, including 1,200 residential homes and public open space. Conducted remedial investigation (RI) and feasibility studies (FSs) to identify final remedies for volatile organic compound- (VOC) impacted soil and groundwater and metal-impacted soils. The selected remedial action will entail in-situ bioremediation of VOC-impacted groundwater using enhanced reductive de-chlorination by injecting soybean oil into the subsurface to enhance natural microbial activities.

Database Specialist/Data Validation Technician: U.S. Army Corps of Engineers - Sacramento District, Fort Ord Groundwater Sampling, Analysis and Reporting, Fort Ord Site (Seaside), California. Responsible for providing data review in accordance with the *Uniform Federal Policy for Quality Assurance Project Plans*; generating quarterly output and maintaining the project libraries for the project's Automated Data Review (ADR) software; writing of the Quality Control Summary Report for inclusion in the Quarterly Report; and conducting ongoing data loading in SQL and Access databases. Scope: Continuation of ongoing groundwater sampling, analysis, and reporting program at Fort Ord site. Quarterly sampling and analysis conducted at more than 300 stations along with evaluation of treatment systems operation.

Database Technician/Data Validation Technician: Former Chemical Manufacturing Facility Perchlorate Investigation, Remediation, Morgan Hill, California. Responsible for providing Level III and Level IV data review in accordance with the *USEPA National Functional Guidelines for Laboratory Data Review, Inorganics*; troubleshooting data validation issues with laboratory personnel; MAROS Mann-Kendall Analysis for determining trends in analyte concentration levels; performing quarterly reporting of QA/QC findings; regulatory uploading of data packages and written reports to Geo-Tracker online website; and data loading and QC tracking in SQL and Access databases. Work is being done in support of a Remedial Investigation to delineate lateral and vertical extent of perchlorate in soil and groundwater at the site of a former flare manufacturing facility. Perchlorate has been detected in onsite soil and onsite and offsite groundwater.

Database Specialist/Data Validation Technician: Confidential Client, Former Manufacturing Facility, Groundwater Investigation and Remediation, Northern California. Responsible for ongoing uploading of chemistry data to SQL database and providing database support in implementation of SQL database relating both historical and incoming chemistry data in support of regulatory review and environmental support services for a former industrial building products manufacturer; Level II and Level III data validation performed in accordance with the project's Quality Assurance Project Plan and the *USEPA National Functional Guidelines for Superfund Organics Data Review* and writing of quarterly data review summary. Services provided include groundwater testing and sampling pertaining to nearby groundwater plume impacted by solvents (PCE and TCE).

Database Specialist/Data Validation Technician: Groundwater Monitoring Program, Los Angeles, California. Responsible for reviewing data for compliance with laboratory control limits and method compliance in accordance with USEPA Level II review; quarterly reporting of validation summary for groundwater data to assist client with making project decisions; MAROS Mann-Kendall analysis to determine trends in chemicals of concern on a quarterly basis. Work is being done in support of O&M of Soil Vapor Extraction (SVE) system and vapor enhanced recovery (VER) system and semi-annual groundwater monitoring program. Site occupies several acres on property converted from manufacturing operation (including buildings) to present day asphalt-covered commercial parking lot.

Database Specialist/Data Validation Technician: Site A Environmental Site Assessment and Remediation, Torrance, California. Responsible for quarterly reporting of validation summary for groundwater data to assist client with making project decisions; review of data for compliance with laboratory control limits and method compliance, in accordance with USEPA Level II review. Work being done in support of soil and groundwater contamination remediation at a 3.2 million square feet industrial complex site comprised of numerous manufacturing buildings. Services included indoor air monitoring for VOCs.

Database Technician: IBM Corporation Phase I Environmental Site Assessments, Groundwater Treatment System O&M and Monitoring, San Jose, California. Provided database support, including data loading, QC, reporting, and archiving. Created and delivered to the client a data extract from SQL database in EQuIS data format. Scope: Phase I Environmental Site Assessments and other environmental services for leased properties at end of lease, prior to being returned to owner. Sites have included offices and manufacturing facilities. Activities included well installation and abandonment; O&M of groundwater extraction system; management of Self-Monitoring Program; and various on-call services to support client's environmental program. MACTEC services saved IBM an average of $40,000-$50,000 a year over a four-year period in monitoring and O&M costs by negotiating closure of over 150 monitoring wells.

Jeffery J. Fenton - *Senior Geologist*
27 total years of experience

EDUCATION

Bachelor of Science, Geology, 1981, Oregon State University, Corvallis

CERTIFICATIONS

HAZWOPER 40 Hour
HAZWOPER 8 Hour Refresher
HAZWOPER 8 Hour Supervisor
OSHA Confined Space Entry

BIOSKETCH

Mr. Fenton is a Senior Geologist and Project Manager with over 27 years of experience. He is responsible for designing and managing programs, developing work plans, performing record searches and evaluation of storage and handling of hazardous wastes, supervising field work and data reduction, and participating in agency and public meetings. He has managed numerous large and small HTRW projects, including the evaluation and characterization of sites with hydrocarbon, solvent, metals, pesticide, PCB, explosive compound, and low-level radioactive wastes. His responsibilities have included preparing RI/FS and site characterization reports, confirmation reports, IA Approval Memos, Environmental Baseline Surveys, FOSTs, FOSLs, FOSETs, environmental compliance reports, BRAC Cleanup Plans, site safety plans, and confirmation reports in compliance with BRAC, DoD, CERCLA, RCRA, USACE, EPA and State and local guidance. He has managed tasks involving industrial facilities, landfills, munitions response sites, service stations, food processing plants, and agricultural facilities for federal DoD agencies (e.g., USACE, Army, and Navy) and private sector clients.

PROJECT EXPERIENCE

Project Manager: Ahtna Engineering Services, Fort Ord Groundwater Monitoring Program, Sites 2 and 12, OU2 and OUCTP. Responsible for the monitoring and characterization of three groundwater plumes at the former Fort Ord, CERCLA site. Manage the collection of groundwater elevations and the chemical sampling of a network of over 300 monitoring wells on a quarterly basis. Samples are analyzed for a variety of inorganic and organic compounds. Groundwater elevation and chemistry data are compiled for inclusion into quarterly and annual monitoring reports that include groundwater elevation contour maps and iso-concentration plots of the data collected for each plume and for each aquifer affected. Responsible for overall project quality control, validation of analytical data and submittal of the quarterly and annual reports to the client, regulatory agencies and the public.

Project Manager: Ageiss, Inc., Data Validation Support, Semi-Annual Groundwater Sampling, Dodge Hill Landfill, Fort Sill Oklahoma. Provide validation and statistical analysis of all groundwater data collected during semi-annual groundwater sampling at the Dodge Hill Landfill, fort Sill Oklahoma. Validation includes Level III review on 100% of the data and Level IV review on 10% of the data with qualifiers applied to the electronic deliverable file (EDD). Data review is presented in a Data Validation Summary Report. Perform statistical analysis on all groundwater analytical data for each sampling event. The statistical analysis is presented in a report which is appended to the client’s semi-annual groundwater report for submittal to the US Army Corps of Engineers (Ageiss client) and the Oklahoma Department of Environmental Quality.

Project Manager: Hydrogeologic Inc. (HGL), Treatment Plant Decommissioning, Fort Ord, California.
Provided technical review of the Work Plan and Completion Report prepared by HGL and provided field oversight of well destruction activities to ensure well destruction was completed as per the permit requirements and HGLs Work Plan. Work performed for HL under Huntsville Small Business Worldwide Environmental Services (WERS) contract.

Project Manager: Innovative Technical Solutions, Inc. (ITSI), A Gilbane Company, Groundwater Modeling and Technical Memorandum Revision, Fort Ord, California. Provided updates to the fort Ord groundwater model to support the design element of the relocation of the Operable Unit 2 (OU2) groundwater treatment plant. Completed a groundwater model run with existing and proposed extraction and injection wells, including a cost benefit analysis used to support the design basis for the new location of the OU2 groundwater treatment plant. Included revision/finalization of the draft groundwater technical memorandum. The technical memorandum included the proposed locations of new extraction wells to supplement and optimize the existing groundwater extraction well network.

Task Manager: Lennar / BVHP, LLC Hunters Point Naval Shipyard Parcel A Environmental Consulting Services, San Francisco California. Environmental consulting services to support client's legal counsel, address special requests for information from project stakeholders, and present information at planning and technical meetings as part of ongoing effort to redevelop Parcel A of area formerly occupied by U.S. Naval shipyard. Provided review of and recommendations on existing documents. ***Lennar achieved compliance with regulatory requirements with MACTEC's assistance.*** Responsible for preparing a Finding of Suitability to Lease document for 8 buildings and 2 open spaces.

Geologist: The Presidio Trust Site Closure Environmental Services, San Francisco California. Environmental services associated with site closure, including site investigation, risk assessment, feasibility study (FS), engineering design, data management, ecological risk assessment, remediation, and reporting at historic 1,416-acre former military base at the south end of the Golden Gate Bridge. Responsible for preparing a Supplemental Health and Safety Plan for Munitions and Explosives of Concern.

Task Manager: U.S. Army Corps of Engineers - Huntsville District, Fort Ord Operable Unit (OU) Habitat Remedial Investigation / Feasibility Study (RI/FS), Monterey California. Since 2004, MACTEC has been conducting full remediation investigation / feasibility study (RI/FS) to address munitions and explosives of concern (MEC) at the Impact Area Munitions Response Area (MRA) for 6,500 acres of a 8,000-acre former U.S. Army training range complex (small arms to artillery fire). Activities included planning, site characterization, archival (historic) search, risk assessment (human health), feasibility study, and community relations support. Responsible for conducting site characterization efforts.

Task Manager: U.S. Army Corps of Engineers - Huntsville and Sacramento Districts, Fort Ord Site RI/FS Reports Track 0&1 Approval Memorandum, Parker Flats ROD and Public Meeting, Monterey California. Under an additional delivery order, completed the development and submittal of additional Track 0 and 1 approval memoranda and ROD for multiple reuse parcels throughout site of former Fort Ord. Activities support remedial investigation efforts as part of Military Munitions Response Program. ***Analysis performed by MACTEC resulted in No Further Action determination for 21 of 24 Track 1 sites.*** Responsible for participating as one of the authors of the Remedial Investigation / Feasibility Studies document.

Task Manager: U.S. Army Corps of Engineers - Huntsville and Sacramento District, Environmental Baseline Survey for Transfer (EBST) Documentation Services, Monterey California. Preparation of documents and associated evaluations relating to broad range of environmental issues (e.g., asbestos and lead-based paint) at Fort Ord as part of work for Environmental Baseline Survey for Transfer (EBST). In support of property transfer MACTEC prepared Findings of Suitability to Transfer (FOST), Findings of Suitability to Lease (FOSL), and Findings of Suitability for Early Transfer (FOSET). ***Early transfer was approved saving $1 million in infrastructure and maintenance cost.*** Responsible for writing the FOST documents for 30 parcels and the FOSET documents for 64 parcels.

Task Manager: U.S. Army Corps of Engineers - Huntsville and Sacramento Districts, Fort Ord Site Investigation and Documentation for FOST, Monterey California. Investigative and documentation activities performed as part of development of environmental basewide survey for transfer (EBST) and findings of suitability for transfer (FOST) at former Fort Ord site. In support of property transfer MACTEC prepared Findings of

Suitability to Transfer (FOST), Findings of Suitability to Lease (FOSL), and Findings of Suitability for Early Transfer (FOSET). ***Early transfer was approved saving $1 million in infrastructure and maintenance cost.*** Responsible for writing the FOST document for one parcel.

Project Manager: U.S. Army Corps of Engineers - Sacramento District, Fort Ord Groundwater Sampling, Analysis and Reporting 2008-2009, Fort Ord Site (Seaside) California. Continuation of ongoing groundwater sampling, analysis and reporting program at Fort Ord site for 2008-2009 (Option Year 3). Quarterly sampling and analysis conducted at more than 300 stations along with evaluation of treatment systems operation. Responsible for data management, data evaluation, and reporting.

Task Leader: U.S. Army Corps of Engineers - Sacramento District, Fort Ord Site Electronic Data Integration and Management, Monterey California. Electronic data integration and management of various environmental databases, administrative records, facilities management information and GIS applications developed for site characterization, OE investigation, and remediation activities at former Fort Ord site. Work is continuation of services under ongoing BRAC and IRP programs. The database contains over one million records. Contract Compliance Screening (CCS), Automated Data Review (ADR), and Environmental Management System software programs were developed and resulted in ***cost savings of up to 50% in labor reduction ($250K) and improvements in the data management process for numerous task orders.*** Responsible for contributing information regarding property transfer-related documents that needed to be integrated into the overall Fort Ord database.

Environmental Task Manager: U.S. Army Corps of Engineers, Sacramento District, Fort Ord Complex Site BRAC Related Environmental Services, Monterey California. Environmental and engineering services under BRAC Program since 1985 for Fort Ord Complex (28,000-acre former Fort Ord, the Presidio of Monterey, and Fort Hunter Liggett, Fritzsche Army Airfield), a National Priorities List (NPL) site. Completed several hundred multidisciplinary, multitask delivery orders, with dozens more in progress. Services have included site investigations, risk assessments, feasibility studies, including ordnance/explosives remedial investigation, remedial designs, remedial actions, environmental compliance, utilities/roads, parcel descriptions, endangered species and habitat assessments, underground storage tank investigations, asbestos assessments, groundwater remediation, planning for base reuse, and community relations. Services have been conducted under CERCLA; RCRA; NEPA/CEQA; California landfill regulations; Monterey County underground storage tank (UST) regulations; air toxics regulations; and other federal, state, and local environmental laws and regulations. ***Successful completion of RI/FS documentation as part of 40+ site RI/FS allowed the Army to meet the congressionally mandated 36 month RI/FS schedule.*** To track the status of the property transfer and to provide the most up-to-date information to community stakeholders on the environmental cleanup, MACTEC developed a public website (www.fortordcleanup.com). This allowed interested parties to view information online. ***This reduced the time needed for onsite staff to manage the paper administrative record by approximately 50%.*** Responsible for serving as the BRAC task manager, preparing appropriate documentation, including Environmental Baseline Surveys (EBSs), Findings of Suitability to Transfer (FOSTs), Findings of Suitability for Early Transfer (FOSETs), Findings of Suitability to Lease (FOSLs), and Notices of Intent (NOIs), under the Comprehensive Environmental Response, Compensation, and Recovery Act (CERCLA) guidance, which accelerated real-property transfers in accordance with the Defense BRAC Act (BRAC Program). Worked closely with the U.S. Department of the Army, U.S. Army Corps of Engineers (USACE), EPA, and State of California to develop approaches that met the requirements of CERCLA 120(h) and satisfied regulatory concern for documenting the environmental condition of the property at the time of transfer. Also responsible for RCRA closure activities.

Technical Consultant: U.S. Army Corps of Engineers - Sacramento District, Fort Ord Wetlands Habitat Monitoring 2003, Monterey California. Continuation of habitat monitoring work as part of the BRAC and IRP activities at site of former Fort Ord. Monitoring activities at wetland sites on property include vegetation sampling, wildlife surveys, and collecting and analyzing physical and hydrological data. ***Results of the habitat monitoring showed that the habitat had recovered in four years and thus eliminated the fifth year of monitoring saving $85,000.*** Responsible for review of property transfer documents related to habitat monitoring activities.

Task Manager: U.S. Army Corps of Engineers - Sacramento District, Fort Ord and Fort Hunter Liggett Groundwater Monitoring Program, Forts Ord, Hunter Liggett California. Groundwater investigations and provided quarterly monitoring; prepared property transfer documents; performed habitat monitoring and groundwater remediation system evaluation; and conducted Small Arms Range remediation pilot study evaluation at site of two former U.S. Army installations under BRAC program. ***The project has been completed and consisted of twelve sites requiring remediation that have been closed with regulatory approval resulting in a reduction in long-term O&M for the client.*** Responsible for data evaluation and management, preparation of reports and cost proposals, and review of invoices.

Task Manager: USACE, Sacramento District, Military Munitions Response Program (MMRP), FortOrd, Monterey County, California. Currently serving as Task Manager responsible for the completion of a RI/FS, Proposed Plan, and Record of Decision at former munitions response sites. Conducted and evaluation of the possible use of military munitions at 24 former military munitions sites. The evaluation included researching the history of each site (PA/SI) and completing a review of the available data to develop conceptual site model(s) for each potential site. Data gaps were identified and the potential risk remaining at each site was also evaluated. Worked directly with federal and state regulatory agencies and community stakeholders throughout the review and approval process. The RI/FS is being conducted following EPA, DoD, and CERLA guidance. Other documentation prepared in support of the Fort Ord MMRP include IA Approval Memorandums, and Notices of Intent (NOI) for Removal Actions and Land disposal Site Plans prepared in support of the Army's Time-Critical Removal Action (TCRA) program. The NOI complies with 40 CFR, Part 300, Section 415 and notifies the regulatory agencies and the public of upcoming removal actions, intended to mitigate or eliminate the threat to public safety presented by the presence of munitions and explosives of concern (MEC).

Task Manager: USACE, Sacramento District, Closure of RCRA Solid Waste Management Units, Former Fort Ord, Monterey County, California. Implementing the closure of two solid waste management units under the Fort Ord RCRA program. Closure involves the site investigation and characterization of a former PCB storage facility and a former Open Burning/Open Detonation (OB/OD) munitions disposal unit. Investigation involved conducting a field investigation including the sampling and analysis for chemicals of concern, and completion of a closure certification report following RCRA guidance.

Task Manager: USACE, Sacramento District, Investigation of Solid Waste Management Units, Former Fort Ord, Monterey County, California. Task manager for the evaluation of former hazardous waste storage units. Evaluation involves physical inspection of the units including a review of the cleanliness and integrity, waste handling and storage practices, determining whether a release has occurred and making sampling recommendations if necessary. Information including any recommendations made to state and federal regulatory agencies through a status report. Wastes stored and evaluated include waste oil, fuel, solvents and paint, PCBs, pesticides, asbestos, used ethylene glycol, adhesives and polymers. Created a detailed historic account of the solid waste management units which has been instrumental in the regulatory approval of the transfer of property containing the units.

Project Geologist: Confidential Client, Regulatory Compliance Audits, Processing and Distribution Facilities, Western U.S. Served on audit teams performing regulatory compliance audits for a major food production, processing and distribution company. The project entailed the completion of audits in a 5-month period at 37 facilities in California, and several other facilities in four states. The audit protocol prepared by HLA addressed facility compliance with regulations for hazardous waste, hazardous materials, air quality, water quality, drinking water and transportation. The protocol further provided for the completion of a preliminary screening evaluation that involves the local facility management in targeting relevant operations and matters of concern for the audit, prior to proceeding with the on-site phase of the program.

Task Manager: USACE, Site Investigations, Fort Ord, Monterey, California. Served as task manager for the investigation of several UST sites. Was responsible for determination of MACTEC and subcontractors scope of work, calculation of excavation volumes, oversight of subcontractors, collection of samples, review of analytical data, preparation of clearance and characterization reports, and budget tracking.

Task Manager: USACE, Remedial Investigation/Feasibility Study, Fort Ord, Monterey, California. Served as task manager for the remedial investigation/feasibility study (RI/FS) of two IRP sites at Fort Ord. Was responsible for the interpretation of chemical and hydrogeologic data, oversight of chemical and geologic database, coordination with risk assessment and engineering personnel, determination of contaminant fate and transport, coordination and production of final RI/FS report, and budget tracking.

Task Manager: Alameda County Department of Public Works, Landfill Investigation, Winton Avenue Landfill, Hayward, California. Served as task manager for landfill investigation under the state Solid Waste Assessment Test (SWAT) program. Was responsible for the preparation of work plan, installation and quarterly sampling of groundwater and leachate monitoring wells, aquifer testing, data evaluation, assessment of impact of leachate on waters of the state, and preparation of SWAT report.

Task Manager: U.S. Navy/PRC, Utilities Investigation, Hunters Point Naval Shipyard, San Francisco, California. Was task manager for a cross-base underground utilities investigation. Study involved the review of as-built drawings of sanitary sewer, storm drain, steam pipelines, and fuel lines, and the collection of soil and water samples adjacent to and within utility systems. Was responsible for the review and interpretation of analytical data, recommendations on remediation and mitigation measures, and the presentation of the results at a series of client and agency meetings.

Task Manager: U.S. Navy/PRC, Remedial Investigation, Hunters Point Naval Shipyard, San Francisco, California. Served as task manager for RI of five sites for contaminants including petroleum hydrocarbons, PNAs, pesticides, and metals. Completed interim-action evaluation in accordance with the EPA Superfund Accelerated Cleanup Model. Was responsible for budget and schedule tracking, chemical and hydrogeologic data interpretation, report preparation, and client representation at regulatory agency meetings.

Field Manager: U.S. Navy/PRC, Field Coordination, Hunters Point Naval Shipyard, San Francisco, California. Managed all aspects of field work, including the development, implementation and tracking of field schedules; coordination with client, subcontractors, and regulatory agencies; scheduling field personnel and reviewing all field documentation; and calculating and ordering all field supplies.

Task Manager: U.S. Navy/PRC, Aquifer Testing, San Francisco, California. Developed and implemented site-wide aquifer characterization program. Work included the development of the scope of work assessment of well construction and suitability, performing step-tests, and constant rate discharge tests.

Project Manager: Confidential Client, Product Removal Investigation, Hunters Point Naval Shipyard, San Francisco, California. As project manager, supervised the field investigation involving the removal of free-phase floating hydrocarbons from monitoring wells. Calculated and tracked the volume of product removed to determine the feasibility of installing a pumping system.

Task Manager: Confidential Client, Monitoring Well Network Installation, Longview, Washington. Installed, developed, and sampled network of groundwater monitoring wells in bedrock to investigate the impacts of a long-term release of mercury.

Task Manager: Montecito Heights Landfill, Monitoring Well Installation, Napa County, California. Installed monitoring well in deep aquifer using air rotary drilling method.

Task Manager: Former Fuel Storage and Dispensing Facility, Contra Costa County, California. Supervised and directed excavation of hydrocarbon-contaminated soil at former oil tank farm.

Task Manager: Site Assessment and Remediation, Richmond, California. Installed and developed monitoring wells and collected soil and groundwater samples. Supervised and directed contractor's removal of lead-, hydrocarbon-, and lime-contaminated soils at former shipyard site.

Field Manager: Well Installation, Morgan Hill, California. Installed double-cased well in deep aquifer using mud rotary drilling methods.

Field Manager: Well Installation, Vorhees, New Jersey. Installed monitoring well nests in shallow and deep aquifers using mud rotary and hollow stem auger methods.

Well Site Geologist: Exploration Logging Geothermal Division, Geothermal Exploration, California, Nevada, and Japan. Experienced in mud rotary, air rotary, and aerated mud drilling systems. Performed geologic logging of deep exploration geothermal boreholes. Responsibilities included descriptive lithologic sample analysis, monitoring of borehole temperature, borehole pressure and borehole gas levels; collection of borehole gas samples for chemical analysis; geothermal well production testing and reservoir analysis. Health and safety monitoring of carbon dioxide, methane and hydrogen sulfide gas levels around the drill site. Field experience in the Geysers California, Steamboat Nevada, Takigami and Fushime Fields, Kyushu Japan.

Kevin E. Garrett Ph.D., P.E., PMP – *Senior Principal*
21 Years Experience

EDUCATION

Doctor of Philosophy, The Pennsylvania State University Chemistry, 1990
Bachelor of Science, Colorado State University Chemistry, 1986

REGISTRATIONS

Colorado Licensed Professional Engineer (License number 43243)
Project Management Institute Project Management Professional (PMP)

BIOSKETCH

Dr. Garrett has a Ph.D. in Chemistry and is a Colorado licensed professional engineer with extensive experience in groundwater and soil remediation, site investigation, and the application of environmental chemistry. Dr. Garrett has managed RCRA facility investigation projects (RFIs) and remediation projects that have included developing innovative regulatory approaches resulting in significant cost savings for associated site remediation. Dr. Garrett has managed projects and applied innovative approaches to remediate groundwater, including monitored natural attenuation (MNA), enhanced reductive dechlorination (ERD), in situ biological remediation, in situ chemical oxidation (ISCO), soil vapor extraction (SVE), and neutralization remediation strategies.

Dr. Garrett has designed a full-scale in situ treatment system to remove chlorinated solvents such as methylene chloride, trichloroethene (TCE), tetrachloroethene (PCE), 1,1,1-trichloroethane (1,1,1-TCA), petroleum products, and inorganic constituents such as nitrate and perchlorate from groundwater. The remediation designs utilizes innovative strategies that that has minimized system complexity with reduced set up, operating and maintenance costs and achieve client and regulatory agency remediation goals in the shortest time possible.

Dr. Garrett has managed projects under a variety of regulatory programs including Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and State Voluntary Cleanup Programs. During these projected, Dr. Garrett has aided clients in negotiating site closure, points of compliance, and remediation criteria with regulatory agencies. . These negotiations have aided AMEC clients to close and/or redevelop sites for other uses while meeting the environmental and human health protection goals of the regulatory agency.

In addition, Dr. Garrett has assisted clients with implementation of client's environmental compliance programs including monitoring. Activities include requirements hazardous waste, waste water and storm water compliance, spill prevention plans, and emergency response planning. Dr. Garrett has extensive experience with Phase I and II environmental site assessments (Phase I and Phase II ESA).

As Project Manager and Senior Principal, Dr. Garrett manages technically difficult projects. Dr Garrett is responsible for all aspects of a project, including compliance with company policies, definition of scope of work, establishment of budgets and schedules, control of project costs, compliance with schedule, timely payment for the work, and assurance of overall client satisfaction. In addition, as project manager, Dr. Garrett ensures project quality control activities are in place and adhered to. Selects and supervises project team members; ensures that team members are assigned appropriate roles. Provides leadership to project team; maintains a positive environment and high morale. As Senior Principal, Dr. Garrett provides senior-level technical expertise for project teams. Acts as primary interface with clients for assigned projects; communicates with clients on an ongoing basis; responds effectively to meets clients' needs.

Dr. Garrett is the Chief Engineer of AMEC's Golden, Colorado office. As Chief Engineer, Dr. Garrett provides leadership role for marketing to major clients, service areas, and technically unusual projects; responsible for selected key clients. Serves as primary quality assurance officer for assigned office(s); verifies implementation of quality programs and initiatives.

In the area of quality assurance, Dr. Garrett has extensive experience in development of project-specific QA / QC programs and writing of quality assurance project plans (QAPPs). He has developed appropriate analytical and QA/QC criteria, selected appropriate methods, and developed appropriate reporting limits and method detection limits (MDLs). Dr. Garrett has extensively validated and evaluated analytical data.

PROJECT EXPERIENCE

Project Manager: Molycorp RCRA Facility Investigation (RFI) and Site Closure Remediation Services, Louviers, Colorado. Dr. Garrett managed design and construction of a full-scale in situ biodenitrification system (under RCRA) to treat the groundwater nitrate plume at the facility's 34-acre pond area and 32acre operations area. He developed an innovative in situ remediation system to remove nitrate from groundwater that minimized system complexity and minimized treatment costs to the client. Negotiated and developed the technical approach and justification to close 6 process water holding ponds two years ahead of the original schedule. Included in the technical approach were negotiations with the state regulatory agency on site-specific soil standards for nitrate that met the state goal of being protective of groundwater. Provided technical oversight of the pond closure contractor to ensure that the closure plan requirements were met. Closure of the ponds allowed for expansion of the groundwater treatment system. The expanded in situ treatment system reduced the time required to meet the compliance schedule with respect to nitrate in groundwater. Developed monitoring and characterization plan for perchlorate and demonstrated that the nitrate treatment was effective in meeting the negotiated site specific remediation goals with CDPHE. Performed radiological dose assessment for groundwater and soil in support of the facilities request to terminate their radioactive materials license. This effort included modeling potential radiation dose to hypothetical future residents from exposure to the sites soil and groundwater.

Project Manager: GSA - Denver Federal Center (DFC), Site-Wide Long-Term Monitoring, Lakewood, Colorado. As project manager, Dr. Garrett is leading the site-wide long-term monitoring activities at the Denver Federal Center. These activities include quarterly sampling of up to 250 monitoring wells and surface water locations on and off of the DFC. Quarterly activities include water level measurements, sampling, data validation, data management, and reporting. Additional activities include a 5-Year Review of the performance of the groundwater corrective measures. These corrective measures include, funnel and gate barrier system, source area pump and treat system, and off site plume. At project manager, Dr. Garrett is responsible for ensuring that the activities area completed on time and within budget.

Project Manager: GSA - Denver Federal Center (DFC), Investigative Area (IA) 13 and 16 Corrective Measures, Lakewood, Colorado. As project manager, Dr. Garrett lead the IA 13 source area characterization activities. These activities included characterization of 2 geophysical anomalies by trenching and soil sampling. In addition, the extent of the source area groundwater plume was evaluated using a Membrane Interface Probe (MIP). Based on the MIP results 20 additional monitoring wells were installed. After characterization activities, AMEC implemented the corrective measure which included injection of potassium permanganate into the alluvium and upper weathered bedrock (UWB) and injection of sodium permanganate into the lower weathered bedrock (LWB). Of particular interest was injection of permanganate at the LWB/consolidated bedrock interface. Injections were conducted in approximately 157 alluvium/UWB locations and 60 LWB locations. Post injection monitoring is currently being performed to evaluate the remediation effort to date.

Project Manager: GSA - Denver Federal Center (DFC), Investigative Area (IA) 04D RCRA Facility Investigation (RFI), Lakewood, Colorado. Dr. Garrett conducted two RCRA Facility Investigations (RFIs) and a survey of asbestos in soil for two parcels for the General Services Administration (GSA) at the DFC. The Interior RFI was completed at Building 41 and 42 and consisted of 68 borings and monitoring wells installed inside the buildings. The drilling was completed in conjunction with the facilities ongoing operations. The work included extensive coordination with the GSA and building tenants to ensure that the RFI activities did not impact their normal business activities. The Exterior RFI for the investigation area 04D included installing 80 borings and monitoring wells, excavating 11 trenches to characterize soil and potential impacts from historic operations at the DFC. The investigation included jetting/cleaning and video survey of sanitary and storm water sewer lines in IA04D. Responsibilities included general supervision of the work and activities such as development of subcontractor scopes of work, soliciting competitive subcontractor bids, insuring compliance with standard operating procedures, and health and safety plan development/implementation. Dr. Garrett was responsible for maintaining project schedules, monitoring the budget and costs, and preparing invoices for submittal to GSA. Dr. Garrett also provided regular project status updates to the GSA Project Manager.

Principal-in-Charge: Colorado Department of Transportation (CDOT) Region 6 Headquarters RCRA Facility Investigation (RFI) and Remediation Project, Denver, Colorado. Dr. Garrett served as a Remediation Specialist and Principal Chemist responsible for evaluating and interpreting groundwater monitoring and treatment data as well as conducting statistical evaluation of the treatment data. He oversees engineering and environmental services implemented to remediate soil and groundwater contaminated with methylene chloride, TCE, PCE, and 1,1-DCE. Dr. Garrett’s responsibilities include ensuring that the project meets the technical and quality requirements for the engineering and environmental services implemented to remediate groundwater and soil. He has assisted in (1) site investigations; (2) design and construction of the bioremediation system; and (3) ongoing O&M activities for the groundwater treatment system.

Remediation Specialist and Principal Chemist: Lowry Assumption Company - Former Lowry Air Force Base Redevelopment Design / Build, Denver, Colorado. Remediation Specialist responsible as for assisting in development of groundwater and soil analytical programs for Operable Unit 2 (OU2) work, and assisting in development of OU2 Work Plan and final report for OU2 landfill closure. Scope: Design and construction of a 67-acre landfill cap, remediation of major groundwater plume, and privatized contaminant characterization and cleanup including groundwater monitoring at 1,866-acre former air force base in large urban area. Services included engineering design and construction quality assurance. Approach is predicted to save several years of cleanup time and has allowed for more efficient and quicker redevelopment activities into a mixed-use community that has been recognized with the Governor’s Award for Smart Growth.

Project Manager, Petroleum Distribution Center, Denver, Colorado. Through a comprehensive liability assessment of the site, AMEC identified an alternative approach to obtaining site closure and significantly reducing the cleanup costs and the amount of time needed to obtain closure from the regulators. This approach required the transfer of the site from the EPA Region VIII’s Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) Emergency Response Administrative Order to the Colorado Department of Public Health and Environment’s (CDPHE’s) Voluntary Cleanup program (VCUP). This strategic transfer from EPA CERCLA oversight to the CDPHE VCUP oversight resulted in an overall project remediation cost savings and has expedited the time necessary to obtain closure from the regulators thereby reducing the time required for remediation activities at the site. Negotiated with CDPHE and developed a strategy to break the site into 5 parcels. Wrote VCUP applications for 4 of the 5 parcels and received no action determinations for 3 of the parcels. Dr. Garrett was responsible for the site-wide operation and maintenance reporting and groundwater monitoring compliance program. The monitored natural attenuation (MNA) approach for groundwater remediation has been implemented. VOC contamination was reduced in soil source areas by applying soil vapor extraction (SVE) remediation strategy. Contracted and provided oversight for the demolition of 3 buildings on the client’s property.

Project Manager: Rocky Mountain Steel Mills South Mills Solid Waste Management Units (SWMUs), RCRA Facility Investigation (RFI), Pueblo, Colorado. Dr. Garrett was responsible for managing the project that included a RCRA Facility Investigation (RFI) for the South Mills SWMUs that includes the South Mills waste water treatment lagoons. RFI work included sampling of soil borings, waste oil skimmer remediation, including surface soil sampling, soil removal and disposal. Sixteen soil borings were logged and sampled and soil around 4 oil water separator were removed and backfilled with clean material. In addition, sediment from three lagoons was samples. An RFI report was prepared and submitted to the CDPHE for approval.

Project Manager: Rocky Mountain Steel Mills Solid Waste Management Unit (SWMU) No. 78 Desulfurizer Baghouse, RCRA Facility Investigation (RFI), Pueblo, Colorado. Dr. Garrett was responsible for managing the project, writing the RFI report, and performing historic research on the design and historic operation of the desulfurizer baghouse facility. He conducted the RCRA Facility Investigation (RFI) for Solid Waste Management Unit (SWMU) No. 78, a former desulfurizer baghouse that was part of former blast furnace operations at the steel mill facility. Research of historic records conducted to demonstrate to State Regulator that the baghouse facility was not connected to the historic coke oven facility (as historic permits incorrectly indicated). This research enabled the client to limit the SWMU investigation and facilitate closure, thereby saving both time and money. Thirty samples also collected from five boring locations as part of investigation.

Project Manager: Confidential Client Site Characterization and Remediation Services, Olathe, Kansas. Responsible for overseeing on-site groundwater monitoring activities, developing budgets, developing site closure and remediation strategy; and providing oversight of remediation activities. The scope includes site characterization and development of final groundwater and soil remediation strategy and plan for final closure of 9,000-SF building site occupying corner of property near source area. Plume extends 1,000 feet to near property boundary.

Remediation Specialist and Principal Chemist: Hamilton Sundstrand, RCRA Facility Investigation (RFI) Project, Denver, Colorado. Dr. Garrett has evaluated the analytical data for this project since 1992. He also assisted in design and implementation of soil, groundwater, NAPL and seepage water investigations (RFIs); feasibility and treatability studies; remedial design pilot-scale testing, engineering and construction; regulatory permitting, treatment systems O&M; treatment systems monitoring and reporting; risk assessments; RCRA and CAP designs and implementation. He redesigned the groundwater quality monitoring program incorporating elements of the RCRA Groundwater Monitoring Technical Enforcement Guidance Document (EPA, 1996). He assisted in preparation of an accelerated RCRA Corrective Action Strategy for site. As Principal Chemist, he was responsible for data evaluation, validation, and interpretation as well as site conceptual model development.

Chemist: University of Nebraska Agricultural Research & Development Center (ARDC) Remedial Investigation / Feasibility Study, Remedial Assessment and Removal Action, Ithaca, Nebraska. Responsible as principal chemist for writing and reviewing project Quality Assurance Project Plan (QAPP), oversight of the analytical program, and project quality assurance program. The scope includes Remedial Investigation / Feasibility Study (RI/FS) and removal actions involving four different sites from one-half to five acres each, distributed over the 9,600-acre R&D facility and including eight disposal trenches, a former landfill and a pesticide rinsate area. Work included excavation, characterization, packaging, disposal and transportation of 30,000 CY of radioactive and chemical wastes produced as part of University medical research program and buried at site many years earlier, quality control planning and data management.

Project Manager, Landfill Monitoring Program, Denver, Colorado Managed groundwater monitoring and reporting for EPA CERCLA groundwater and surface-water monitoring program. Tasks include coordinating the analytical laboratory and field activities for the Landfill Operation and Maintenance (O&M) monitoring program for the semiannual groundwater and surface-water sampling. Prepare laboratory scope of work, oversight of data management activities, and coordination with field and laboratory personnel. Oversaw data validation for the project and reported the analytical and QA/QC results to the client and regulatory agencies. Dr. Garrett prepared a statistical approach to find potentially flawed or inconsistent data. Reported results of site O&M and groundwater monitoring program to the EPA on a semiannual basis.

CHEMICAL RESEARCH

Research Associate, University of Delaware. Research Associate in organometallic, inorganic, and catalytic chemistry. Studied the interaction of metal clusters on metal oxide supports. Developed new methodology for the synthesis of mixed metal transition metal clusters on metal oxide supports. Studied these supported metal clusters by a variety of instrumental and analytical techniques.

Graduate Student Researcher, Pennsylvania State University. Researcher in organometallic and inorganic chemistry. Studied the interaction of a variety of organic compounds with highly reactive transition metal complexes. Demonstrated the use of tungsten complexes as substrates in the synthesis of organic compounds such as naphthols. Studied the mechanisms by which the organic products are formed. Studied organic, organometallic, and inorganic compounds by a variety of instrumental and analytical techniques.

CERTIFICATIONS AND TRAINING

OSHA 8-Hour Hazardous Materials/Waste Health and Safety Training Refresher Course
OSHA 40-Hour Hazardous Materials/Waste Health and Safety Training Course
OSHA 8-Hour Supervisory Hazardous Materials/Waste Health and Safety Training Course
Project Management Training the AMEC Way, 2012
Project Controls Level I and Level II Training, 2010
Capturing and Winning AMEC Business, Shipley 2006
Optimizing Injection Strategies for Full-Scale In Situ Reactive Zone Remediation, 2005
Contract Review Seminar, 2005
Applications of Ground Water Geochemistry, 2004
Economic Analysis for Ground Water Remediation a Tool for Decision Making, 2003
The Remediation Course, Princeton Groundwater, Inc., 2003
Environmental Geochemistry of Metals, 2003
Principles and Practices of Project Management, 2002
Groundwater Pollution and Hydrology Course, Princeton Groundwater, Inc., 2001
Environmental Law Short Course, Environmental Education Enterprises, Inc., 1996

PUBLICATIONS AND PRESENTATIONS

2007. Selecting the Optimal Remediation Strategy. *Presentation at the March 2007 Society of American Military Engineers Frontier Post Meeting, March 22, 2007, Cheyenne Wyoming.*

2005. In situ Biodenitrification Groundwater Remediation System. *Proceedings of the Eighth International In Situ and On-Site Bioremediation Symposium, Baltimore, Maryland, June 6-9, 2005*, B.C. Alleman and M.E. Kelley: Battelle Press: Columbus, OH, 2005; Paper O-02 (with Amy L. Hudson).

2005. In situ Biodenitrification Groundwater Treatment System. *Presentation to the New Mexico Environment Department, May 9, 2005, Santa Fe, New Mexico.*

2005. Large-Scale Application of In Situ Remediation to Remove Nitrate from Groundwater. *Federal Facilities Environmental Journal*, Wiley Periodicals, Inc., Spring 2005; p 97 (with Amy L. Hudson)

2004. Impacts of Near Mountain Geology on an In Situ Biodenitrification System. *Presentation at the 2004 Geological Society of America (GSA) Annual Meeting, November 2004, Denver, Colorado* ; (with Amy Hudson).

2004. Large Scale Application of In Situ Biodenitrification. *Presentation at the 9th Annual Joint Services Environmental Management Conference , August 2004, San Antonio, Texas,* (with Amy Hudson).

2003. In Situ Biodenitrification – A Case Study. *Proceedings of NGWA Conference on Remediation: site Closure and the Total Cost of Clean-Up, November 13-14, 2003, New Orleans, Louisiana*: National Ground Water Association; p 378 (with Amy Hudson).

2001. Accelerating the Reductive Dechlorination Process in Groundwater. *Anaerobic Degradation of Chlorinated Solvents*, Magar V.S., et. al.: Battelle Press: Columbus, 2001; p. 205 (with D. South, J. Seracuse, D. Li).

1996. Removal of N-nitrosodimethylamine from Rocky Mountain Arsenal waters using innovative adsorption technologies. Technical report EL-96-11, U.S. Army Corps of Engineers Waterways Experiment Station, Vicksburg, MS (with E. C. Fleming, J. C. Pennington, N. R. Francingues, D. R. Felt, B. G. Wachob, R. A. Howe, and M. R. Colsman).

1990. Further studies of the synthesis of 1-naphthols and 4-hydroxy-5,6-dimethylbenzothiophene by protonation of $Cp(CO)_2WCTol$ and $Cp(CO)_2WC(2\text{-}C_4H_3S)$ in the presence of alkynes and CO. *J. Organomet. Chem.*, 394, 251 (with W. C. Feng, H. Matsuzaka, G. L. Geoffroy, and A. L. Rheingold).

1990. The synthesis and characterization of size selective Pt-Ir clusters on metal oxide surfaces. Annual Research Review, Center for Catalytic Science and Technology, University of Delaware, October (with B. C. Gates, and A. L. Rheingold).

1989. Transient generation of the reactive carbene complex $[Cp(CO)_2W{=}CH(Tol)]^+$ and its reactions with alkynes to form vinylcarbene, allyl, naphthol, diene, and metallafuran complexes. *J. Am. Chem. Soc.*, 111, 8383 (with J. B. Sheridan, D. B. Pourreau, W. C. Feng, G. L. Geoffroy, D. L. Staley, and A. L. Rheingold).

1989. In situ generation of the benzylidene complex $[Cp(CO)_2W{=}CH(Tol)]^+$ and its reaction with alkynes. *Advances in Metal Carbene Chemistry,* Schubert U. Ed.: Kluwer Academic Publishers: Dordrecht, 1989; p. 189 (with G. L. Geoffroy, J. B. Sheridan, and D. B. Pourreau).

1989. Cycloaddition of imines and $Bu^tN{=}O$ with the carbyne complexes $[Cp(CO)_2MCTol]^+$ (M=Mn, Re). *Organometallics*, 9, 1562 (with B. M. Handwerker, K. L. Nagle, G. L. Geoffroy, and A. L. Rheingold).

1989. New types of metallacycles formed by cycloaddition of imines and $Bu^tN{=}O$ with Mn and Re carbyne complexes. *J. Am. Chem. Soc.*, 111, 369 (with B. M. Handwerker, G. L. Geoffroy, and A. L. Rheingold).

1989. Transient generation of the reactive carbene complex $[Cp(CO)_2W{=}CH(Tol)]^+$ and its reactions with alkynes to form vinylcarbene, allyl, naphthol, and metallafuran complexes. Presented at 23rd Middle Atlantic Regional Meeting of the American Chemical Society, May (with J. B. Sheridan, D. B. Pourreau, G. L. Geoffroy, and A. L. Rheingold).

1988. Preparation and structural characterization of $[\{Cp(CO)_2W\}_2(\eta\square TolCC(OH)CTol)][BF_4]\ CH_2Cl_3$. *Inorg. Chem.*, 27, 3248 (with J. B. Sheridan, G. L. Geoffroy, and A. L. Rheingold).

1988. Reaction of $[Cp(CO_2MCTol]^+$ (M=Mn, Re) with imines and hydrazones. *Third Chemical Congress of North America*, June (with B. M. Handwerker, G. L. Geoffroy, and A. L. Rheingold).

Scott Graham

Project Geologist

Professional summary

Mr. Graham, a Geologist and Environmental Scientist, has been working in the environmental consulting field since 1995. He has demonstrated ability to effectively manage projects, personnel, and budgets. He has extensive knowledge of environmental compliance, including site assessments, remedial feasibility testing, remediation system design and construction, reporting, risk assessment, project and lifecycle budget forecasting, case planning, client and regulatory liaison, and staff training and management. The majority of his project experience is in the governmental, real estate, and petroleum industries.

Employment history

Wood Environment & Infrastructure, Petaluma, CA, Technical Professional 3, 2017-Present

Amec Foster Wheeler Environment & Infrastructure, Inc., Petaluma, CA Project Geologist, 2014 to 2017

AMEC Environment & Infrastructure, Inc., Petaluma, CA, Project Geologist, 2011–2014

MACTEC Engineering and Consulting, Inc., Petaluma, CA, Project Geologist, 2005–2011

SCS Engineers, Santa Rosa, CA, Geologist, 6/2005–12/2005

Delta Environmental Consultants, Incorporated, Sacramento, Project Manager, 10/2004–5/2005

SECOR International, Incorporated, Sacramento, CA, Associate Geologist, 7/2003–10/2004

Environmental Resolutions, Incorporated, Novato, CA, Project Manager, 1/2001–6/2003

Environmental Resolutions, Incorporated, Novato, CA, Senior Staff Geologist, 4/2000–1/2001

Environmental Resolutions, Incorporated, Novato, CA, Staff Geologist, 7/1998–4/2000
Environmental Resolutions, Incorporated, Novato, CA, Environmental Technician, 5/1995–7/1998

Non-professional certifications and training

CPR/AED

Defensive Driving

First Aid

HAZWOPER 40 Hour

HAZWOPER 8 Hour Refresher

HAZWOPER 8 Hour Supervisor

OSHA 10 Hour Construction Safety and Health

OSHA 30 Hour Construction Safety and Health

U.S. Army Corps of Engineers Construction Quality Management for Contractors

Doyle Scholarship, Santa Rosa Junior College, 1988

Representative projects

Beale Air Force Base, 2017, Yuba City, CA, Field Geologist. As Field Geologist, oversaw installation of soil borings and monitoring wells. Scope: Perform remedial investigation tasks as associated with the Air Force’s PFAS Investigation activities. Tasks include planning, driller oversight, and soil and groundwater sampling.

March Air Force Base, 2017, Riverside County, CA, Field Geologist. As Field Geologist, oversaw installation of soil borings and monitoring wells. Scope: Perform remedial

Years with Wood: 13

Years’ Experience: 23

Education

Bachelor of Science, Geology, California State University, Sonoma, 1995

Associate of Science, Science, Santa Rosa Junior College, 1991

Location

West US - Petaluma

Languages

English

investigation tasks as associated with the Air Force's PFAS Investigation activities. Tasks include planning, driller oversight, and soil and groundwater sampling.

Alameda Naval Air Force Base, 2016 and 2017, Alameda, CA, Field Geologist. As Field Geologist oversaw the installation and development of groundwater monitoring wells. Tasks include permitting, driller oversight, soil and groundwater sampling.

Borehole Field Verification Activities, 2016 to 2018, California Department of Transportation (Caltrans), Various Cities and Counties, CA. As Field Geologist, Perform Field verification of the presence and location of geotechnical borings and wells throughout the state. Tasks include planning, research of online databases, QA/QC of historical documents, and field verification activities associated with locating geotechnical borings and wells installed at various construction sites throughout the state.

ABB Chico 2012, Chico, CA 107652, 880,000, 2010. Field Geologist. As Field Geologist, oversaw installation of monitoring wells. Scope: Perform remedial investigation/feasibility study tasks specified by the DTSC's Partial Consent Agreement issued to ABB Inc. to investigate and remediate impacted groundwater at the site. Tasks include litigation support and project management, monthly status reports, RI implementation, annual wellhead treatment system sampling, and quarterly groundwater monitoring. Chlorinated solvents and TCE were found along the Skyway plume.

Roadside Vegetated Treatment System (RVTS) Study Oversight 2007-2008, California Department of Transportation (Caltrans) - Environmental Program Office, Various Cities, CA, United States. 074859 RVTS, 250,080, 2010. Project Geologist. Responsible for conducting stormwater monitoring and maintenance activities at two sites (Napa and San Mateo) in Northern California. Collected water samples and tabulated data related to major storms at both sites. Scope: Monitoring oversight, data management, and reporting for 2007-2008 Roadside Vegetated Treatment Study (RVTS). Study designed to assess treatment performance of vegetated slopes with varied configurations of vegetative cover, dependent on slope and soil, for effectiveness of erosion control. Services also included post-storm monitoring of stormwater runoff; technical memorandum reviews; and updating of both Sampling & Analysis Plan and Health & Safety Plan.

Casmalia Resources Superfund Site Maintenance, Remedial Investigation / Feasibility Study (RI/FS), Groundwater Monitoring, Bingham McCutchen, LLP (formerly McCutchen, Doyle, Brown & Enerson), Casmalia, CA, United States. 990061, 21,900,000, 2009. Geologist. Responsible for assisting with non-aqueous phase liquid monitoring and well development via air lifting and WaTerra Pump under work conditions involving development and monitoring in Class C PPE. Scope: Site maintenance and management, RI/FS, regulatory compliance and support of investigation at a 252-acre, former Class I Superfund, Hazardous Waste Management Facility comprising five separate landfills and which included approximately 40,000 tons of industrial waste on site (with acids, caustics, solvents, pesticides and metals). Implemented 24-hour operating leachate collection and contaminated groundwater treatment system, and over 300 monitoring wells.

Chico Facility Regulatory Review Environmental Support Services, Major Chemical Manufacturing Company, CONFIDENTIAL CLIENT ABB, Inc.- Combustion Engineering (CE), Chico, CA, United States. 072198, 3,400,000, 2016. Geologist. Responsible for providing drilling/well construction oversight for installation of sonic wells. Finished long-term, out of town project on schedule with a minimum downtime. Assisted with preparation of RI/FS Work Plan, with drilling price quote and drilling set-up, and provided oversight of drilling and sampling.**DO NOT USE THIS PROJECT IN ANY PROPOSAL OR MARKETING MATERIALS WITHOUT FIRST CONTACTING THE AMEC PROJECT MANAGER. DUE TO LITIGIOUS OF THIS PROJECT, WHICH IS THE REASON IT IS BEING PERFORMED IN THE FIRST PLACE, THIS CLIENT DOES NOT WANT US TO USE THEIR PROJECTS IN ANY PUBLIC COMMUNICATIONS OR MARKETING EFFORTS WITHOUT FIRST OBTAINING THEIR PERMISSION.** Scope: Regulatory review and litigation-related environmental support services for former industrial building products manufacturer. Services include subsurface characterization, groundwater quality testing and sampling pertaining to characterizing the extent of a groundwater plume impacted by the historic disposal of solvents (PCE and TCE).

Signal Oil Semiannual Groundwater Sampling, Major Industrial Client, CONFIDENTIAL CLIENT Honeywell International, Inc., Edgewood, WA, United States. 031612, 38,000, 2007. Geologist. Responsible for site schedule, performing pre-drill protocols, writing HASP, coordinating equipment shipment for out of state locations, overseeing drilling of five hollow stem auger borings to collect soil and water data, performing quarterly monitoring, and sampling field work for the 4th quarter 2005; assisted in determining the extent of hydrocarbon contamination and future placement of oxygen releasing product injection.**DO NOT USE THIS PROJECT IN ANY PROPOSAL OR MARKETING MATERIALS WITHOUT FIRST CONTACTING THE AMEC PROJECT MANAGER. Although this project was not performed under the Alliance agreement, it should be considered CONFIDENTIAL in view of the client's recent mandate.** Scope: Semiannual groundwater monitoring and sampling of three onsite wells at site of former service station (approximately 110 ft. X 120 ft. site) and installation of soil borings. One well exhibits concentrations of fuel hydrocarbons.

Former Chemical Manufacturing Facility Perchlorate Investigation, Remediation, Confidential Chemical Manufacturer, CONFIDENTIAL CLIENT, Morgan Hill, CA, United States. 020905, 6,000,000, 2010. Geologist. Responsible for assisting in door-to-door sampling of privately-owned domestic wells, and well development of offsite monitoring wells using airlifting, and groundwater sampling using airlifting and a WaTerra pump. PLEASE CONTACT THE AMEC PROJECT MANAGER BEFORE USING THIS PROJECT IN ANY PROPOSAL OR MARKETING MATERIALS. Scope: Prepared and implemented several phases of remedial investigation to delineate lateral and vertical extent of perchlorate in soil and groundwater for design of an on-site remediation system at the site of a former flare manufacturing facility. Perchlorate has been detected in on-site soil, and on-site and off-site groundwater extending from the site and to depths in excess of 600 feet below ground surface. AMEC identified and implemented innovative monitoring well installation techniques, in situ aquifer testing procedures, and groundwater sampling methods. AMEC devised several monitoring and evaluation programs to save the client additional future remediation and monitoring well installation costs.

Hunters Point Naval Shipyard Parcel A Environmental Consulting Services, Lennar / BVHP, LLC, San Francisco, CA, United States. 053085, 850,000, 2012. Project Geologist. Provided review of and recommendations on existing documents. Lennar achieved compliance with regulatory requirements with Amec Foster Wheeler's assistance. Performed air/dust monitoring at Hunters Point. Scope: Environmental consulting services to support client's legal counsel, address special requests for information from project stakeholders, and present information at planning and technical meetings as part of ongoing effort to redevelop Parcel A of area formerly occupied by U.S. Naval shipyard. Provided review of and recommendations on existing documents. ***Lennar achieved compliance with regulatory requirements with AMEC's assistance.***

Leviathan Mine Field Support (IWO), Atlantic Richfield Company, Markleeville, CA 115724, 75,600, 2011. Field Geologist. Performed drilling and exploration services at Leviathan Mine. Scope: Drilling and exploration services at Leviathan Mine. This site is an abandoned open-pit sulfur mine located in Alpine County, California. The mine is located at on the eastern slope of the Sierra Nevada at about 7,000-foot (2,100 m) elevation, 6 miles (9.7 km) east of Markleeville and 24 miles (39 km) southeast of Lake Tahoe. The mine site comprises approximately 250 acres.

Brownfields Land Recycling Program, Nevada Division of Environmental Protection (NDEP), Henderson, NV, United States. 010476, 850,000, 2007. Geologist. Responsible for writing the Work Plan and Sampling and Analysis Plan for future excavation work to remove lead contamination at a former firing range. Scope: Master Services Agreement for 4 years to provide brownfields assessment and cleanup services in a statewide program to recycle / redevelop brownfields sites. ***Project included successful completion of cleanup of almost a century's worth of waste materials at the Northern Nevada Railway Museum (Ely, NV), which allowed continuation of preservation efforts, and should improve attendance and increase local revenue because more historical buildings on the site will soon be open to the public.***

Queen of the Valley Medical Center Geotechnical Engineering Services, St. Joseph Health System, Napa, CA 107815, 127,000, 2011. Field Geologist. Served as Field Geologist with responsibility for overseeing the exterior site grading and pavement construction. Scope: Geotechnical engineering services during the construction of the new, three-story acute care building in Napa. Building footprint dimensions are 105 x 225 feet.

Site Closure Environmental Services, The Presidio Trust, San Francisco, CA, United States. 008379, 6,655,330, 2011. Geologist. Oversaw the installation of Test pits to determine the extent of fill materials and contaminants, install soil borings and test pits to determine extent of asphalt roofing materials, log soils and debris across site, collect soil samples, and assist in results report. As a Field Geology Professional, conducted field operations for a subsurface investigation, assisted in writing a technical memorandum and Corrective Action Plan, wrote a Corrective Action Implementation Work Plan, and attended site meetings with clients and regulators. Also assisted with developing a master reference cost spreadsheet and providing quality assurance/control of several cost spreadsheets used to price remedial options for Corrective Action Plans. Produced investigation reports for multiple sites within the Presidio. Performed field investigations (i.e., surface sediments and shallow soil borings) at Building 1450/1451, Nike Facility, and Building 1369 sites to specify excavation areas, amounts to be excavated, procedures, and remedial methods to be used in site cleanup.

- For Fill Site 1 and Landfill 2, provided drilling oversight for the installation of hollow stem auger soil borings to delineate the boundaries of the debris, fill, and native materials.
- For Building 1065, developed construction completion report. Also authored Corrective Action Implementation Work Plan; oversaw field work, including excavation, collection of soil and water samples, land use control cap inspection; served as regulatory liaison between Presidio and regulators to complete work in a manner acceptable to all parties.
- Assisted with the production of pre-remedial investigation Work Plans, Corrective Action Plans, a technical memorandum, and investigation reports for multiple sites within the Presidio; performed field investigations (surface sediments and shallow soil borings) at Building 1450/1451, Nike Facility, and Building 1369 sites to specify excavation areas, amounts to be excavated, procedures, and remedial methods to be used in site cleanup.
- Oversaw the installation of Test pits to determine the extent of fill materials and contaminants, install soil borings and test pits to determine extent of asphalt roofing materials, log soils and debris across site, collect soil samples, and assist in results report.

Environmental services associated with site closure, including site investigation, risk assessment, feasibility study (FS), engineering design, data management, ecological risk assessment, remediation, and reporting at historic 1,416-acre former military base at the south end of the Golden Gate Bridge.

Environmental Services at 8 Army Reserve Centers, Kemron - North Division, Seven U.S. Department of the Army - Northern Region Contracting Center, US, United States. 040979, 3,387,120, 2010. Project Geologist. Responsible for remediation implementation for Camp Parks Site and organized remediation field efforts and reporting. Scope: Full range of environmental and technical services at eight U.S. Army installations in five states (Massachusetts, Connecticut, Rhode Island, Maine, and California) addressing soil and groundwater contamination at landfills, underground storage tank sites and other waste storage and disposal sites. Work included remedial investigations / feasibility studies (RI/FS) and environmental remediation design services.

Fort Ord Operable Unit (OU) Habitat Remedial Investigation / Feasibility Study (RI/FS), U.S. Army Corps of Engineers (USACE) – Huntsville District, Monterey, CA, United States. 027629 FTORD, 20,000,000, 2009. Project Geologist. 1) Responsible for gathering, reviewing, and summarizing historical data for a Basewide RI/FS. Assisted with the development of tables and site maps and addressed agency comments regarding the RI/FS. Assisted in developing and writing a Technical Memo for part of the Base detailing the site history and proposed scope of future work. 2) Assisted in data gathering and writing of a technical memorandum and assessment approach for multiple sites across Fort Ord. Assisted in design of the RI pathways and methods. Scope: Since 2004, AMEC has been conducting full remediation investigation / feasibility study (RI/FS) to address munitions and explosives of concern (MEC) at the Impact Area Munitions Response Area (MRA) for 6,500 acres of a 8,000-acre former U.S. Army training range complex (small arms to artillery fire). Activities included planning, site characterization, archival (historic) search, risk assessment (human health), feasibility study, and community relations support.

Unlinked Amec Foster Wheeler projects

Industrial Hygiene Services, 50 California Street, Shorenstein Realty Services, San Francisco, CA, United States. 8415180450. Ongoing. Industrial Hygiene Technician. Performed annual Heating, Ventilation, and Air Conditioning (HVAC) and Transmission Electron Microscopy (TEM) surveys and reporting to monitor the air quality and performance of the HVAC system to ensure compliance with applicable health and safety standards.

Environmental Services, MDC Engineered Process Solutions, Hayward and San Jose, CA, United States. 8615180420. Geology Professional. Performed site inspection (phase I environmental screening analysis) and comprehensive compliance audit of environmental program.

Environmental Services, California Paperboard Company, Santa Clara, CA, United States. OD13165230. December 2015. Geologic Professional. Performed permitting, job preparation and setup, and field oversight for the installation of two monitoring wells, direct push soil borings, and soil vapor wells. Performed site oversight for the removal and over excavation of three undocumented underground storage tanks (USTs) and performed set up and sampling of groundwater, over excavation soil samples, and soil vapor.

Environmental Services, Hertz Northfield QTA Facility, Oakland, CA, United States. Ongoing. Geologic Professional. Performed field oversight and reporting for the installation and sampling of 25 direct push soil borings, three test trenches, and six groundwater monitoring wells to evaluate the site conditions, transport mechanisms, and extent of the hydrocarbon plume. Performed oversight and soil sampling for over excavation and removal of impacted soils in source area.

Environmental Services, Alameda Naval Yard – Site 6, Alameda CA, United States. 5023136030. Geology Professional. Performed operations and oversight of 2 subcontractors during the extraction and injection activities of 30+ wells and 20,000 gallons of injection materials. Scheduling, set-up, and operation of post-injection groundwater monitoring activities.

Environmental services, Former Honeywell Site, Newark CA, United States. OD14171100. Geology Professional. Performed oversight and soil logging for the installation of 29 injection wells and four groundwater monitoring wells.

Environmental Investigation Chevron Estero Facility, Chevron, Morro Bay, CA, United States. OD11161540. Estimate completion: April through October 2012. Geologic Professional. Performed job preparation and field oversight for the installation of four well pairs using hollow stem auger and attempted water supply wells using air-rotary drilling techniques. Oversaw well development and pump testing of one water supply well. Helped to develop an asbestos monitoring/abatement plan and performed the asbestos monitoring and oversight during drilling through rock containing naturally occurring asbestos (NOA).

Environmental Services, Fort Hunter Liggett, U.S. Army, Jolon, CA, United States. 4084106586.02.3. June 2011. Geologic Professional. Performed field oversight for the installation of direct push borings using a membrane interface probe and a ultra-violet optical screening tool to detect free product and PAHs to get an estimate of the vertical and horizontal extent of the hydrocarbon plume and determine any data gaps in the monitoring well setup.

Santa Rosa Service Center, CONFIDENTIAL CLIENT, Pacific Gas and Electric, Santa Rosa, CA, United States. 013045005H.2. Geologic Professional. Performed field oversight for the installation of sub-slab and subsurface soil vapor sampling probes and direct push soil borings onsite and offsite. Soil vapor sampling probes and onsite soil borings were installed inside buildings using limited access rigs.

Mojave National Preserve, National Park Service, Mojave, CA, United States. Geology Professional. Performed planning, field oversight, sampling, and reporting in conjunction with excavation work at three sites within the preserve. Site work performed for auditing purposes and to allow for site closures.

Continued...

Site Conceptual Model and Corrective Action Plan, Mariposa Ranger Unit Headquarters, Mariposa, CA, United States. Geology Professional. Developed and wrote a Site Conceptual Model and Corrective Action Plan recommending hydrogen peroxide injection to treat residual hydrocarbon concentrations in groundwater at the subject site. Wrote the fourth quarter 2005 quarterly monitoring and sampling report.

Camp Parks, Corrective Action Plan, Dublin, CA, United States. Geology Professional. Wrote corrective action plan and helped to compile data from site conceptual model, assessment report, and CAP into one coherent report. Allowed for future excavation of contaminated soils and providing remedy in place to allow for property transfer. Provided oversight of excavation and injection activities to finish cleanup activities at site and help to develop results and closure report which allowed final site closure.

Circuit City, Puyallup, WA, United States. Geology Professional. Setup drilling, performed pre-drill protocols, wrote HASP, coordinated equipment shipment (for out of state job), and oversaw drilling of 2 hollow stem auger borings to geotechnical data for new loading dock.

Phase I Environmental Site Assessments, Pacific Oroville Power, Inc., Oroville, CA, United States. 3031122016. Geologic Professional. Performed a Phase 1 Environmental Site Assessment at the former power plant for use as due diligence as part of a potential property transaction. Wrote the report detailing the findings of the site visit.

Caitlin Elizabeth Brice, M.Sc.

315 Bellerose Dr. Apt. 2
San Jose, CA 95128
Tel. 954-651-3395
caity63@yahoo.com
LinkedIn Profile

EDUCATION

Nova Southeastern University, Master of Science in Marine Biology **May 2014**
Thesis title: "The Detection of Amazonian Manatees (*Trichechus inunguis*) Using Side-Scan Sonar and the Effect of Oil Activities on Their Habitats in Eastern Ecuador" GPA: 3.79
http://nsuworks.nova.edu/occ_stuetd/8/
GRE: Verbal – 530, Quantitative – 750, Writing – 4.5

St. Andrews University, Introduction to Distance® Sampling **August 2012**

Drury University, Bachelor of Arts in Biology and Chemistry (with Honors) **May 2009**
Minor in Global Studies GPA 3.95
Summa Cum Laude
ACT: 31

PROFESSIONAL EXPERIENCE

Accutest Northern California, Quality Assurance Officer **Jan. 2015 – Present**

- Manage, enforce, and audit the quality systems, procedures, data, reports, and analyst competency at a certified environmental laboratory for conformance to NELAC, DOD, DOE, ISO, and EPA requirements, state specific requirements (CA, AK, AZ, OR, WA, NV), client specific objectives, and improvement of laboratory performance.

Florida Spectrum Environmental Services, Inc., Quality Assurance Director **Dec. 2012-Jan. 2015**

- Direct, enforce, and audit the quality systems, procedures, data, reports, and analyst competency at five certified laboratories for conformance to NELAC, FDOH, FDEP, and EPA requirements, client specific objectives, and improvement of laboratory performance.

Florida Spectrum Environmental Services, Inc., **Feb. 2010 – Dec. 2012**
Analytical Chemist and Microbiologist

- Performed EPA methods in inorganics, organics, extractions, and microbiology in solid, water, and chemical matrices.
- Analyzed samples using HPLC, IC, GC/MS, Flow Analyzers, Discrete Analyzers, Block Digesters, Distillation Units, and Incubators.

RESEARCH EXPERIENCE

Nova Southeastern University, Graduate Research Assistant **August 2010 – May 2014**

- Collected water samples, conducted interviews, and performed side-scan sonar surveys to detect Amazonian Manatees and investigate their population ecology in the rivers and lagoons of the Amazon River basin in Eastern Ecuador. Field time: 6 weeks.

Newfound Harbor Marine Institute Seacamp, Research Intern **May 2006**

- Surveyed marine life in Big Pine Key, FL.

TEACHING EXPERIENCE

Nova Southeastern University, Laboratory Assistant **Aug. 2009-May 2011**

- Assisted with the set-up and teaching of Biology 101 laboratory classes.

PUBLICATIONS

Brice, Caitlin E. 2014. "The Detection of Amazonian Manatees (Trichechus inunguis) Using Side-Scan Sonar and the Effect of Oil Activities on Their Habitats in Eastern Ecuador." http://nsuworks.nova.edu/occ_stuetd/8.

Brice, Caitlin. October 2011. "The Status of Amazonian Manatees (*Trichechus inunguis*) and Their Habitats in Eastern Ecuador". Sirenews. Number 56. www.sirenian.org/sirenews/56OCT2011.pdf

PRESENTATIONS

Florida Marine Mammal Health Conference, Poster Presenter **April 2012**
"Oil Effects on the Amazonian Manatee (*Trichechus inunguis)* in Eastern Ecuador: Evaluating the Risks"
Southeast and Mid Atlantic Marine Mammal Symposium, Oral Presenter **March 2012**
"Oil Effects on the Amazonian Manatee (*Trichechus inunguis*) in Eastern Ecuador: Evaluating the Risks"
19th Biennial Conference on the Biology of Marine Mammals, Oral Presenter **Nov. 2011**
"The Status of Amazonian Manatees (*Trichechus inunguis*) and Their Habitats in Eastern Ecuador"
Fifth Annual International Sirenian Symposium, Oral Presenter **Nov. 2011**
"The Status of Amazonian Manatees (*Trichechus inunguis*) and Their Habitats in Eastern Ecuador"

SKILLS

Superior Organization and Communication
Management of Multiple Teams Effectively Toward a Common Goal
Rapid Learning and Adaptability
Trained Protected Species Observer (PSO)
Certified PADI Open Water Diver
Proficient with Laboratory Internal Management Systems (LIMS), JMP®, Humviewer®, ArcGIS®, Agilent ChemStation®, Distance® software, and Microsoft® Office
Intermediate Spanish Reading, Writing, and Conversational Skills
Violinist

HONORS AND AWARDS

First Place - Southeast and Mid Atlantic Marine Mammal Symposium (2012)
Walter H. Hoffman Chemistry Award for outstanding academic performance (2009)
Beta Beta Beta, Chi Chapter Inductee – Biology Honor Society (2008)
Omicron Delta Kappa – Leadership Honor Society Inductee (2008)
National Honor Society (Inducted 2003)
Concert Master – Drury Chamber Orchestra and Drury String Quartet (2007-2009)
Girl Scout Gold Award Recipient (2008)
Community Leadership Scholarship (2005)
Elk's Lodge Scholarship (2005)
Presidential Academic Scholarship (2005)
Presidential Musical Scholarship for Violin (2005)
Women in Science Award (May 2005)

ORGANIZATIONS AND AFFILIATIONS

Marine Animal Rescue Society (MARS) – Trained Volunteer
The Society of Marine Mammalogy
Florida Society of Environmental Analysts (FSEA)
The NELAC Institute (TNI)
American Chemical Society

REFERENCES

Dr. Caryn Self-Sullivan, Ph.D.
Areas of Expertise: Marine Mammal Surveys and Surveys in Remote Areas
Major Thesis Advisor - Nova Southeastern University Oceanographic Center
Co-founder - Sirenian International, Inc.
540-287-8207
cs1733@nova.edu

Dr. Donald McCorquodale, Ph.D.
Areas of Expertise: Environmental Assessments, Project Management, and Microbiology
Thesis Committee Member - Nova Southeastern University Oceanographic Center
Founder, Former Quality Assurance Director, Microbiologist, and Mentor - Florida Spectrum Environmental Services, Inc.
954-258-4630
mccorq@nova.edu

Richard Vicchiarelli, M.S.
Areas of Expertise: Analytical Chemistry
Chemist – Florida Spectrum Environmental Services, Inc.
954-547-4296
vicchi@bellsouth.net

Dr. Daniel Gonzalez-Socoloske, Ph.D.
Areas of Expertise: Marine Mammal Surveys and Side-Scan Sonar Surveys
Thesis Committee Member – Andrews University
Associate Editor – Latin American Journal of Aquatic Mammals
gonzalezd@andrews.edu

Dr. Roger Reep, Ph.D.
Areas of Expertise: Florida Manatees and Marine Mammal Surveys
Thesis Committee Member – University of Florida
reepr@ufl.edu

SGS ACCUTEST

Professional Summary

Name: **Norman Farmer**
Title: **Corporate Technical Director,**
SGS Accutest Inc.

Education: BS Chemical Oceanography
Florida Institute of Technology

Post Baccalaureate Study
Florida Institute of Technology

Employment History:

2014 – present	Accutest Laboratories Southeast, SGS-Accutest Technical Director, Corporate Technical Director
2001 – 2014	Accutest Laboratories Southeast Technical Director
1996 – 2001	Accutest Laboratories Southeast Organics Manager
1994 – 1996	Orlando Laboratories, Inc. Organics Supervisor (Semivolatiles)
1991 – 1994	Orlando Laboratories, Inc. Senior GC/MS Analyst
1990 – 1992	Orlando Laboratories, Inc. Extraction Supervisor

Experience/Qualifications:

Mr. Farmer currently oversees the technical operation for SGS-Accutest. This includes co-ordinating projects between the facilities, project review, Research and Development oversight, instrumentation acquisition and method validation. In addition, Mr. Farmer is responsible for creating and maintaining project specific requirements in the LIMS and EDD development.

Mr. Farmer is also active on various regulatory committees and advisory groups.

Prior Mr. Farmer managed the Organics Department of Accutest Laboratories' Southeast Lab. The laboratory utilizes GC, GC/MS, and HPLC instrumentation to analyze samples by EPA 600 and 8000 Series Methods.

Mr. Farmer is familiar with the various QC and reporting criteria for Navy, U. S. Army Corps of Engineers, and AFCEE. Mr. Farmer reviews Quality Assurance Project Plans to ensure that all data quality objectives and reporting requirements are met by laboratory.

SGS ACCUTEST

Professional Summary

Name:	**Elvin Kumar**
Title:	**Project Manager** **SGS Accutest Inc. – Orlando**
Education:	Auckland University of Technology, New Zealand. **2004** Fiji Institute of Technology Bachelor of Applied Science (Environmental Studies)
	Fiji Institute of Technology Diploma in Environmental Science

Additional Professional courses/Certificates

40 Hour HAZWOPER – 29CFR 1910.120(e)
DOT 49 CFR 172.704 - Hazardous Material Transportation
IATA-Shipping Dangerous Goods by Air
Compliance Solution Occupational Trainers, Inc.

Employment History:

2016-Present	SGS Accutest – Orlando Project Manager
2013-2016	SGS Accutest – San Jose Project Manager
2008-2013	Accutest Laboratories, Northern California Sample Control Manager/Safety Officer
2007-2008	Entech Analytical Labs, Santa Clara Laboratory Technician
2005-2006	Emperor Gold Mining Co., Fiji Islands Environmental Technician/EHS/Field Sampler

Experience/Qualifications:

Mr. Kumar is currently a Project Manager for the SGS Accutest – Orlando, assisting both commercial clients and clients serving the Department of Defense. His background includes client services, sample management and routine interface with various departments to ensure timeliness of sample analyses. His responsibilities include management of client projects, addressing client inquiries and issues, and preparing sample bottle orders. Additionally, Mr. Kumar acts as a liaison between the clients and various laboratory departments to ensure timeliness of data and addressing project-specific requirements.

Professional Summary

Name: **Svetlana Izosimova**
Title: **Quality Assurance Officer**
Southeast Regional Laboratory

Education: B.S./M.S. – Chemical Engineering
Waste Recovery Technology – 1987, Leningrad Institute of Pulp and Paper Industry, Russia.

Ph.D. – Colloid Chemistry, “Physical-Chemical Basis of Pulp Deresination Using Surfactants” – 1991, Leningrad Institute of Pulp and Paper Industry, Russia.

Employment History:

2001 – Present	Accutest Laboratories Southeast, SGS Accutest - Orlando Quality Assurance Officer
2000 – 2001	STL Tampa East, Tampa, FL MS/Semivolatiles Section Leader
1999 – 2000	PBS&J Analytical Services, Orlando, FL Quality Assurance Officer
1991 – 1998	PBS&J Analytical Services, Orlando, FL GC/MS Analyst
1987 – 1991	Leningrad Institute of Pulp and Paper Industry, Russia Researcher, Junior Grade

Experience/Qualifications:

Ms. Izosimova is currently the Quality Assurance Officer for Accutest Laboratories Southeast. She is responsible for implementing the Corporate Quality Assurance Program in the Southeast Laboratory. Ms. Izosimova has 25 years of experience in environmental analytical chemistry, organic and inorganic testing instrumentation, and industrial hygiene. Ms. Izosimova has served as a QA Officer for projects performed under U.S. Department of Defence.

ATTACHMENT C

Field Documentation Forms

1. Example Field Daily Logbook
2. Water Level Field Data Worksheet
3. Passive Diffusion Sampler (PDS) Groundwater Sampling Form
4. Groundwater Sampling and Pressure Levels Form for Westbay Wells
5. Water Level Indicator Calibration by Steel Tape
6. Ahtna Daily Site Safety Tailgate / Inspection Log
7. Task Specific Health and Safety Worksheet
8. Fort Ord Munitions and Explosives of Concern (MEC) Incident Reporting Form
9. Wood Chain of Custody Form
10. Ahtna Chain of Custody (Water / Soil)
11. Example Sample Labels
12. Post-Treatment Parameter Monitoring Form

Pm Jeff Fenton
Ft. Ord. GW monitoring Q406
12/14

Team 2
SB/JK
Sounder 36392
Cor. -.06

0746 @ MW-02-04-180 WL - 94.57
Cor - -.06
SN2 @ 103'

0757 sampled # 0650L002024F
Dropped 1@2

0808 @ mw-12-05-180 WL - 74.61
Cor - -.06
SN3 @ 88'

18
0820 sampled # 0650L012025F & 026D
Dropped 1@3

0835 @ MW-10-04-180 WL - 259.75
Cor. -.06
SN2 @ 271'

0845 sampled # 0650L010027F
Dropped 1@2

0902 @ MW-OU2-25-A WL - 129.38
Cor. -.06
SN4 @ 146'

0910 sampled # 0650LOU2028F
Dropped 1@4

0919 @ MW-OU2-53-180 WL - 204.09
Cor. -.06
SN5 @ 259'

0927 sampled # 66500U2029F
Dropped 1@5

0934 @ MW-OU2-39-180 WL - 203.99
Cor. -.06
SW4 @ 244'

0943 sampled # 0650LOU2030F
Dropped 1@4

Team 2
SB/JK
12/14/06

0950 @ mw-OU2-24-180 WL - 187.97
Cor. -.06
SN 3 @ 214

1002 sampled # 0650LOU2031F
Dropped 1@3

1009 @ MW-OU2-09-180R
SN2 @ 199' WL - 156.08
Cor. -.06

1022
1024 sampled # 0650LOU2032F & 033D
Dropped 1@2

1029 @ MW-OU2-06-A WL - 106.26
Cor. -.06
SN6 @ 128'

1039 Sampled # 0650LOU2034F
Dropped 1@6

1046 @ MW-OU2-06-180R WL - 157.87
Cor. -.06
SN 4 @ 214'

1053 sampled # 0650LOU2035F (MS/MSD)
Dropped 1@4

1110 @ MW-OU2-07-180R WL - 182.36
Cor. -.06
SN3 @ 233'

1117 sampled # 0650LOU2036F
Dropped 1@3

1123 @ MW-OU2-05-180 WL - 155.49
Cor. -.06
SN4 @ 215'

1130 sampled # 0650LOU2037F
Dropped 1@1

Field Activity Daily Logbook

Water Level Field Data Worksheet

For Event: WL2011Q2, 2011 2nd Quarter water levels

Team: 3 Sounder Serial #:________ Calibration Diff :_________ Initials::_________ Scheduled Sampling Date: 06/20/ 2011

Station Name	Plate #	Notes	Avg. DTW (ft)	Date	Time	Measured DTW:1	Measured DTW: 2	Calibration Difference from Steel Tape	Calc. DTW	Total Depth (ft)	Measured Total Depth	Comments
MP-BW-34-492		westbay	140									
MP-BW-34-537		westbay	141									
MP-BW-35-242		westbay	146									
MP-BW-35-312		westbay	152									
MP-BW-35-366		westbay	152									
MP-BW-35-467		westbay	151									
MP-BW-35-527		westbay	151									
MP-BW-35-562		westbay	153									
MP-BW-35-402		westbay	152									
MP-BW-37-178	4	westbay	143							477.		
MP-BW-37-193	4	westbay	143							477.		
MP-BW-37-303	4	westbay	146							477.		
MP-BW-37-328	4	westbay	146							477.		
MP-BW-37-368	4	westbay	146							477.		
MP-BW-37-398	4	westbay	145							477.		
MP-BW-38-327	5	westbay	139							457.		
MP-BW-38-341	5	westbay	132							457.		
MP-BW-38-353	5	westbay	135							457.		
MP-BW-38-368	5	westbay	139							457.		
MP-BW-38-418	5	westbay	139							457.		
MP-BW-39-310	4	westbay	152							467.		
MP-BW-39-330	4	westbay	152							467.		
MP-BW-39-350	4	westbay	152							467.		
MP-BW-39-395	4	westbay	151							467.		
MP-BW-40-333	5	westbay	142							496.		

Reviewed by ________________________ Date ____________

Passive Diffusion Sampler (PDS) Groundwater Sampling Form
Former Fort Ord Groundwater Sampling Program

wood.

Project_Task Number: ____________________ Sampled By: __________
Task Manager: ____________________
Team Number: __________ Site Report: __________
Recorded by: ____________________
Reviewed by: ____________________ Water Level Indicator Serial #: __________

Well	# Stations	Sample Number	Dup	Bag Sampled	# of bottles	Analysis	Pres.	Lab	Sample Date	Sample Time	Bag Drop	DTW	Cooler Temp.

Quality Control Samples

Type		Sample No.

General Comments: ____

wood.

Groundwater Sampling and Pressure Levels Form for Westbay Wells

Project Number: ______________________

Task Manager ______________________

Technicians: ______________________

Recorded By: ______________________ / ______
(Signature) (Initials)

Reviewed By: ______________________ / ______
(Signature) (Initials)

Well Name: ______________________

Sample Date: ______________________

Barometric Pressure: ______________

Sample Time: **Start:** ______________
Finish: ______________

Sample # First Port: ______________________

Client: USACE

Location: Former Fort Ord

Probe Type: West Bay

Probe Serial No.: ______________

Port Identification			**Surface Functioning Tests (Probe in Flushing Collar)**						**Position Sampler**	**Pressure Test and Sample Collection Check at Port (Pressure Test) (Sample Collection)**								
Port No.	Port Name	Port Depth (Cable)	Arm Out Land Probe Shoe Out	Close Valve	Check Vacuum	Open Valve	Evacuate Container	Close Valve Shoe In	1. Locate Port 2. Arm Out 3. Land Probe	Pressure in MP (Internal)	Shoe Out	Zone Pressure (External)	Open Valve	Zone Pressure (External)	Close Valve	Shoe In	Pressure in MP (Internal)	Last 4 Digits of Sample #
1	**282**		☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
2	**317**		☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
3	**342**		☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
4	**397**		☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
5	**467**		☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
6	**537**		☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		
			☐	☐	☐	☐	☐	☐	☐		☐		☐		☐	☐		

General Comments: **Cooler Temp:** °C

QC Sample # Associated Sample:

Page ______ of ______

Second Quarter, 2008

4084086506 02.1.1

Fort Ord Quarterly Groundwater Monitoring Program

Water Level Indicator Calibration by Steel Tape

Well #:	
Steel Tape DTW:	
Date:	

Serial No.	Measured DTW	Calibration Differential

Reviewed by:	
Date:	

AHTNA DAILY SITE SAFETY TAILGATE / INSPECTION LOG

GENERAL DATA	**Date:**
Site:	Site Location:
AHTNA Site Manager:	AHTNA SSHO:

DOCUMENTATION OF WORKDAY SAFETY MEETING (List Topics of Discussion**):**

Other items to address as appropriate (**check those discussed**):

- ☐ Scope of day's work
- ☐ Site SH&E Plan / Revisions
- ☐ AHA's / PTSP's completed/reviewed?
- ☐ Emergency SOPs (i.e. rally pt., tele #s)
- ☐ Communications Check
- ☐ PPE Requirements
- ☐ OSHA's Focus Four
  - ☐ Fall Hazards
  - ☐ Electrical Hazards
  - ☐ Struck-by Hazards
  - ☐ Caught in / between Hazards
- ☐ Other Primary Hazards
- ☐ Recent near miss / injuries / lessons
- ☐ Lifting Safety / Materials Handling
- ☐ BBS Hazard Triggers[1]
- ☐ BBS Trigger Controls[2]
- ☐ Other (heat, noise, trench, confine sp)

MEETING ATTENDEES: (place * next to subcontractor safety representatives**)**

NAME / COMPANY		NAME / COMPANY

SUBCONTRACTOR SAFETY REPs COMMENTS**?**

DAILY INSPECTIONS: (SSHO shall initial each completed applicable inspection item)

Y	N	NA	Inspection Item	Y	N	NA	Inspection Item	Y	N	NA	INSPECTION ITEM OTHER (List)
☐	☐	☐	Postings/Plans (APP) readily avail.	☐	☐	☐	Signs (No Smoking, Site Control)	☐	☐	☐	
☐	☐	☐	Designated Parking / Traffic Control	☐	☐	☐	PPE(head/eye/foot/hand/ear/body)	☐	☐	☐	
☐	☐	☐	Subcontractor Safety Rep Involved	☐	☐	☐	Hi-Vis, PFD's, Ring Buoys, Etc.	☐	☐	☐	
☐	☐	☐	Subcontractor / Task AHA's	☐	☐	☐	Excav./Trench/Spoils Protection	☐	☐	☐	
☐	☐	☐	Subcontractor Equip. Inspections	☐	☐	☐	Confined Spaces Management	☐	☐	☐	
☐	☐	☐	Emergency Equip. (PFE's, FA Kits)	☐	☐	☐	Physical Barriers / Covers	☐	☐	☐	
☐	☐	☐	Eye Wash / Shower	☐	☐	☐	Fall Hazards (Protected)	☐	☐	☐	
☐	☐	☐	Communications Check	☐	☐	☐	Ladders	**ISSUES TO FOLLOW-UP**			
☐	☐	☐	Sanitation (Toilets, Hand Wash)	☐	☐	☐	Power & Portable Hand Tools	(Immediately Correct Deficiencies if able)			
☐	☐	☐	Water & Shade, Non-Pot Identified	☐	☐	☐	Company Field Equipment				
☐	☐	☐	Utilities Identified / Controlled	☐	☐	☐	Alarms / Seatbelts				
☐	☐	☐	Material Storage Proper	☐	☐	☐	GFCI's, Whip-Checks, Slings				
☐	☐	☐	Lay Down Areas Orderly	☐	☐	☐	Exposed Rebar Protected				
☐	☐	☐	Waste Containers	☐	☐	☐	Safety / Health Behaviors:				
☐	☐	☐	Spill Control (Pads, Snakes, Drums)	☐	☐	☐	Competent / Qualified Persons				

Immediately Correct any deficiencies. Note any uncorrected deficiencies on the APP Safety and Occupational Health Deficiency Tracking Log.

Comments/Field Notes:

I acknowledge that above elements performed (SSHO/Inspector signature): **Date:**

---

[1] **BBS Triggers**: (e.g. Distractions, rushing, short-cuts, frustration, exhaustion, complacency, anger, multi-tasking, mind elsewhere)

[2] **BBS Trigger Controls**: (e.g. communicating, accountability, patience, relaxation techniques, healthy lifestyle, and adequate sleep).

AHTNA DAILY SITE SAFETY TAILGATE / INSPECTION LOG

Additional MEETING ATTENDEES: **(**place * next to subcontractor safety representatives**)**

NAME / COMPANY		NAME / COMPANY

NOTES / COMMENTS / SKETCHES

TASK SPECIFIC HEALTH AND SAFETY WORKSHEET
SUPPLEMENT TO THE PROGRAM HEALTH AND SAFETY PLAN

This worksheet shall be used in conjunction with the AHTNA Accident Prevention Plan, March 2015, and the U.S. Army Corps of Engineers Safety and Health Manual, EM 385-1-1, November 2014.

GENERAL PROJECT INFORMATION

Project Number:______________________________
Site or Activity Description:____________________
____
Location Description:_________________________

Date:__________________________________
Prepared by:_____________________________
Reviewed by:____________________________

TASK DESCRIPTION (Check all that apply)

______Sample Location Marking
______Geophysics borehole clearance
______Biological borehole clearance
______Monitoring well installation
______Soil Borings
______Trenching
______Hand augering
______Soil gas survey
______Geophysics
______Groundwater sampling
______Soil sampling
______Other (specify)______________________________
_____Water level surveys
_____Sediment sampling
_____Biological inventory
_____Hazardous waste handing /mgmt
_____Hydropunch

SITE HAZARDS (check all that apply)

______Contaminated water
- _____VOC
- _____SOC
- _____Metals
- _____PCB
- _____Pesticides
- _____Petroleum
- _____Chlorinated hydrocarbons
- _____Other (specify_______________

______Contaminated Soil
- _____VOC
- _____SOC
- _____Metals
- _____PCB
- _____Pesticides
- _____Petroleum
- _____Chlorinated hydrocarbons
- _____Other (specify)____________

______Contaminated Air
- _____VOC
- _____SOC
- _____Metals
- _____PCB
- _____Pesticides
- _____Petroleum
- _____Chlorinated hydrocarbons
- _____Other (specify)___________________

______Ionizing radiation (specify)_______
____
______Non-ionizing radiation (specify)
____
______Noise
______Biological hazards (specify) mountain lions, dogs, spiders, snakes, ticks, poison oak__
______Temperature extremes Heat______Cold_________
______Overhead/underground utilities
______Vehicle traffic
______Air traffic/noise
______Unexploded ordnance (UXO)
______Equipment/mechanical
______Other (specify)________________
____

LEVEL OF PROTECTION REQUIRED (A, B, C, or D) _____minimum______maximum
PPE REQUIRED (Check all that apply)

Head:_____hardhat
Eye: _____safety glasses
_____chemical goggles
_____face shield
Ear: _____earplug
_____earmuff
Foot: _____steel-toed boots (specify)____________________
_____disposable overbooties (specify)______________
Hand: _____gloves (check type)
_____Neoprene
_____Viton
_____Nitrile
_____PVC
_____Underglove (type)____________________
_____Other (specify)_______________________

Body: _____ fully encapsulated suit
_____two-piece rain suit
_____apron
_____Tyvek suit
_____Saranex suit
_____hooded Tyvek suit
_____hooded Saranex suit
_____hooded polyethylene suit
_____cloth overalls
_____high visibility vest
_____Other (specify)_____________
Respiratory: _____SCBA (pressure demand)
_____airline respiratory (pressure demand)
_____full face respirator, cartridge=____
_____half mask respirator cartridge=___
_____escape mask/bottle (specify)_____

OTHER SAFETY EQUIPMENT REQUIRED (Check all that apply)

______ventilation blower/fan
______traffic cones
______barrier tape
______blast alarm

______ground fault circuit interrupter
______lifeline with harness
______radiation dosimeter
______first aid kit

______fire extinguisher
______emergency eye wash
______cellular telephone
______Other (specify)____________

REQUIRED CLEARANCES

______Utilities Date Completed:__________
______Biological Date Completed:__________
______Airfield Date Completed:__________
______UXO/EOD Date Completed:__________

______Military Operations Date Completed:_______________________
______ Vehicle traffic area: Date Completed:_______________________
______Archaeological: Date Completed:_______________________
______Other (specify):______Date Completed:_______________________

LIST OF PERSONNEL ASSIGNED TO SITE AND RECORDS VERIFICATION

(Note: SSHO must initial verification that each personnel record is present in field binder.)

NAME	**HAZWOPER CERTIFICATION**	**MEDICAL CLEARANCE**	**RESPIRATOR FIT TEST**	**FIRST AID/CPR**	**CELL PHONE NUMBER**

I have read and become familiar with all aspects of the Site Safety and Health Plan. I also understand that the Site Safety and Health Plan may be supplemented with other site-specific health and safety documents for which I will be held equally responsible.

NAME	**DATE**	**COMPANY**	**SIGNATURE**

USACE PROJECT SITE SAFETY LOG

GENERAL DATA

Job # ____

Activity ____

Location Description ____

____

DOCUMENTATION OF DAILY MORNING SAFETY MEETING:
TOPICS OF DISCUSSION (check all that apply)

______scope of work/SAP
______potential hazards
______health and safety plan highlights/revisions
______emergency procedures

______PPE requirements
______equipment calibration
______special topics (specify)_________
____

MEETING ATTENDEES:

NAME	DATE	COMPANY	SIGNATURE

DAILY INSPECTIONS: (Site crew chief shall initial each completed inspection)

______PPE
______field equipment
______vehicles
______safety equipment
______field health and safety binder in vehicle
______first aid kit

_______required eyewash station filled, and charged
_______fire extinguisher
_______communication check
method_____________________________
time_______________________________

Note any deficiencies:

____

____

I acknowledge that the above health and safety program self audit and inspections have been performed prior to the initiation of scheduled work.

Signature of Site Safety and Health Officer (SSHO)_____________________________________

LIST OF AUTHORIZED VISITORS NOT NORMALLY ASSIGNED TO THIS SITE

(Note: SSHO must initial verification that each personnel record is present in the field binder.)

NAME	HAZWOPER CERTIFICATION	MEDICAL CLEARANCE	RESPIRATOR FIT TEST	FIRST AID/CPR

FORT ORD MUNITIONS AND EXPLOSIVES OF CONCERN (MEC)
INCIDENT REPORTING FORM

If you recognize any object that resembles munitions or explosives on current or former Fort Ord property, retreat to a safe location, and report the finding to the **appropriate agencies immediately** (see below)

A. PROVIDE THE FOLLOWING INFORMATION:

Name of Person Reporting:	Telephone:
Agency:	Fax:
Date & Time of Incident/Discovery:	
Description of Item Found (refer to the "Safety Alert" pamphlet if possible):	
Location (direction from nearest road/building, attach map if possible):	
GPS Coordinate Location: (Type of Instrument, NAD83 California State Plan Coordinates Zone IV, feet)	
Describe how the item was found:	

CONTACT THE APPROPRIATE AGENCIES IMMEDIATELY:

Initial when completed	Mon– Thu (6 a.m. – 5 p.m.) Contact and FAX Form to:	Contact Number	Date & Time Called
	USACE Ordnance Safety Specialist or MMRP Site Safety Manager	Ph: (831) 884-9925 ext.226 Cell: (831) 760-2571 Fax:(831) 884-9030 Ph: (831) 242-7919 Fax:(831) 242-7019 Cell: (831) 760-2575	
	Fri – Sun (24 Hours) 60th Civ Engr Sqdn EOD	Phone: (707) 424-5517	
	Note: If 60th Civ Engr Sqdn EOD is contacted, notify the MMRP Site Safety Manager: (831) 242-7919, Cell (831) 760-2575.		

B. To be completed by USACE Ordnance Safety Specialist when applicable (Mon – Thu)

Form Received By:		Date & Time:
Identification of Item Found:		
Extent of Area Surveyed:		Name of digital file for picture (date):
Disposition of Item:		
Fax completed form to MMRP Site Safety Mgr Bldg 4463 Gigling Rd, POM (Fort Ord) when response complete	Fax: (831) 242-7091 Phone: (831) 242-7919	Date & Time:

C. To be completed by MMRP Site Safety Manager:

Acknowledge Completed Form Received:	Date & Time:
Regulatory Agencies Notified (Date):	

Seq. No. 1389

Lab:

1465 North McDowell Blvd.
Suite 200
Petaluma, CA 94954
(707) 793-3800

CHAIN OF CUSTODY FORM

wood.

Samplers:

Job Number:

Name/Location:

Project Manager:

Recorder:
(Signature Required)

MATRIX				# CONTAINERS						SAMPLE NUMBER	DATE				STATION DESCRIPTION	
Water	Soil	Air		Unpres.	H2SO4	HNO3	HCL				YR	MO	DAY	TIME		DEPTH

ANALYSIS REQUESTED		
8260	8270	TITLE 22 METALS

ADDITIONAL INFORMATION

REPORT TO:

PO#:

TAT:

Comments: Field Filtered Y/N

CHAIN OF CUSTODY RECORD

Relinquished By *(Signature)* *(Print Name)* *(Company)* *(Date/Time)*

Received By (Signature): *(Print Name)* *(Company)* *(Date/Time)*

Relinquished By *(Signature)* *(Print Name)* *(Company)* *(Date/Time)*

Received By (Signature): *(Print Name)* *(Company)* *(Date/Time)*

Relinquished By *(Signature)* *(Print Name)* *(Company)* *(Date/Time)*

Received By (Signature): *(Print Name)* *(Company)* *(Date/Time)*

Method of Shipment:

White - Laboratory Copy Yellow - Project Office Copy Pink - Field or Office Copy

F1008-E

Ahtna

296 12th St
Marina, CA 93933
(831) 384-3735

CHAIN OF CUSTODY

WATER / SOIL

Chain of Custody #: ___________________
Carbon Copies: White - Laboratory Yellow - Ahtna

Project Information:

Project Location: ___________________________________
Sampler/s: ______________________________________
Project Name: ___________________________________
Report To: ______________________________________
Project Number: ___________________________________
E-Mail: ______________________________________
Sampling Event: ___________________________________
Laboratory: ______________________________________

Lab Sample Receipt

Laboratory Sample Delivery
Group #: __________________
Custody Seal: ______________
Temp (°C): ________________

Lab Number	Sample Number/Description	Sample Collection		Matrix			Total # of Bottles	Number of Preserved Bottles								Analysis Requested								Notes
		Date	Time	Water	Soil	Other		HCl	HNO_3	H_2SO_4	NaOH	MeOH	$NaHSO^4$	None	Other									

Turnaround Time: _____: Standard _____: 3-5 Day Rush _____: 48 Hour Rush _____: 24 Hour Rush

Shipment: **Method:** ________________ **Tracking ID:** __________________________________

Comments:

Chain of Custody Tracking:

Relinquished By Sampler:	**Date/Time:**	**Received By:**	**Date/Time:**
Relinquished By:	**Date/Time:**	**Received By:**	**Date/Time:**
Relinquished By:	**Date/Time:**	**Received By Laboratory:**	**Date/Time:**

Wood/Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: Time: ________
Sample #:

Wood/Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: Time: ________
Sample #:

Wood/Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: Time: ________
Sample #:

Wood/Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: Time: ________
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Ft Ord GW Monitoring-
Samplers:
Date: Time: ________
Sample #:

Wood/Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: Time: ________
Sample #:

Wood/Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: Time: ________
Sample #:

Ahtna

POST-TREATMENT PARAMETER MONITORING FORM

Project Information:

Project and Task No.: ____

Project Name: ____

Date: ____

Field Personnel Name/s: ________________________________

Well Information:

Well ID: ____

Total Depth: ___________ **Well Diameter:** _______________

Three Casing Volumes: _______________________________

Parameter Collection Information:

Method of Monitoring: ☐ **Purging** ☐ **Downhole Meter**

Downhole Meter Type and ID: __________________________

Pump Type and ID:___________________________________

Multi-Meter Type and ID:______________________________

Meter Calibration Completed (except Temperature)[1]: ☐

Water Level Information:

Initial Depth to Water: _______________________________________

Depth to Water after Monitoring: _____________________________

Time	Pump Intake Depth	Rate (mL/min)	Cum. Vol. (L)	Temp. (°C)	pH (units)	Specific Electrical Conductance (μS/cm)	Dissolved Oxygen (mg/L)	Oxidation-Reduction Potential (mV)	Turbidity (NTU)	Remarks (color, odor, suspended materials, etc.)

NOTES:

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[1] If the Horiba U-50 Series multi-meter is used, calibration should occur daily. If the YSI 6-Series Multi-Parameter Water Quality Sonde with downhole probe is used, calibration is performed by the vendor and field calibration is not required for field events lasting less than 1 month, unless field conditions present erroneous data or the Sonde experiences mechanical issues.

ATTACHMENT D

Three Phase Quality Control Process and Documentation

INVESTIGATION, MONITORING, O&M PROJECTS
PREPARATORY PHASE INSPECTION COVER SHEET

Contract No.: ____________________ Date: _______________

Task No.: ____________________

Location/Project: ____________________

A. Key Personnel Present:

Name	Position	Company

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
10. ____________________

B. Submittals:

1. Review submittals and/or submittal register. Have all applicable submittals been approved? Yes___ No___

If No, what items have not been submitted?

a. ____________________

b. ____________________

c. ____________________

______________________ USACE Representative Signature

______________________ Quality Control Manager Signature

INVESTIGATION, MONITORING, O&M PROJECTS: PREPARATORY PHASE INSPECTION CHECKLIST

Assessment Activity	**Assessment Mechanism**	**Person(s) Responsible**	**Response Action**	**Completed by/Date**
Have planning documents been prepared in accordance with the statement of work, regulatory requirements, and contract requirements?	Quality control review of document by Project Manager and QC reviewer.	Project Manager, QC Reviewer	Modify document as directed by reviewers	
Prior to project activities: Have planning documents been read by appropriate project personnel (including subcontractors) before work is conducted.	Documentation (e.g., sign-off form, note to file, email acknowledgement) that document has been read and requirements are understood.	Subcontractors as required. Project Manager, Task Manager, and Project Chemist to check signoff and forms.	Direct project personnel to read relevant documents.	
Prior to project activities: Has required preliminary work (e.g., clearance activities, permits, site access) been completed in accordance with project plan.	Comparison of information obtained from preliminary work completion assessment as specified in the project planning document(s).	Project Manager, Safety and Health Officer, QC Manger/Reviewer, Task Manager, Project Chemist, Field Staff	Delay startup if necessary preliminary work has not been completed. Implement corrective actions by directing appropriate personnel or subcontractors to complete necessary preliminary work.	
Prior to project activities: Are staff and subcontractors prepared to implement project activities according to planning documents?	Review and discussion of planned activities prior to implementation.	Project Manager, Safety and Health Officer, Quality Control System Manager, Task Manager, Project Chemist, Field staff.	Delay startup if staff and subcontractors are not prepared to implement activities *in* accordance with specification.	
Prior to project activities: Is necessary field equipment available and in acceptable working order?	Compare field equipment list with planned activities. Compare field equipment calibration documentation with project goals specified in the SAP.	Project Manager, Quality Control System Manager, Task Manager, Project Chemist, Field staff.	Delay startup if equipment is unavailable or not in proper working order. Implement corrective actions to include use of alternate equipment, or recalibration of available equipment.	

INVESTIGATION, MONITORING, O&M PROJECTS
INITIAL PHASE INSPECTION COVER SHEET

Contract No.: ____________________ Date: _______________

Task No.: ____________________

Location/Project: ____________________

Description and Location of Work Inspected: ____

____

A. Key Personnel Present:

	Name	Position	Company
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

____

Quality Control Manager Signature

INVESTIGATION, MONITORING, O&M PROJECTS: INITIAL PHASE INSPECTION CHECKLIST

Assessment Activity	Assessment Mechanism	Person(s) Responsible	Response Action	Completed by/Date
Beginning of project activity: Is work being performed according to project plans?	Conduct field and laboratory audits.	Project Manager, Quality Control System Manager, Task Manager, Project Chemist, Field staff.	Stop work if audits indicate significant deviation from project plan. Implement immediate or long- term corrective actions. Communicate deficiencies to USACE Project Manager.	
Early phase of project: Have necessary audits been performed?	Review project phase and check to see if required audits have *been* satisfactorily completed.	Project Manager, Project Manager, Quality Control System Manager	Stop work if reviewer decides that absence of audit jeopardizes successful implementation of project plans. Immediately schedule necessary audits.	
Ongoing throughout project: Are daily quality control reports being prepared according to contract requirements?	Review Content and delivery schedules of daily quality control reports.	Project Manager, Task Manager, Project Chemist, Project Staff	Correct deficiencies in reports or reporting delays.	
Ongoing throughout project: Do project plans adequately address any changes in project activities or goal?	Compare data gathered to assess conformance to the project plan and conceptual site model.	Project Manager, Safety and Health Officer, Quality Control System Manager, Task Manager, Project Chemist, Field staff.	Stop work if assessor decides that project plan deficiencies are significant. Implement corrective action to include modification of project plans. Notify USACE Project Manager.	
Ongoing throughout project: Do project plans adequately address any changes in project activities or goals?	Compare data gathered to assess conformance to the conceptual site model, data quality objectives, and project plan.	Project Manager, Quality Control System Manager, Task Manager, Project Chemist, data users and evaluators.	Propose additional data collection activities to fill data gaps. Notify USACE Project Manager. Revise or update planning documents as appropriate.	

INVESTIGATION, MONITORING, O&M PROJECTS
FOLLOW-UP PHASE INSPECTION COVER SHEET

Contract No.: ______________________ Date: ________________
Task No.: ______________________
Location/Project: ______________________

Project/Area of Inspection: ____
____
____

A. Key Personnel Present:

	Name	Position	Company
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

B. Definable Features of Work: Status of Inspection:

____
____
____
____
____
____
____
____
____
____
____
____
____

____
Quality Control Manager

INVESTIGATION PROJECT FOLLOW-UP PHASE INSPECTION CHECKLIST

Assessment Activity	Assessment Mechanism	Person(s) Responsible	Response Action	Completed by/Date
Reporting phase of project: Have data reports been prepared in accordance with project plans?	Compare data reports to specifications detailed in planning documents.	Project Manager, Quality Control Manager, Task Manager, Project Chemist, data users and evaluators.	Revise documents and reports as appropriate.	
After draft report submittal or project completion: Are reports adequate to meet client and regulatory agency requirements?	Review client and agency comments. Prepare responses to comments.	Project Manager, Quality Control Manager, Task Manager, Project Chemist, data users and evaluators.	Revise documents and reports as appropriate.	
Have other definable features of work been completed in accordance to project requirements	Compare definable features of work with project requirements.	Project Manager, Quality Control Manager	Complete definable feature of work as required.	

ATTACHMENT E

ADR Library and Qualifier Tables

Project Accuracy and Precision Report

eQapp Name: FtOrd_UFP_QAPP_Rev7
Description: Quality Assurance Project Plan Former Fort Ord, California

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: EPA6010C	**Matrix: AQ**					
QC Type: LCS						
ANTIMONY	7440-36-0		80.00	120.00		20.00
COPPER	7440-50-8		80.00	120.00		20.00
LEAD	7439-92-1		80.00	120.00		20.00
QC Type: MS						
ANTIMONY	7440-36-0		80.00	120.00		20.00
COPPER	7440-50-8		80.00	120.00		20.00
LEAD	7439-92-1		80.00	120.00		20.00
Method: EPA8260-SIM	**Matrix: AQ**					
QC Type: LCS						
1,1-DICHLOROETHANE	75-34-3		81.00	122.00		15.00
1,1-DICHLOROETHYLENE	75-35-4		78.00	137.00		18.00
1,2-DICHLOROETHANE	107-06-2		75.00	125.00		14.00
1,2-DICHLOROETHENE (TOTAL)	540-59-0		76.00	127.00		17.00
1,2-DICHLOROPROPANE	78-87-5		76.00	124.00		14.00
1,3-Dichloropropene (total)	542-75-6		75.00	120.00		23.00
BENZENE	71-43-2		81.00	122.00		14.00
CARBON TETRACHLORIDE	56-23-5		76.00	136.00		23.00
CHLOROFORM	67-66-3		80.00	124.00		15.00
CIS-1,2-DICHLOROETHYLENE	156-59-2		78.00	120.00		15.00
METHYLENE CHLORIDE	75-09-2		69.00	135.00		16.00
TETRACHLOROETHYLENE	127-18-4		76.00	135.00		16.00
TRICHLOROETHYLENE	79-01-6		81.00	126.00		15.00
VINYL CHLORIDE	75-01-4		69.00	159.00		18.00

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: EPA8260-SIM	**Matrix:** AQ					
QC Type: MS						
1,1-DICHLOROETHANE	75-34-3		81.00	122.00		15.00
1,1-DICHLOROETHYLENE	75-35-4		78.00	137.00		18.00
1,2-DICHLOROETHANE	107-06-2		75.00	125.00		14.00
1,2-DICHLOROETHENE (TOTAL)	540-59-0		76.00	127.00		17.00
1,2-DICHLOROPROPANE	78-87-5		76.00	124.00		14.00
1,3-Dichloropropene (total)	542-75-6		75.00	120.00		23.00
BENZENE	71-43-2		81.00	122.00		14.00
CARBON TETRACHLORIDE	56-23-5		76.00	136.00		23.00
CHLOROFORM	67-66-3		80.00	124.00		15.00
CIS-1,2-DICHLOROETHYLENE	156-59-2		78.00	120.00		15.00
METHYLENE CHLORIDE	75-09-2		69.00	135.00		16.00
TETRACHLOROETHYLENE	127-18-4		76.00	135.00		16.00
TRICHLOROETHYLENE	79-01-6		71.00	126.00		15.00
VINYL CHLORIDE	75-01-4		69.00	159.00		18.00
QC Type: SURR						
1,2-DICHLOROETHANE-D4	17060-07-0	30.00	74.00	125.00		
TOLUENE-D8	2037-26-5	30.00	88.00	111.00		
Method: EPA9056A	**Matrix:** AQ					
QC Type: LCS						
Chloride	1003		90.00	110.00		
QC Type: MS						
Chloride	1003		90.00	110.00		20.00

Project Holding Time Report

eQapp Name: FtOrd_UFP_QAPP_Rev7
Description: Quality Assurance Project Plan Former Fort Ord, California

Analyte Group	Sampling to Analysis	Sampling to Extraction	Sampling to Leaching	Leaching to Extraction	Leaching to Analysis	Extraction to Analysis	Units	Rejection Factor
Method: EPA6010C **Matrix: AQ**								
Primary	180.00						Days	2.00
Method: EPA8260-SIM **Matrix: AQ**								
Primary	14.00						Days	2.00
Method: EPA9056A **Matrix: AQ**								
Primary	28.00						Days	2.00

Project Target Analyte Reporting Limit, Blank Contamination, and Lab & Field Duplicate RPD Criteria

eQapp Name: FtOrd_UFP_QAPP_Rev7
Description: Quality Assurance Project Plan Former Fort Ord, California

Target Analyte Name	Analyte Label (CAS)	Quantitation Limit	Detection Limit	Units	Blank Contamination Rule	LabDup RPD	FieldDup RPD
Method: EPA6010C **Matrix: AQ**							
ANTIMONY	7440-36-0	6.0	5.0	ug/L	5.00	20.00	30.00
COPPER	7440-50-8	10	5.0	ug/L	5.00	20.00	30.00
LEAD	7439-92-1	10	3.0	ug/L	5.00	20.00	30.00
Method: EPA8260-SIM **Matrix: AQ**							
1,1-DICHLOROETHANE	75-34-3	0.50	0.25	ug/L	5.00	20.00	30.00
1,1-DICHLOROETHYLENE	75-35-4	0.50	0.25	ug/L	5.00	20.00	30.00
1,2-DICHLOROETHANE	107-06-2	0.50	0.25	ug/L	5.00	20.00	30.00
1,2-DICHLOROETHENE (TOTAL)	540-59-0	1.0	0.25	ug/L	5.00	20.00	30.00
1,2-DICHLOROPROPANE	78-87-5	0.50	0.25	ug/L	5.00	20.00	30.00
1,3-Dichloropropene (total)	542-75-6	0.50	0.25	ug/L	5.00	20.00	30.00
BENZENE	71-43-2	0.50	0.25	ug/L	5.00	20.00	30.00
CARBON TETRACHLORIDE	56-23-5	0.50	0.25	ug/L	5.00	20.00	30.00
CHLOROFORM	67-66-3	0.50	0.25	ug/L	5.00	20.00	30.00
CIS-1,2-DICHLOROETHYLENE	156-59-2	0.50	0.25	ug/L	5.00	20.00	30.00
METHYLENE CHLORIDE	75-09-2	2.0	1.0	ug/L	10.00	20.00	30.00
TETRACHLOROETHYLENE	127-18-4	0.50	0.25	ug/L	5.00	20.00	30.00
TRICHLOROETHYLENE	79-01-6	0.50	0.25	ug/L	5.00	20.00	30.00
VINYL CHLORIDE	75-01-4	0.10	0.050	ug/L	5.00	20.00	30.00
Method: EPA9056A **Matrix: AQ**							
Chloride	1003	250	0.50	mg/L	5.00	20.00	30.00

ADR **Data Qualification Table**

Description	VOA	
	Detect Qualifier	Non-detect Qualifier
Calibration Blank Contamination	U	
Continuing Calibration Verification Percent Difference Lower Estimation	J-	UJ
Continuing Calibration Verification Percent Difference Lower Rejection	J-	R
Continuing Calibration Verification Percent Difference Upper Estimation	J+	
Continuing Calibration Verification Percent Difference Upper Rejection	J+	UJ
Continuing Calibration Verification Relative Response Factor	J	UJ
Continuing Tune	J	R
Equipment Blank Contamination	U	
Extraction to Analysis Estimation	J-	UJ
Extraction to Analysis Rejection	J-	R
Field Blank Contamination	U	
Initial calibration Correlation Coefficient	J	UJ
Initial Calibration Percent Relative Standard Deviation	J	UJ
Initial Calibration Relative Response Factor	J	UJ
Initial Calibration Verification Percent Difference Lower Estimation	J-	UJ
Initial Calibration Verification Percent Difference Lower Rejection	J-	R
Initial Calibration Verification Percent Difference Upper Estimation	J+	
Initial Calibration Verification Percent Difference Upper Rejection	J+	UJ
Initial Calibration Verification Relative Response Factor	J	UJ
Initial Tune	J	R
Internal Standard Estimation	J	UJ
Internal Standard Rejection	J	R
Laboratory Control Precision	J	UJ
Laboratory Control Spike Lower Estimation	J-	UJ
Laboratory Control Spike Lower Rejection	J-	R
Laboratory Control Spike Upper Estimation	J+	
Laboratory Control Spike Upper Rejection	J+	R
Laboratory Duplicate Precision	J	UJ
Matrix Spike Lower Estimation	J-	UJ
Matrix Spike Lower Rejection	J-	R
Matrix Spike Precision	J	UJ
Matrix Spike Upper Estimation	J+	
Matrix Spike Upper Rejection	J+	R
Method Blank Contamination	U	
Preservation	J-	UJ
Sampling to Analysis Estimation	J-	UJ
Sampling to Analysis Rejection	J-	R
Sampling to Extraction Estimation	J-	UJ
Sampling to Extraction Rejection	J-	R
Sampling to Leaching Estimation	J-	UJ
Sampling to Leaching Rejection	J-	R
Surrogate Recovery Lower Estimation	J-	UJ
Surrogate Recovery Lower Rejection	J-	R
Surrogate Recovery Upper Estimation	J+	
Surrogate Recovery Upper Rejection	J+	R
Temperature Estimation	J-	UJ
Temperature Rejection	J-	R
Trip Blank Contamination	U	

ADR **Data Qualification Table**

Description	Metals	
	Detect Qualifier	Non-detect Qualifier
Calibration Blank Contamination	U	
Continuing Calibration Verification Percent Recovery Lower Estimation	J-	UJ
Continuing Calibration Verification Percent Recovery Lower Rejection	R	R
Continuing Calibration Verification Percent Recovery Upper Estimation	J+	
Continuing Calibration Verification Percent Recovery Upper Rejection	R	
Equipment Blank Contamination	U	
Extraction to Analysis Estimation	J-	UJ
Extraction to Analysis Rejection	J-	R
Field Blank Contamination	U	
Initial Calibration Relative Response Factor	J	UJ
Initial Calibration Verification Percent Recovery Lower Estimation	J-	UJ
Initial Calibration Verification Percent Recovery Lower Rejection	R	R
Initial Calibration Verification Percent Recovery Upper Estimation	J+	
Initial Calibration Verification Percent Recovery Upper Rejection	R	
Laboratory Control Precision	J	UJ
Laboratory Control Spike Lower Estimation	J-	UJ
Laboratory Control Spike Lower Rejection	J-	R
Laboratory Control Spike Upper Estimation	J+	
Laboratory Control Spike Upper Rejection	J+	R
Laboratory Duplicate Precision	J	UJ
Matrix Spike Lower Estimation	J-	UJ
Matrix Spike Lower Rejection	J-	R
Matrix Spike Precision	J	UJ
Matrix Spike Upper Estimation	J+	
Matrix Spike Upper Rejection	J+	R
Method Blank Contamination	U	
Sampling to Analysis Estimation	J-	UJ
Sampling to Analysis Rejection	J-	R
Sampling to Extraction Estimation	J-	UJ
Sampling to Extraction Rejection	J-	R
Sampling to Leaching Estimation	J-	UJ
Sampling to Leaching Rejection	J-	R
Trip Blank Contamination	U	

ADR **Data Qualification Table**

Description	GenChem	
	Detect Qualifier	Non-detect Qualifier
Calibration Blank Contamination	U	
Continuing Calibration Verification Percent Recovery Lower Estimation	J-	UJ
Continuing Calibration Verification Percent Recovery Lower Rejection	R	R
Continuing Calibration Verification Percent Recovery Upper Estimation	J+	
Continuing Calibration Verification Percent Recovery Upper Rejection	R	
Equipment Blank Contamination	U	
Extraction to Analysis Estimation	J-	UJ
Extraction to Analysis Rejection	J-	R
Field Blank Contamination	U	
Initial Calibration Relative Response Factor	J	UJ
Initial Calibration Verification Percent Recovery Lower Estimation	J-	UJ
Initial Calibration Verification Percent Recovery Lower Rejection	R	R
Initial Calibration Verification Percent Recovery Upper Estimation	J+	
Initial Calibration Verification Percent Recovery Upper Rejection	R	
Laboratory Control Precision	J	UJ
Laboratory Control Spike Lower Estimation	J-	UJ
Laboratory Control Spike Lower Rejection	J-	R
Laboratory Control Spike Upper Estimation	J+	
Laboratory Control Spike Upper Rejection	J+	R
Laboratory Duplicate Precision	J	UJ
Matrix Spike Lower Estimation	J-	UJ
Matrix Spike Lower Rejection	J-	R
Matrix Spike Precision	J	UJ
Matrix Spike Upper Estimation	J+	
Matrix Spike Upper Rejection	J+	R
Method Blank Contamination	U	
Sampling to Analysis Estimation	J-	UJ
Sampling to Analysis Rejection	J-	R
Sampling to Extraction Estimation	J-	UJ
Sampling to Extraction Rejection	J-	R
Sampling to Leaching Estimation	J-	UJ
Sampling to Leaching Rejection	J-	R
Trip Blank Contamination	U	

ATTACHMENT F

Analytical Laboratory Certifications

CERTIFICATE OF ACCREDITATION

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

This is to certify that

SGS North America Inc. - Orlando
4405 Vineland Road, Suite C-15
Orlando, FL 32811

has been assessed by ANAB
and meets the requirements of international standard

ISO/IEC 17025:2005

and DoD Quality Systems Manual for Environmental Laboratories (DoD QSM V 5.1.1)

while demonstrating technical competence in the fields of

TESTING

Refer to the accompanying Scope of Accreditation for information regarding the types of calibrations and/or tests to which this accreditation applies.

L2229
Certificate Number

ANAB Approval

Certificate Valid: 12/05/2018-12/15/2021
Version No. 003 Issued: 12/05/2018

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).

ANSI-ASQ National Accreditation Board

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005 AND DOD QUALITY SYSTEMS MAUAL FOR ENVIRONMENTAL LABORATORIES (DOD QSM V 5.1.1)

SGS North America Inc. - Orlando

4405 Vineland Road, Suite C-15
Orlando, FL 32811
Svetlana Izosimova, Ph. D., QA Officer
407-425-6700

TESTING

Valid to: **December 15, 2021** Certificate Number: **L2229**

Environmental

Drinking Water		
Technology	**Method**	**Analyte**
LC/MS/MS	EPA 537 rev. 1.1	Perfluorohexanoic Acid
LC/MS/MS	EPA 537 rev. 1.1	Perfluoroheptanoic Acid
LC/MS/MS	EPA 537 rev. 1.1	Perfluorooctanoic Acid
LC/MS/MS	EPA 537 rev. 1.1	Perfluorononanoic Acid
LC/MS/MS	EPA 537 rev. 1.1	Perfluorodecanoic Acid
LC/MS/MS	EPA 537 rev. 1.1	Perfluoroundecanoic Acid
LC/MS/MS	EPA 537 rev. 1.1	Perfluorododecanoic Acid
LC/MS/MS	EPA 537 rev. 1.1	Perfluorotridecanoic Acid
LC/MS/MS	EPA 537 rev. 1.1	Perfluorotetradecanoic Acid
LC/MS/MS	EPA 537 rev. 1.1	Perfluorobutanesulfonic Acid
LC/MS/MS	EPA 537 rev. 1.1	Perfluorohexanesulfonic Acid
LC/MS/MS	EPA 537 rev. 1.1	Perfluorooctanesulfonic Acid
LC/MS/MS	EPA 537 rev. 1.1	N-Methyl perfluorooctanesulfonamidoacetic acid
LC/MS/MS	EPA 537 rev. 1.1	N-Ethyl perfluorooctanesulfonamidoacetic acid

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8011	1,2-Dibromoethane (EDB)
GC/ECD	EPA 8011	1,2-Dibromo-3-Chloropropane (DBCP)
GC/ECD	EPA 504.1	1,2-Dibromoethane (EDB)
GC/ECD	EPA 504.1	1,2-Dibromo-3-Chloropropane (DBCP)
GC/ECD	EPA 504.1	1,2,3-Trichloropropane (1,2,3-TCP)
GC/FID	EPA 8015C/D	Diesel range organics (DRO)
GC/FID	EPA 8015C/D	Oil Range Organics (ORO)
GC/FID	EPA 8015C/D	Gasoline range organics (GRO)
GC/FID	EPA 8015C/D	Ethanol
GC/FID	EPA 8015C/D	2-Ethoxyethanol
GC/FID	EPA 8015C/D	Isobutyl alcohol (2-Methyl-1-propanol)
GC/FID	EPA 8015C/D	Isopropyl alcohol (2-Propanol)
GC/FID	EPA 8015C/D	Methanol
GC/FID	EPA 8015C/D	n-Butyl alcohol
GC/FID	EPA 8015C/D	n-Propanol
GC/ECD	EPA 608.3; EPA 8081B	4,4`-DDD
GC/ECD	EPA 608.3; EPA 8081B	4,4`-DDE
GC/ECD	EPA 608.3; EPA 8081B	4,4`-DDT
GC/ECD	EPA 608.3; EPA 8081B	Aldrin
GC/ECD	EPA 608.3; EPA 8081B	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	EPA 608.3; EPA 8081B	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	EPA 608.3; EPA 8081B	delta-BHC
GC/ECD	EPA 608.3; EPA 8081B	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	EPA 608.3; EPA 8081B	Chlordane (tech.)
GC/ECD	EPA 608.3; EPA 8081B	alpha-Chlordane
GC/ECD	EPA 608.3; EPA 8081B	gamma-Chlordane
GC/ECD	EPA 608.3; EPA 8081B	Dieldrin
GC/ECD	EPA 608.3; EPA 8081B	Endosulfan I
GC/ECD	EPA 608.3; EPA 8081B	Endosulfan II
GC/ECD	EPA 608.3; EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 608.3; EPA 8081B	Endrin
GC/ECD	EPA 608.3; EPA 8081B	Endrin aldehyde
GC/ECD	EPA 608.3; EPA 8081B	Endrin ketone
GC/ECD	EPA 608.3; EPA 8081B	Heptachlor
GC/ECD	EPA 608.3; EPA 8081B	Heptachlor epoxide

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 608.3; EPA 8081B	Methoxychlor
GC/ECD	EPA 608.3; EPA 8081B	Toxaphene (Chlorinated camphene)
GC/ECD	EPA 608.3; EPA 8081B	Aroclor-1016 (PCB-1016)
GC/ECD	EPA 608.3; EPA 8081B	Aroclor-1221 (PCB-1221)
GC/ECD	EPA 608.3; EPA 8081B	Aroclor-1232 (PCB-1232)
GC/ECD	EPA 608.3; EPA 8081B	Aroclor-1242 (PCB-1242)
GC/ECD	EPA 608.3; EPA 8081B	Aroclor-1248 (PCB-1248)
GC/ECD	EPA 608.3; EPA 8081B	Aroclor-1254 (PCB-1254)
GC/ECD	EPA 608.3; EPA 8081B	Aroclor-1260 (PCB-1260)
GC/ECD	EPA 8082A	Aroclor-1262 (PCB-1262)
GC/ECD	EPA 8082A	Aroclor-1268 (PCB-1268)
GC/FPD	EPA 8141B	Azinphos-methyl (Guthion)
GC/FPD	EPA 8141B	Bolstar (Sulprofos)
GC/FPD	EPA 8141B	Carbophenothion
GC/FPD	EPA 8141B	Chlorpyrifos
GC/FPD	EPA 8141B	Coumaphos
GC/FPD	EPA 8141B	Demeton-o
GC/FPD	EPA 8141B	Demeton-s
GC/FPD	EPA 8141B	Diazinon
GC/FPD	EPA 8141B	Dichlorovos (DDVP Dichlorvos)
GC/FPD	EPA 8141B	Dimethoate
GC/FPD	EPA 8141B	Disulfoton
GC/FPD	EPA 8141B	EPN
GC/FPD	EPA 8141B	Ethion
GC/FPD	EPA 8141B	Ethoprop
GC/FPD	EPA 8141B	Famphur
GC/FPD	EPA 8141B	Fensulfothion
GC/FPD	EPA 8141B	Fenthion
GC/FPD	EPA 8141B	Malathion
GC/FPD	EPA 8141B	Merphos
GC/FPD	EPA 8141B	Methyl parathion (Parathion methyl)
GC/FPD	EPA 8141B	Mevinphos
GC/FPD	EPA 8141B	Monocrotophos
GC/FPD	EPA 8141B	Naled
GC/FPD	EPA 8141B	Parathion ethyl
GC/FPD	EPA 8141B	Phorate
GC/FPD	EPA 8141B	Ronnel

Non-Potable Water

Technology	Method	Analyte
GC/FPD	EPA 8141B	Stirofos
GC/FPD	EPA 8141B	Sulfotepp
GC/FPD	EPA 8141B	Tetraethyl pyrophosphate (TEPP)
GC/FPD	EPA 8141B	Thionazin (Zinophos)
GC/FPD	EPA 8141B	Tokuthion (Prothiophos)
GC/FPD	EPA 8141B	Trichloronate
GC/FPD	EPA 8141B	O,O,O-Triethyl phosphorothioate
GC/ECD	EPA 8151A	2,4,5-T
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	Dichloroprop (Dichlorprop)
GC/ECD	EPA 8151A	Dinoseb (2-sec-butyl-4,6-dinitrophenol DNBP)
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP
GC/ECD	EPA 8151A	Pentachlorophenol
GC/ECD	EPA 8151A	Silvex (2,4,5-TP)
GC/FID	RSK-175	Acetylene
GC/FID	RSK-175	Methane
GC/FID	RSK-175	Ethane
GC/FID	RSK-175	Ethene
GC/FID	RSK-175	Propane
GC/FID	FL-PRO	Total Petroleum Hydrocarbons (TPH)
GC/FID	MA-VPH	Volatile petroleum range organics (VPH)
GC/FID	MA-EPH	Extractable petroleum range organics (EPH)
GC/FID	IA-OA1	Gasoline range organics (GRO)
GC/FID	IA-OA2	Diesel range organics (DRO)
GC/FID	TN-GRO	Gasoline range organics (GRO)
GC/FID	TN-EPH	Extractable petroleum range organics (EPH)
GC/FID	WI-DRO	Diesel range organics (DRO)
GC/FID	AK-101	Gasoline range organics (GRO)
GC/FID	AK-102	Diesel range organics (DRO)
GC/FID	OK-GRO	Gasoline range organics (GRO)

Non-Potable Water

Technology	Method	Analyte
GC/FID	OK-DRO	Diesel range organics (DRO)
GC/FID	TX-1005	Total Petroleum Hydrocarbons (TPH)
GC/FID	KS LRH	Low-Range Hydrocarbons (LRH)
GC/FID	KS MRH	Mid-Range Hydrocarbons (MRH)
GC/FID	KS HRH	High-Range Hydrocarbons (HRH)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,1,1,2-Tetrachloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,1,1-Trichloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,1,2,2-Tetrachloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,1,2-Trichloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,1-Dichloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,1-Dichloroethylene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,1-Dichloropropene
GC/MS	EPA 624.1; EPA 8260B/C	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,2,3-Trichlorobenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,2,3-Trichloropropane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,2,4-Trichlorobenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,2,4-Trimethylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,2-Dibromoethane (EDB Ethylene dibromide)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,2-Dichlorobenzene (o-Dichlorobenzene)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,2-Dichloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,2-Dichloropropane
GC/MS	EPA 8260B/C	1,2-Dichlorotrifluoroethane (Freon 123)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,3,5-Trimethylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,3-Dichlorobenzene (m-Dichlorobenzene)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,3-Dichloropropane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	1,4-Dichlorobenzene (p-Dichlorobenzene)
GC/MS	EPA 8260B/C	1-Chlorohexane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	2,2-Dichloropropane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	2-Butanone (Methyl ethyl ketone MEK)
GC/MS	EPA 624.1; EPA 8260B/C	2-Chloroethyl vinyl ether
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	2-Chlorotoluene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	2-Hexanone
GC/MS	EPA 8260B/C	2-Nitropropane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	4-Chlorotoluene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	4-Methyl-2-pentanone (MIBK)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Acetone
GC/MS	EPA 8260B/C	Acetonitrile
GC/MS	EPA 624.1; EPA 8260B/C	Acrolein (Propenal)
GC/MS	EPA 624.1; EPA 8260B/C	Acrylonitrile
GC/MS	EPA 8260B/C	Allyl chloride (3-Chloropropene)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Benzene
GC/MS	EPA 8260B/C	Benzyl Chloride
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Bromobenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Bromochloromethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Bromodichloromethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Bromoform
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	n-Butylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	sec-Butylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	tert-Butylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Carbon disulfide
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Carbon tetrachloride
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Chlorobenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Chloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Chloroform
GC/MS	EPA 8260B/C	Chloroprene
GC/MS	EPA 624.1; EPA 8260B/C	Cyclohexane
GC/MS	EPA 8260B/C	Cyclohexanone
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	cis-1,2-Dichloroethylene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	trans-1,2-Dichloroethylene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	cis-1,3-Dichloropropene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	trans-1,3-Dichloropropylene
GC/MS	EPA 8260B/C	cis-1,4-Dichloro-2-butene
GC/MS	EPA 8260B/C	trans-1,4-Dichloro-2-butene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Di-isopropylether (DIPE)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Dibromochloromethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Dibromomethane (Methylene Bromide)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Dichlorodifluoromethane
GC/MS	EPA 8260B/C	Diethyl ether
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C SIM	p-Dioxane (1,4-Dioxane)

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Ethanol (Ethyl Alcohol)
GC/MS	EPA 8260B/C	Ethyl acetate
GC/MS	EPA 8260B/C	Ethyl methacrylate
GC/MS	EPA 8260B/C	Ethyl tert-butyl alcohol (ETBA)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Ethyl tert-butyl ether (ETBE)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Ethylbenzene
GC/MS	EPA 8260B/C	Ethylene Oxide
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Hexachlorobutadiene
GC/MS	EPA 8260B/C	Hexane
GC/MS	EPA 8260B/C	Iodomethane (Methyl iodide)
GC/MS	EPA 8260B/C	Isobutyl alcohol (2-Methyl-1-propanol)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	p-Isopropyltoluene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Isopropylbenzene
GC/MS	EPA 8260B/C	Methacrylonitrile
GC/MS	EPA 624.1; EPA 8260B/C	Methyl Acetate
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Methyl bromide (Bromomethane)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Methyl chloride (Chloromethane)
GC/MS	EPA 624.1; EPA 8260B/C	Methylcyclohexane
GC/MS	EPA 8260B/C	Methyl methacrylate
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Methyl tert-butyl ether (MTBE)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Methylene chloride
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Naphthalene
GC/MS	EPA 8260B/C	Pentachloroethane
GC/MS	EPA 8260B/C	Propionitrile (Ethyl cyanide)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	n-Propylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Styrene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	tert-Amyl alcohol (TAA)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	tert-Amyl methyl ether (TAME)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	tert-Butyl alcohol (TBA)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	tert-Butyl formate (TBF)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Tetrachloroethylene (Perchloroethylene)
GC/MS	EPA 8260B/C	Tetrahydrofuran
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Toluene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Trichloroethene (Trichloroethylene)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Trichlorofluoromethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Vinyl acetate
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Vinyl chloride

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	Xylene (total)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	m,p-Xylene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260B/C	o-Xylene
GC/MS	EPA 8260B/C	1-Bromopropane
GC/MS	EPA 8260B/C	Isopropyl Alcohol
GC/MS	EPA 8260B/C	n-Butyl Alcohol
GC/MS	EPA 625.1; EPA 8270D	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 625.1; EPA 8270D	1,2,4-Trichlorobenzene
GC/MS	EPA 625.1; EPA 8270D	1,2-Dichlorobenzene (o-Dichlorobenzene)
GC/MS	EPA 625.1; EPA 8270D	1,2-Diphenylhydrazine
GC/MS	EPA 8270D	1,3,5-Trinitrobenzene (1,3,5-TNB)
GC/MS	EPA 625.1; EPA 8270D	1,3-Dichlorobenzene (m-Dichlorobenzene)
GC/MS	EPA 8270D	1,3-Dinitrobenzene (1,3-DNB)
GC/MS	EPA 625.1; EPA 8270D	1,4-Dichlorobenzene (p-Dichlorobenzene)
GC/MS	EPA 8270D	1,4-Dithiane
GC/MS	EPA 8270D	1,4-Oxathiane
GC/MS	EPA 8270D	1,4-Naphthoquinone
GC/MS	EPA 8270D	1,4-Phenylenediamine
GC/MS	EPA 8270D	1-Chloronaphthalene
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	1-Methylnaphthalene
GC/MS	EPA 8270D	1-Naphthylamine
GC/MS	EPA 625.1; EPA 8270D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 625.1; EPA 8270D	2,4,5-Trichlorophenol
GC/MS	EPA 625.1; EPA 8270D	2,4,6-Trichlorophenol
GC/MS	EPA 625.1; EPA 8270D	2,4-Dichlorophenol
GC/MS	EPA 625.1; EPA 8270D	2,4-Dimethylphenol
GC/MS	EPA 625.1; EPA 8270D	2,4-Dinitrophenol
GC/MS	EPA 625.1; EPA 8270D	2,4-Dinitrotoluene (2,4-DNT)
GC/MS	EPA 8270D	2,6-Dichlorophenol
GC/MS	EPA 625.1; EPA 8270D	2,6-Dinitrotoluene (2,6-DNT)
GC/MS	EPA 8270D	2-Acetylaminofluorene
GC/MS	EPA 625.1; EPA 8270D	2-Chloronaphthalene
GC/MS	EPA 625.1; EPA 8270D	2-Chlorophenol
GC/MS	EPA 625.1; EPA 8270D	2-Methyl-4,6-dinitrophenol (4,6-Dinitro-o-cresol)
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	2-Methylnaphthalene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 625.1; EPA 8270D	2-Methylphenol (o-Cresol)
GC/MS	EPA 8270D	2-Naphthylamine
GC/MS	EPA 625.1; EPA 8270D	2-Nitroaniline
GC/MS	EPA 625.1; EPA 8270D	2-Nitrophenol
GC/MS	EPA 8270D	2-Picoline (2-Methylpyridine)
GC/MS	EPA 625.1; EPA 8270D	3,3`-Dichlorobenzidine
GC/MS	EPA 8270D	3,3`-Dimethylbenzidine
GC/MS	EPA 8270D	3-Methylcholanthrene
GC/MS	EPA 625.1; EPA 8270D	3&4-Methylphenol (m,p-Cresol)
GC/MS	EPA 625.1; EPA 8270D	3-Nitroaniline
GC/MS	EPA 8270D	4-Aminobiphenyl
GC/MS	EPA 625.1; EPA 8270D	4-Bromophenyl phenyl ether
GC/MS	EPA 625.1; EPA 8270D	4-Chloro-3-methylphenol
GC/MS	EPA 625.1; EPA 8270D	4-Chloroaniline
GC/MS	EPA 625.1; EPA 8270D	4-Chlorophenyl phenylether
GC/MS	EPA 8270D	4-Dimethyl aminoazobenzene
GC/MS	EPA 625.1; EPA 8270D	4-Nitroaniline
GC/MS	EPA 625.1; EPA 8270D	4-Nitrophenol
GC/MS	EPA 8270D	4,4’-methylene-bis(2-chloroaniline)
GC/MS	EPA 8270D	5-Nitro-o-toluidine
GC/MS	EPA 8270D	7,12-Dimethylbenz(a) anthracene
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Acenaphthene
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Acenaphthylene
GC/MS	EPA 625.1; EPA 8270D	Acetophenone
GC/MS	EPA 625.1; EPA 8270D	Aniline
GC/MS	EPA 8270D	Anilazine
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Anthracene
GC/MS	EPA 8270D	Aramite
GC/MS	EPA 625.1; EPA 8270D	Atrazine
GC/MS	EPA 625.1; EPA 8270D	Benzaldehyde
GC/MS	EPA 625.1; EPA 8270D	Benzidine
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Benzo(a)anthracene
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Benzo(a)pyrene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Benzo(b)fluoranthene
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Benzo(g,h,i)perylene
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Benzo(k)fluoranthene
GC/MS	EPA 625.1; EPA 8270D	Benzoic acid
GC/MS	EPA 625.1; EPA 8270D	Benzyl alcohol
GC/MS	EPA 625.1; EPA 8270D	Biphenyl (1,1’-Biphenyl)
GC/MS	EPA 625.1; EPA 8270D	bis(2-Chloroethoxy)methane
GC/MS	EPA 625.1; EPA 8270D	bis(2-Chloroethyl) ether
GC/MS	EPA 625.1; EPA 8270D	bis(2-Chloroisopropyl) ether (2,2`-Oxybis(1-chloropropane))
GC/MS	EPA 625.1; EPA 8270D	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	EPA 625.1; EPA 8270D	Butyl benzyl phthalate
GC/MS	EPA 625.1; EPA 8270D	Carbazole
GC/MS	EPA 625.1; EPA 8270D	Caprolactam
GC/MS	EPA 8270D	Chlorobenzilate
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Chrysene
GC/MS	EPA 8270D	Diallate
GC/MS	EPA 8270D	Dinoseb
GC/MS	EPA 625.1; EPA 8270D	Di-n-butyl phthalate
GC/MS	EPA 625.1; EPA 8270D	Di-n-octyl phthalate
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Dibenz(a,h)anthracene
GC/MS	EPA 8270D	Dibenz(a,j)acridine
GC/MS	EPA 625.1; EPA 8270D	Dibenzofuran
GC/MS	EPA 625.1; EPA 8270D	Diethyl phthalate
GC/MS	EPA 625.1; EPA 8270D	Dimethyl phthalate
GC/MS	EPA 8270D	a,a-Dimethylphenethylamine
GC/MS	EPA 8270D	Diphenyl Ether
GC/MS	EPA 8270D	p-Dioxane (1,4-Dioxane)
GC/MS	EPA 8270D	Ethyl methanesulfonate
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Fluoranthene
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Fluorene
GC/MS	EPA 625.1; EPA 8270D	Hexachlorobenzene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 625.1; EPA 8270D	Hexachlorobutadiene
GC/MS	EPA 625.1; EPA 8270D	Hexachlorocyclopentadiene
GC/MS	EPA 625.1; EPA 8270D	Hexachloroethane
GC/MS	EPA 8270D	Hexachlorophene
GC/MS	EPA 8270D	Hexachloropropene
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270D	Isodrin
GC/MS	EPA 625.1; EPA 8270D	Isophorone
GC/MS	EPA 8270D	Isosafrole
GC/MS	EPA 8270D	Kepone
GC/MS	EPA 8270D	Methapyrilene
GC/MS	EPA 8270D	Methyl methanesulfonate
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Naphthalene
GC/MS	EPA 8270D	Nicotine
GC/MS	EPA 625.1; EPA 8270D	Nitrobenzene
GC/MS	EPA 8270D	Nitroquinoline-1-oxide
GC/MS	EPA 8270D	n-Nitroso-di-n-butylamine
GC/MS	EPA 625.1; EPA 8270D	n-Nitrosodi-n-propylamine
GC/MS	EPA 8270D	n-Nitrosodiethylamine
GC/MS	EPA 625.1; EPA 8270D	n-Nitrosodimethylamine
GC/MS	EPA 625.1; EPA 8270D	n-Nitrosodiphenylamine
GC/MS	EPA 8270D	n-Nitrosodiphenylamine/Diphenylamine (analyte pair)
GC/MS	EPA 8270D	n-Nitrosomethylethylamine
GC/MS	EPA 8270D	n-Nitrosomorpholine
GC/MS	EPA 8270D	n-Nitrosopiperidine
GC/MS	EPA 8270D	n-Nitrosopyrrolidine
GC/MS	EPA 8270D	Pentachlorobenzene
GC/MS	EPA 8270D	Pentachloroethane
GC/MS	EPA 8270D	Pentachloronitrobenzene
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Pentachlorophenol
GC/MS	EPA 8270D	Phenacetin
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Phenanthrene
GC/MS	EPA 625.1; EPA 8270D	Phenol

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D	Pronamide (Kerb)
GC/MS	EPA 8270D	Propazine
GC/MS	EPA 625.1; EPA 8270D; EPA 8270D SIM	Pyrene
GC/MS	EPA 625.1; EPA 8270D	Pyridine
GC/MS	EPA 8270D	Resorcinol
GC/MS	EPA 8270D	Safrole
GC/MS	EPA 8270D	Simazine
GC/MS	EPA 8270D	Thionazin (Zinophos)
GC/MS	EPA 8270D	o-Toluidine
GC/MS	EPA 8270D	Dimethoate
GC/MS	EPA 8270D	Disulfoton
GC/MS	EPA 8270D	Famphur
GC/MS	EPA 8270D	Methyl parathion (Parathion methyl)
GC/MS	EPA 8270D	Parathion ethyl
GC/MS	EPA 8270D	Phorate
GC/MS	EPA 8270D	O,O,O-Triethyl phosphorothioate
HPLC	EPA 610	1-Methylnaphthalene
HPLC	EPA 610	2-Methylnaphthalene
HPLC	EPA 610	Acenaphthene
HPLC	EPA 610	Acenaphthylene
HPLC	EPA 610	Anthracene
HPLC	EPA 610	Benzo(a)anthracene
HPLC	EPA 610	Benzo(a)pyrene
HPLC	EPA 610	Benzo(b)fluoranthene
HPLC	EPA 610	Benzo(g h i)perylene
HPLC	EPA 610	Benzo(k)fluoranthene
HPLC	EPA 610	Chrysene
HPLC	EPA 610	Dibenz(a,h)anthracene
HPLC	EPA 610	Fluoranthene
HPLC	EPA 610	Fluorene
HPLC	EPA 610	Indeno(1,2,3-cd)pyrene
HPLC	EPA 610	Naphthalene
HPLC	EPA 610	Phenanthrene
HPLC	EPA 610	Pyrene
HPLC	EPA 8330A/B	1,3,5-Trinitrobenzene (1,3,5-TNB)
HPLC	EPA 8330A/B	1,3-Dinitrobenzene (1,3-DNB)

Non-Potable Water

Technology	Method	Analyte
HPLC	EPA 8330A/B	2,4,6-Trinitrotoluene (2,4,6-TNT)
HPLC	EPA 8330A/B	2,4-Dinitrotoluene (2,4-DNT)
HPLC	EPA 8330A/B	2,6-Dinitrotoluene (2,6-DNT)
HPLC	EPA 8330A/B	2-Amino-4,6-dinitrotoluene (2-am-dnt)
HPLC	EPA 8330A/B	2-Nitrotoluene
HPLC	EPA 8330A/B	3,5-Dinitroaniline
HPLC	EPA 8330A/B	3-Nitrotoluene
HPLC	EPA 8330A/B	4-Amino-2,6-dinitrotoluene (4-am-dnt)
HPLC	EPA 8330A/B	4-Nitrotoluene
HPLC	EPA 8330A/B	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC	EPA 8330A/B	Nitrobenzene
HPLC	EPA 8330A/B	Nitroglycerin
HPLC	EPA 8330A/B	Methyl-2,4,6-trinitrophenylnitramine (Tetryl)
HPLC	EPA 8330A/B	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC	EPA 8330A/B	Pentaerythritoltetranitrate (PETN)
HPLC	EPA 8330A	2,2’,6,6’-Tetranitro-4,4’-azoxytoluene
HPLC	EPA 8330A/B	2-amino-6-Nitrotoluene
HPLC	EPA 8330A/B	4-amino-2-Nitrotoluene
HPLC	EPA 8330A/B	2-amino-4-Nitrotoluene
HPLC	EPA 8330A/B	2,4-diamino-6-Nitrotoluene
HPLC	EPA 8330A/B	2,6-diamino-4-Nitrotoluene
HPLC	EPA 8330A/B	DNX
HPLC	EPA 8330A/B	MNX
HPLC	EPA 8330A/B	TNX
HPLC	EPA 8330A	Nitroguanidine
HPLC	EPA 8330A	Guanidine Nitrate
LC/MS/MS	EPA 6850	Perchlorate
LC/MS/MS	EPA 537 MOD[2]	Perfluorobutanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluoropentanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorohexanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluoroheptanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorooctanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorononanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorodecanoic Acid

Non-Potable Water

Technology	Method	Analyte
LC/MS/MS	EPA 537 MOD[2]	Perfluoroundecanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorododecanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorotridecanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorotetradecanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorobutanesulfonic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorohexanesulfonic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorooctanesulfonic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorodecanesulfonic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorooctanesulfonic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorononanesulfonic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorodecanesulfonic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluoroheptanesulfonic acid
LC/MS/MS	EPA 537 MOD[2]	Perfluoropentanesulfonic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorooctane sulfonamide
LC/MS/MS	EPA 537 MOD[2]	N-Methyl perfluorooctane sulfonamide
LC/MS/MS	EPA 537 MOD[2]	N-Ethyl perfluorooctane sulfonamide
LC/MS/MS	EPA 537 MOD[2]	Perfluoro-1-octanesulfonamidoacetic acid
LC/MS/MS	EPA 537 MOD[2]	N-Methyl perfluorooctanesulfonamidoacetic acid
LC/MS/MS	EPA 537 MOD[2]	N-Ethyl perfluorooctanesulfonamidoacetic acid
LC/MS/MS	EPA 537 MOD[2]	N-Methyl perfluorooctane sulfonamidoethanol
LC/MS/MS	EPA 537 MOD[2]	N-Ethyl perfluorooctane sulfonamidoethanol
LC/MS/MS	EPA 537 MOD[2]	4:2 Fluorotelomer Sulfonate
LC/MS/MS	EPA 537 MOD[2]	6:2 Fluorotelomer Sulfonate
LC/MS/MS	EPA 537 MOD[2]	8:2 Fluorotelomer Sulfonate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorobutanoic Acid (PFBA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluoropentanoic Acid (PFPeA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorohexanoic Acid (PFHxA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluoroheptanoic Acid (PFHpA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorooctanoic Acid (PFOA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorononanoic Acid (PFNA)

Non-Potable Water		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorodecanoic Acid (PFDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluoroundecanoic Acid (PFUnA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorododecanoic Acid(PFDoA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorotridecanoic Acid (PFTrDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorotetradecanoic Acid (PFTA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorobutanesulfonic Acid (PFBS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorohexanesulfonic Acid(PFHxS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorooctanesulfonic Acid(PFOS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorononanesulfonic Acid(PFNS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorodecanesulfonic Acid(PFDS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluoroheptanesulfonic acid(PFHpS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluoropentanesulfonic Acid(PFPeS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorooctane sulfonamide (PFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	N-Methyl perfluorooctanesulfonamidoacetic acid (MeFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	N-Ethyl perfluorooctanesulfonamidoacetic acid (EtFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	4:2 Fluorotelomer Sulfonate (FTS 4:2)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	6:2 Fluorotelomer Sulfonate(FTS 6:2)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	8:2 Fluorotelomer Sulfonate (FTS 8:2)
ICP	EPA 200.7; EPA 6010C/D	Aluminum
ICP	EPA 200.7; EPA 6010C/D	Antimony
ICP	EPA 200.7; EPA 6010C/D	Arsenic
ICP	EPA 200.7; EPA 6010C/D	Barium
ICP	EPA 200.7; EPA 6010C/D	Beryllium

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP	EPA 200.7; EPA 6010C/D	Cadmium
ICP	EPA 200.7; EPA 6010C/D	Calcium
ICP	EPA 200.7; EPA 6010C/D	Chromium
ICP	EPA 200.7; EPA 6010C/D	Cobalt
ICP	EPA 200.7; EPA 6010C/D	Copper
ICP	EPA 200.7; EPA 6010C/D	Iron
ICP	EPA 200.7; EPA 6010C/D	Lead
ICP	EPA 200.7; EPA 6010C/D	Magnesium
ICP	EPA 200.7; EPA 6010C/D	Manganese
ICP	EPA 200.7; EPA 6010C/D	Molybdenum
ICP	EPA 200.7; EPA 6010C/D	Nickel
ICP	EPA 200.7; EPA 6010C/D	Potassium
ICP	EPA 200.7; EPA 6010C/D	Selenium
ICP	EPA 200.7; EPA 6010C/D	Silver
ICP	EPA 200.7; EPA 6010C/D	Sodium
ICP	EPA 200.7; EPA 6010C/D	Strontium
ICP	EPA 200.7; EPA 6010C/D	Thallium
ICP	EPA 200.7; EPA 6010C/D	Tin
ICP	EPA 200.7; EPA 6010C/D	Titanium
ICP	EPA 200.7; EPA 6010C/D	Vanadium
ICP	EPA 200.7; EPA 6010C/D	Zinc
ICP/MS	EPA 200.8; EPA 6020A/B	Aluminum
ICP/MS	EPA 200.8; EPA 6020A/B	Antimony
ICP/MS	EPA 200.8; EPA 6020A/B	Arsenic
ICP/MS	EPA 200.8; EPA 6020A/B	Barium
ICP/MS	EPA 200.8; EPA 6020A/B	Beryllium
ICP/MS	EPA 200.8; EPA 6020A/B	Cadmium
ICP/MS	EPA 200.8; EPA 6020A/B	Calcium
ICP/MS	EPA 200.8; EPA 6020A/B	Chromium
ICP/MS	EPA 200.8; EPA 6020A/B	Cobalt
ICP/MS	EPA 200.8; EPA 6020A/B	Copper
ICP/MS	EPA 200.8; EPA 6020A/B	Iron
ICP/MS	EPA 200.8; EPA 6020A/B	Lead
ICP/MS	EPA 200.8; EPA 6020A/B	Magnesium
ICP/MS	EPA 200.8; EPA 6020A/B	Manganese
ICP/MS	EPA 200.8; EPA 6020A/B	Molybdenum
ICP/MS	EPA 200.8; EPA 6020A/B	Nickel

Non-Potable Water

Technology	Method	Analyte
ICP/MS	EPA 200.8; EPA 6020A/B	Potassium
ICP/MS	EPA 200.8; EPA 6020A/B	Selenium
ICP/MS	EPA 200.8; EPA 6020A/B	Silver
ICP/MS	EPA 200.8; EPA 6020A/B	Sodium
ICP/MS	EPA 200.8; EPA 6020A/B	Strontium
ICP/MS	EPA 200.8; EPA 6020A/B	Thallium
ICP/MS	EPA 200.8; EPA 6020A/B	Tin
ICP/MS	EPA 200.8; EPA 6020A/B	Titanium
ICP/MS	EPA 200.8; EPA 6020A/B	Vanadium
ICP/MS	EPA 200.8; EPA 6020A/B	Zinc
CVAA	EPA 7470A	Mercury
CVAA	EPA 245.1	Mercury
UV/VIS	EPA 7196A	Hexavalent Chromium (Cr6+)
UV/VIS	EPA 9012B	Cyanide (Total)
IC	EPA 300; EPA 9056A	Bromide
IC	EPA 300; EPA 9056A	Chloride
IC	EPA 300; EPA 9056A	Fluoride
IC	EPA 300; EPA 9056A	Nitrate
IC	EPA 300; EPA 9056A	Nitrite
IC	EPA 300; EPA 9056A	Sulfate
IC	EPA 300; EPA 9056A	Total nitrate-nitrite
Automated Colorimetry	EPA 350.1	Ammonia
Automated Colorimetry	EPA 350.1	Ammonia, Gas Diffusion Option
Automated Colorimetry	EPA 351.2	Total Kjeldahl Nitrogen
Automated Colorimetry	EPA 420.4	Total Phenolics
Automated Colorimetry	EPA 353.2	Nitrate
Automated Colorimetry	EPA 353.2	Nitrite
Automated Colorimetry	EPA 353.2	Nitrate+Nitrite
Manual Colorimetry	EPA 365.3	Orthophosphate
Manual Colorimetry	EPA 365.3	Total Phosphorus
Titrimetric	SM 2320B-11	Alkalinity, Total
Titrimetric	SM 4500-S2 F-11	Sulfide, Iodometric
Gravimetric Methods	EPA 1664A; EPA 1664B; EPA 9070A	Oil and Grease
Gravimetric Methods	SM 2540B-11	Total Residue (Total Solids)
Gravimetric Methods	SM 2540C-11	Filterable Residue (Total Dissolved Solids)
Gravimetric Methods	SM 2540D-11	Non-Filterable Residue (Total Suspended Solids)

Non-Potable Water

Technology	Method	Analyte
Electrometric Methods	SM 4500H+B-11; EPA 9040C	Hydrogen Ion (Ph)
Electrometric Methods	EPA 120.1	Specific conductivity
Combustion	EPA 9060A	Total Organic Carbon
Combustion	SM 5310B-11	Total Organic Carbon
Ignitability	EPA 1010A	Flash Point
Waste Characterization	EPA Ch.7	Reactive Cyanide and Reactive Sulfide
Waste Characterization	EPA Section 7.3	Reactive Cyanide
Waste Characterization	EPA Section 7.3	Reactive Sulfide
Preparation	**Method**	**Type**
Organic Preparation	EPA 3510C	Separatory Funnel Liquid-Liquid Extraction
Organic Preparation	EPA 3511	Micro-extraction
Organic Preparation	EPA 3535A; EPA 3535A MOD	Solid Phase Extraction
Organic Preparation	EPA 8015C/D	Non-Halogenated Organics (Alcohols), direct injection
Organic Preparation	EPA 8151A	Chlorinated Herbicides, Liquid-Liquid Extraction
Organic Preparation	EPA 608; EPA 610; EPA 625	Separatory Funnel Liquid-Liquid Extraction
Volatile Organic Preparation	SW836 5030B	Closed System Purge and Trap
Volatile Organic Preparation	EPA 624	Closed System Purge and Trap
Volatile Organic Preparation	SM 6200B-11	Closed System Purge and Trap
Lachat MicroDistillation	EPA 9012B	Cyanide MicroDistillation; proprietary method
Inorganic Preparation	EPA 3010A	Metals Acid Digestion by Hotblock
Inorganic Preparation	EPA 7470A	CVAA Digestion by Hotblock
Organics Cleanup	EPA 3660B	Sulfur Cleanup
Organics Cleanup	EPA 3665A	Sulfuric Acid Cleanup

Solid and Chemical Materials

Technology	Method	Analyte
GC/ECD	EPA 8011	1,2-Dibromoethane (EDB)
GC/ECD	EPA 8011	1,2-Dibromo-3-Chloropropane (DBCP)
GC/FID	EPA 8015C/D	Diesel range organics (DRO)
GC/FID	EPA 8015C/D	Oil Range Organics (ORO)
GC/FID	EPA 8015C/D	Gasoline range organics (GRO)

Solid and Chemical Materials

Technology	Method	Analyte
GC/FID	EPA 8015C/D	Ethanol
GC/FID	EPA 8015C/D	2-Ethoxyethanol
GC/FID	EPA 8015C/D	Isobutyl alcohol (2-Methyl-1-propanol)
GC/FID	EPA 8015C/D	Isopropyl alcohol (2-Propanol)
GC/FID	EPA 8015C/D	Methanol
GC/FID	EPA 8015C/D	n-Butyl alcohol
GC/FID	EPA 8015C/D	n-Propanol
GC/ECD	EPA 8081B	4,4`-DDD
GC/ECD	EPA 8081B	4,4`-DDE
GC/ECD	EPA 8081B	4,4`-DDT
GC/ECD	EPA 8081B	Aldrin
GC/ECD	EPA 8081B	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	delta-BHC
GC/ECD	EPA 8081B	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Chlordane (tech.)
GC/ECD	EPA 8081B	alpha-Chlordane
GC/ECD	EPA 8081B	gamma-Chlordane
GC/ECD	EPA 8081B	Dieldrin
GC/ECD	EPA 8081B	Endosulfan I
GC/ECD	EPA 8081B	Endosulfan II
GC/ECD	EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 8081B	Endrin
GC/ECD	EPA 8081B	Endrin aldehyde
GC/ECD	EPA 8081B	Endrin ketone
GC/ECD	EPA 8081B	Heptachlor
GC/ECD	EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 8081B	Methoxychlor
GC/ECD	EPA 8081B	Toxaphene (Chlorinated camphene)
GC/ECD	EPA 8082A	Aroclor-1016 (PCB-1016)
GC/ECD	EPA 8082A	Aroclor-1221 (PCB-1221)
GC/ECD	EPA 8082A	Aroclor-1232 (PCB-1232)
GC/ECD	EPA 8082A	Aroclor-1242 (PCB-1242)
GC/ECD	EPA 8082A	Aroclor-1248 (PCB-1248)
GC/ECD	EPA 8082A	Aroclor-1254 (PCB-1254)

Solid and Chemical Materials

Technology	Method	Analyte
GC/ECD	EPA 8082A	Aroclor-1260 (PCB-1260)
GC/ECD	EPA 8082A	Aroclor-1262 (PCB-1262)
GC/ECD	EPA 8082A	Aroclor-1268 (PCB-1268)
GC/FPD	EPA 8141B	Azinphos-methyl (Guthion)
GC/FPD	EPA 8141B	Bolstar (Sulprofos)
GC/FPD	EPA 8141B	Carbophenothion
GC/FPD	EPA 8141B	Chlorpyrifos
GC/FPD	EPA 8141B	Coumaphos
GC/FPD	EPA 8141B	Demeton-o
GC/FPD	EPA 8141B	Demeton-s
GC/FPD	EPA 8141B	Diazinon
GC/FPD	EPA 8141B	Dichlorovos (DDVP Dichlorvos)
GC/FPD	EPA 8141B	Dimethoate
GC/FPD	EPA 8141B	Disulfoton
GC/FPD	EPA 8141B	EPN
GC/FPD	EPA 8141B	Ethion
GC/FPD	EPA 8141B	Ethoprop
GC/FPD	EPA 8141B	Famphur
GC/FPD	EPA 8141B	Fensulfothion
GC/FPD	EPA 8141B	Fenthion
GC/FPD	EPA 8141B	Malathion
GC/FPD	EPA 8141B	Merphos
GC/FPD	EPA 8141B	Methyl parathion (Parathion methyl)
GC/FPD	EPA 8141B	Mevinphos
GC/FPD	EPA 8141B	Monocrotophos
GC/FPD	EPA 8141B	Naled
GC/FPD	EPA 8141B	Parathion ethyl
GC/FPD	EPA 8141B	Phorate
GC/FPD	EPA 8141B	Ronnel
GC/FPD	EPA 8141B	Stirofos
GC/FPD	EPA 8141B	Sulfotepp
GC/FPD	EPA 8141B	Tetraethyl pyrophosphate (TEPP)
GC/FPD	EPA 8141B	Thionazin (Zinophos)
GC/FPD	EPA 8141B	Tokuthion (Prothiophos)
GC/FPD	EPA 8141B	Trichloronate
GC/FPD	EPA 8141B	O,O,O-Triethyl phosphorothioate
GC/ECD	EPA 8151A	2,4,5-T

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
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	Dichloroprop (Dichlorprop)
GC/ECD	EPA 8151A	Dinoseb (2-sec-butyl-4,6-dinitrophenol DNBP)
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP
GC/ECD	EPA 8151A	Pentachlorophenol
GC/ECD	EPA 8151A	Silvex (2,4,5-TP)
GC/FID	FL-PRO	Total Petroleum Hydrocarbons (TPH)
GC/FID	MA-VPH	Volatile petroleum range organics (VPH)
GC/FID	MA-EPH	Extractable petroleum range organics (EPH)
GC/FID	IA-OA1	Gasoline range organics (GRO)
GC/FID	IA-OA2	Diesel range organics (DRO)
GC/FID	TN-GRO	Gasoline range organics (GRO)
GC/FID	TN-EPH	Extractable petroleum range organics (EPH)
GC/FID	AK-101	Gasoline range organics (GRO)
GC/FID	AK-102	Diesel range organics (DRO)
GC/FID	AK-103	Residual range organics (RRO)
GC/FID	OK-GRO	Gasoline range organics (GRO)
GC/FID	OK-DRO	Diesel range organics (DRO)
GC/FID	TX-1005	Total Petroleum Hydrocarbons (TPH)
GC/FID	KS LRH	Low-range Hydrocarbons (LRH)
GC/FID	KS MRH	Mid-Range Hydrocarbons (MRH)
GC/FID	KS HRH	High-Range Hydrocarbons (HRH)
GC/MS	EPA 8260B/C	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B/C	1,1,1-Trichloroethane
GC/MS	EPA 8260B/C	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B/C	1,1,2-Trichloroethane
GC/MS	EPA 8260B/C	1,1-Dichloroethane
GC/MS	EPA 8260B/C	1,1-Dichloroethylene
GC/MS	EPA 8260B/C	1,1-Dichloropropene
GC/MS	EPA 8260B/C	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	EPA 8260B/C	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B/C	1,2,3-Trichloropropane
GC/MS	EPA 8260B/C	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B/C	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B/C	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 8260B/C	1,2-Dibromoethane (EDB Ethylene dibromide)
GC/MS	EPA 8260B/C	1,2-Dichlorobenzene (o-Dichlorobenzene)
GC/MS	EPA 8260B/C	1,2-Dichloroethane
GC/MS	EPA 8260B/C	1,2-Dichloropropane
GC/MS	EPA 8260B/C	1,2-Dichlorotrifluoroethane (Freon 123)
GC/MS	EPA 8260B/C	1,3,5-Trimethylbenzene
GC/MS	EPA 8260B/C	1,3-Dichlorobenzene (m-Dichlorobenzene)
GC/MS	EPA 8260B/C	1,3-Dichloropropane
GC/MS	EPA 8260B/C	1,4-Dichlorobenzene (p-Dichlorobenzene)
GC/MS	EPA 8260B/C	1-Chlorohexane
GC/MS	EPA 8260B/C	2,2-Dichloropropane
GC/MS	EPA 8260B/C	2-Butanone (Methyl ethyl ketone MEK)
GC/MS	EPA 8260B/C	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B/C	2-Chlorotoluene
GC/MS	EPA 8260B/C	2-Hexanone
GC/MS	EPA 8260B/C	2-Nitropropane
GC/MS	EPA 8260B/C	4-Chlorotoluene
GC/MS	EPA 8260B/C	4-Methyl-2-pentanone (MBK)
GC/MS	EPA 8260B/C	Acetone
GC/MS	EPA 8260B/C	Acetonitrile
GC/MS	EPA 8260B/C	Acrolein (Propenal)
GC/MS	EPA 8260B/C	Acrylonitrile
GC/MS	EPA 8260B/C	Allyl chloride (3-Chloropropene)
GC/MS	EPA 8260B/C	Benzene
GC/MS	EPA 8260B/C	Benzyl Chloride
GC/MS	EPA 8260B/C	Bromobenzene
GC/MS	EPA 8260B/C	Bromochloromethane
GC/MS	EPA 8260B/C	Bromodichloromethane
GC/MS	EPA 8260B/C	Bromoform
GC/MS	EPA 8260B/C	n-Butylbenzene
GC/MS	EPA 8260B/C	sec-Butylbenzene

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	EPA 8260B/C	tert-Butylbenzene
GC/MS	EPA 8260B/C	Carbon disulfide
GC/MS	EPA 8260B/C	Carbon tetrachloride
GC/MS	EPA 8260B/C	Chlorobenzene
GC/MS	EPA 8260B/C	Chloroethane
GC/MS	EPA 8260B/C	Chloroform
GC/MS	EPA 8260B/C	Chloroprene
GC/MS	EPA 8260B/C	Cyclohexane
GC/MS	EPA 8260B/C	Cyclohexanone
GC/MS	EPA 8260B/C	cis-1,2-Dichloroethylene
GC/MS	EPA 8260B/C	trans-1,2-Dichloroethylene
GC/MS	EPA 8260B/C	cis-1,3-Dichloropropene
GC/MS	EPA 8260B/C	trans-1,3-Dichloropropylene
GC/MS	EPA 8260B/C	cis-1,4-Dichloro-2-butene
GC/MS	EPA 8260B/C	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260B/C	Di-isopropylether (DIPE)
GC/MS	EPA 8260B/C	Dibromochloromethane
GC/MS	EPA 8260B/C	Dibromomethane (Methylene Bromide)
GC/MS	EPA 8260B/C	Dichlorodifluoromethane
GC/MS	EPA 8260B/C	Diethyl ether
GC/MS	EPA 8260B/C; EPA 8260B/C SIM	p-Dioxane (1,4-Dioxane)
GC/MS	EPA 8260B/C	Ethanol (Ethyl Alcohol)
GC/MS	EPA 8260B/C	Ethyl acetate
GC/MS	EPA 8260B/C	Ethyl methacrylate
GC/MS	EPA 8260B/C	Ethyl tert-butyl alcohol (ETBA)
GC/MS	EPA 8260B/C	Ethyl tert-butyl ether (ETBE)
GC/MS	EPA 8260B/C	Ethylbenzene
GC/MS	EPA 8260B/C	Ethylene Oxide
GC/MS	EPA 8260B/C	Hexachlorobutadiene
GC/MS	EPA 8260B/C	Hexane
GC/MS	EPA 8260B/C	Iodomethane (Methyl iodide)
GC/MS	EPA 8260B/C	Isobutyl alcohol (2-Methyl-1-propanol)
GC/MS	EPA 8260B/C	p-Isopropyltoluene
GC/MS	EPA 8260B/C	Isopropylbenzene
GC/MS	EPA 8260B/C	Methacrylonitrile
GC/MS	EPA 8260B/C	Methyl Acetate
GC/MS	EPA 8260B/C	Methyl bromide (Bromomethane)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/C	Methyl chloride (Chloromethane)
GC/MS	EPA 8260B/C	Methylcyclohexane
GC/MS	EPA 8260B/C	Methyl methacrylate
GC/MS	EPA 8260B/C	Methyl tert-butyl ether (MTBE)
GC/MS	EPA 8260B/C	Methylene chloride
GC/MS	EPA 8260B/C	Naphthalene
GC/MS	EPA 8260B/C	Pentachloroethane
GC/MS	EPA 8260B/C	Propionitrile (Ethyl cyanide)
GC/MS	EPA 8260B/C	n-Propylbenzene
GC/MS	EPA 8260B/C	Styrene
GC/MS	EPA 8260B/C	tert-Amyl alcohol (TAA)
GC/MS	EPA 8260B/C	tert-Amyl methyl ether (TAME)
GC/MS	EPA 8260B/C	tert-Butyl alcohol (TBA)
GC/MS	EPA 8260B/C	tert-Butyl formate (TBF)
GC/MS	EPA 8260B/C	Tetrachloroethylene (Perchloroethylene)
GC/MS	EPA 8260B/C	Tetrahydrofuran
GC/MS	EPA 8260B/C	Toluene
GC/MS	EPA 8260B/C	Trichloroethene (Trichloroethylene)
GC/MS	EPA 8260B/C	Trichlorofluoromethane
GC/MS	EPA 8260B/C	Vinyl acetate
GC/MS	EPA 8260B/C	Vinyl chloride
GC/MS	EPA 8260B/C	Xylene (total)
GC/MS	EPA 8260B/C	m,p-Xylene
GC/MS	EPA 8260B/C	o-Xylene
GC/MS	EPA 8260B/C	1-Bromopropane
GC/MS	EPA 8260B/C	Isopropyl Alcohol
GC/MS	EPA 8260B/C	n-Butyl Alcohol
GC/MS	EPA 8270D	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270D	1,2,4-Trichlorobenzene
GC/MS	EPA 8270D	1,2-Dichlorobenzene (o-Dichlorobenzene)
GC/MS	EPA 8270D	1,2-Diphenylhydrazine
GC/MS	EPA 8270D	1,3,5-Trinitrobenzene (1,3,5-TNB)
GC/MS	EPA 8270D	1,3-Dichlorobenzene (m-Dichlorobenzene)
GC/MS	EPA 8270D	1,3-Dinitrobenzene (1,3-DNB)
GC/MS	EPA 8270D	1,4-Dichlorobenzene (p-Dichlorobenzene)
GC/MS	EPA 8270D	1,4-Dithiane
GC/MS	EPA 8270D	1,4-Oxathiane

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	EPA 8270D	1,4-Naphthoquinone
GC/MS	EPA 8270D	1,4-Phenylenediamine
GC/MS	EPA 8270D	1-Chloronaphthalene
GC/MS	EPA 8270D; EPA 8270D SIM	1-Methylnaphthalene
GC/MS	EPA 8270D	1-Naphthylamine
GC/MS	EPA 8270D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270D	2,4,5-Trichlorophenol
GC/MS	EPA 8270D	2,4,6-Trichlorophenol
GC/MS	EPA 8270D	2,4-Dichlorophenol
GC/MS	EPA 8270D	2,4-Dimethylphenol
GC/MS	EPA 8270D	2,4-Dinitrophenol
GC/MS	EPA 8270D	2,4-Dinitrotoluene (2,4-DNT)
GC/MS	EPA 8270D	2,6-Dichlorophenol
GC/MS	EPA 8270D	2,6-Dinitrotoluene (2,6-DNT)
GC/MS	EPA 8270D	2-Acetylaminofluorene
GC/MS	EPA 8270D	2-Chloronaphthalene
GC/MS	EPA 8270D	2-Chlorophenol
GC/MS	EPA 8270D	2-Methyl-4,6-dinitrophenol (4,6-Dinitro-o-cresol)
GC/MS	EPA 8270D; EPA 8270D SIM	2-Methylnaphthalene
GC/MS	EPA 8270D	2-Methylphenol (o-Cresol)
GC/MS	EPA 8270D	2-Naphthylamine
GC/MS	EPA 8270D	2-Nitroaniline
GC/MS	EPA 8270D	2-Nitrophenol
GC/MS	EPA 8270D	2-Picoline (2-Methylpyridine)
GC/MS	EPA 8270D	3,3`-Dichlorobenzidine
GC/MS	EPA 8270D	3,3`-Dimethylbenzidine
GC/MS	EPA 8270D	3-Methylcholanthrene
GC/MS	EPA 8270D	3&4-Methylphenol (m,p-Cresol)
GC/MS	EPA 8270D	3-Nitroaniline
GC/MS	EPA 8270D	4-Aminobiphenyl
GC/MS	EPA 8270D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270D	4-Chloro-3-methylphenol
GC/MS	EPA 8270D	4-Chloroaniline
GC/MS	EPA 8270D	4-Chlorophenyl phenylether
GC/MS	EPA 8270D	4-Dimethyl aminoazobenzene
GC/MS	EPA 8270D	4-Nitroaniline

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	EPA 8270D	4-Nitrophenol
GC/MS	EPA 8270D	4,4’-methylene-bis(2-chloroaniline)
GC/MS	EPA 8270D	5-Nitro-o-toluidine
GC/MS	EPA 8270D	7,12-Dimethylbenz(a) anthracene
GC/MS	EPA 8270D; EPA 8270D SIM	Acenaphthene
GC/MS	EPA 8270D; EPA 8270D SIM	Acenaphthylene
GC/MS	EPA 8270D	Acetophenone
GC/MS	EPA 8270D	Aniline
GC/MS	EPA 8270D	Anilazine
GC/MS	EPA 8270D; EPA 8270D SIM	Anthracene
GC/MS	EPA 8270D	Aramite
GC/MS	EPA 8270D	Atrazine
GC/MS	EPA 8270D	Benzaldehyde
GC/MS	EPA 8270D	Benzidine
GC/MS	EPA 8270D; EPA 8270D SIM	Benzo(a)anthracene
GC/MS	EPA 8270D; EPA 8270D SIM	Benzo(a)pyrene
GC/MS	EPA 8270D; EPA 8270D SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270D; EPA 8270D SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270D; EPA 8270D SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270D	Benzoic acid
GC/MS	EPA 8270D	Benzyl alcohol
GC/MS	EPA 8270D	Biphenyl (1,1’-Biphenyl)
GC/MS	EPA 8270D	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270D	bis(2-Chloroethyl) ether
GC/MS	EPA 8270D	bis(2-Chloroisopropyl) ether (2,2`-Oxybis(1-chloropropane))
GC/MS	EPA 8270D	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	EPA 8270D	Butyl benzyl phthalate
GC/MS	EPA 8270D	Carbazole
GC/MS	EPA 8270D	Caprolactam
GC/MS	EPA 8270D	Chlorobenzilate
GC/MS	EPA 8270D; EPA 8270D SIM	Chrysene
GC/MS	EPA 8270D	Diallate
GC/MS	EPA 8270D	Dinoseb
GC/MS	EPA 8270D	Di-n-butyl phthalate
GC/MS	EPA 8270D	Di-n-octyl phthalate
GC/MS	EPA 8270D; EPA 8270D SIM	Dibenz(a,h)anthracene

Solid and Chemical Materials

Technology	Method	Analyte
GC/MS	EPA 8270D	Dibenz(a,j)acridine
GC/MS	EPA 8270D	Dibenzofuran
GC/MS	EPA 8270D	Diethyl phthalate
GC/MS	EPA 8270D	Dimethyl phthalate
GC/MS	EPA 8270D	a,a-Dimethylphenethylamine
GC/MS	EPA 8270D	Diphenyl Ether
GC/MS	EPA 8270D	p-Dioxane (1,4-Dioxane)
GC/MS	EPA 8270D	Ethyl methanesulfonate
GC/MS	EPA 8270D; EPA 8270D SIM	Fluoranthene
GC/MS	EPA 8270D; EPA 8270D SIM	Fluorene
GC/MS	EPA 8270D	Hexachlorobenzene
GC/MS	EPA 8270D	Hexachlorobutadiene
GC/MS	EPA 8270D	Hexachlorocyclopentadiene
GC/MS	EPA 8270D	Hexachloroethane
GC/MS	EPA 8270D	Hexachlorophene
GC/MS	EPA 8270D	Hexachloropropene
GC/MS	EPA 8270D; EPA 8270D SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270D	Isodrin
GC/MS	EPA 8270D	Isophorone
GC/MS	EPA 8270D	Isosafrole
GC/MS	EPA 8270D	Kepone
GC/MS	EPA 8270D	Methapyrilene
GC/MS	EPA 8270D	Methyl methanesulfonate
GC/MS	EPA 8270D; EPA 8270D SIM	Naphthalene
GC/MS	EPA 8270D	Nicotine
GC/MS	EPA 8270D	Nitrobenzene
GC/MS	EPA 8270D	Nitroquinoline-1-oxide
GC/MS	EPA 8270D	n-Nitroso-di-n-butylamine
GC/MS	EPA 8270D	n-Nitrosodi-n-propylamine
GC/MS	EPA 8270D	n-Nitrosodiethylamine
GC/MS	EPA 8270D	n-Nitrosodimethylamine
GC/MS	EPA 8270D	n-Nitrosodiphenylamine
GC/MS	EPA 8270D	n-Nitrosodiphenylamine/Diphenylamine (analyte pair)
GC/MS	EPA 8270D	n-Nitrosomethylethylamine
GC/MS	EPA 8270D	n-Nitrosomorpholine
GC/MS	EPA 8270D	n-Nitrosopiperidine

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270D	n-Nitrosopyrrolidine
GC/MS	EPA 8270D	Pentachlorobenzene
GC/MS	EPA 8270D	Pentachloroethane
GC/MS	EPA 8270D	Pentachloronitrobenzene
GC/MS	EPA 8270D; EPA 8270D SIM	Pentachlorophenol
GC/MS	EPA 8270D	Phenacetin
GC/MS	EPA 8270D; EPA 8270D SIM	Phenanthrene
GC/MS	EPA 8270D	Phenol
GC/MS	EPA 8270D	Pronamide (Kerb)
GC/MS	EPA 8270D	Propazine
GC/MS	EPA 8270D; EPA 8270D SIM	Pyrene
GC/MS	EPA 8270D	Pyridine
GC/MS	EPA 8270D	Resorcinol
GC/MS	EPA 8270D	Safrole
GC/MS	EPA 8270D	Simazine
GC/MS	EPA 8270D	o-Toluidine
GC/MS	EPA 8270D	Dimethoate
GC/MS	EPA 8270D	Disulfoton
GC/MS	EPA 8270D	Famphur
GC/MS	EPA 8270D	Methyl parathion (Parathion methyl)
GC/MS	EPA 8270D	Parathion ethyl
GC/MS	EPA 8270D	Phorate
GC/MS	EPA 8270D	Sulfotepp
GC/MS	EPA 8270D	Thionazin (Zinophos)
GC/MS	EPA 8270D	O,O,O-Triethyl phosphorothioate
HPLC	EPA 8330A/B	1,3,5-Trinitrobenzene (1,3,5-TNB)
HPLC	EPA 8330A/B	1,3-Dinitrobenzene (1,3-DNB)
HPLC	EPA 8330A/B	2,4,6-Trinitrotoluene (2,4,6-TNT)
HPLC	EPA 8330A/B	2,4-Dinitrotoluene (2,4-DNT)
HPLC	EPA 8330A/B	2,6-Dinitrotoluene (2,6-DNT)
HPLC	EPA 8330A/B	2-Amino-4,6-dinitrotoluene (2-am-dnt)
HPLC	EPA 8330A/B	2-Nitrotoluene
HPLC	EPA 8330A/B	3,5-Dinitroaniline
HPLC	EPA 8330A/B	3-Nitrotoluene
HPLC	EPA 8330A/B	4-Amino-2,6-dinitrotoluene (4-am-dnt)
HPLC	EPA 8330A/B	4-Nitrotoluene

Solid and Chemical Materials

Technology	Method	Analyte
HPLC	EPA 8330A/B	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC	EPA 8330A/B	Nitrobenzene
HPLC	EPA 8330A/B	Nitroglycerin
HPLC	EPA 8330A/B	Methyl-2,4,6-trinitrophenylnitramine (Tetryl)
HPLC	EPA 8330A/B	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC	EPA 8330A/B	Pentaerythritoltetranitrate (PETN)
HPLC	EPA 8330A	2,2’,6,6’-Tetranitro-4,4’-azoxytoluene
HPLC	EPA 8330A/B	2-amino-6-Nitrotoluene
HPLC	EPA 8330A/B	4-amino-2-Nitrotoluene
HPLC	EPA 8330A/B	2-amino-4-Nitrotoluene
HPLC	EPA 8330A/B	2,4-diamino-6-Nitrotoluene
HPLC	EPA 8330A/B	2,6-diamino-4-Nitrotoluene
HPLC	EPA 8330A/B	DNX
HPLC	EPA 8330A/B	MNX
HPLC	EPA 8330A/B	TNX
HPLC	EPA 8330A	Nitroguanidine
HPLC	EPA 8330A	Guanidine Nitrate
LC/MS/MS	EPA 6850	Perchlorate
LC/MS/MS	EPA 537 MOD[2]	Perfluorobutanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluoropentanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorohexanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluoroheptanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorooctanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorononanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorodecanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluoroundecanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorododecanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorotridecanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorotetradecanoic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorononanesulfonic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorobutanesulfonic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorohexanesulfonic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorooctanesulfonic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorodecanesulfonic Acid
LC/MS/MS	EPA 537 MOD[2]	Perfluoropentanesulfonic Acid

Solid and Chemical Materials

Technology	Method	Analyte
LC/MS/MS	EPA 537 MOD[2]	Perfluoroheptanesulfonic acid
LC/MS/MS	EPA 537 MOD[2]	Perfluorooctane sulfonamide
LC/MS/MS	EPA 537 MOD[2]	N-Methyl perfluorooctane sulfonamide
LC/MS/MS	EPA 537 MOD[2]	N-Ethyl perfluorooctane sulfonamide
LC/MS/MS	EPA 537 MOD[2]	Perfluoro-1-octanesulfonamidoacetic acid
LC/MS/MS	EPA 537 MOD[2]	N-Methyl perfluorooctanesulfonamidoacetic acid
LC/MS/MS	EPA 537 MOD[2]	N-Ethyl perfluorooctanesulfonamidoacetic acid
LC/MS/MS	EPA 537 MOD[2]	N-Methyl perfluorooctane sulfonamidoethanol
LC/MS/MS	EPA 537 MOD[2]	4:2 Fluorotelomer Sulfonate
LC/MS/MS	EPA 537 MOD[2]	N-Ethyl perfluorooctane sulfonamidoethanol
LC/MS/MS	EPA 537 MOD[2]	6:2 Fluorotelomer Sulfonate
LC/MS/MS	EPA 537 MOD[2]	8:2 Fluorotelomer Sulfonate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorobutanoic Acid (PFBA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluoropentanoic Acid (PFPeA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-1515	Perfluorohexanoic Acid (PFHxA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluoroheptanoic Acid (PFHpA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorooctanoic Acid (PFOA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorononanoic Acid (PFNA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorodecanoic Acid (PFDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluoroundecanoic Acid (PFUnA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorododecanoic Acid(PFDoA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorotridecanoic Acid (PFTrDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorotetradecanoic Acid (PFTA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorobutanesulfonic Acid (PFBS)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorohexanesulfonic Acid(PFHxS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorooctanesulfonic Acid(PFOS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorononanesulfonic Acid(PFNS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorodecanesulfonic Acid(PFDS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluoroheptanesulfonic acid(PFHpS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluoropentanesulfonic Acid(PFPeS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	Perfluorooctane sulfonamide (PFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	N-Methyl perfluorooctanesulfonamidoacetic acid (MeFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	N-Ethyl perfluorooctanesulfonamidoacetic acid (EtFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	4:2 Fluorotelomer Sulfonate (FTS 4:2)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	6:2 Fluorotelomer Sulfonate(FTS 6:2)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.1 Table B-15	8:2 Fluorotelomer Sulfonate (FTS 8:2)
ICP	EPA 6010C/D	Aluminum
ICP	EPA 6010C/D	Antimony
ICP	EPA 6010C/D	Arsenic
ICP	EPA 6010C/D	Barium
ICP	EPA 6010C/D	Beryllium
ICP	EPA 6010C/D	Cadmium
ICP	EPA 6010C/D	Calcium
ICP	EPA 6010C/D	Chromium
ICP	EPA 6010C/D	Cobalt
ICP	EPA 6010C/D	Copper
ICP	EPA 6010C/D	Iron
ICP	EPA 6010C/D	Lead
ICP	EPA 6010C/D	Magnesium
ICP	EPA 6010C/D	Manganese
ICP	EPA 6010C/D	Molybdenum

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP	EPA 6010C/D	Nickel
ICP	EPA 6010C/D	Potassium
ICP	EPA 6010C/D	Selenium
ICP	EPA 6010C/D	Silver
ICP	EPA 6010C/D	Sodium
ICP	EPA 6010C/D	Strontium
ICP	EPA 6010C/D	Thallium
ICP	EPA 6010C/D	Tin
ICP	EPA 6010C/D	Titanium
ICP	EPA 6010C/D	Vanadium
ICP	EPA 6010C/D	Zinc
ICP/MS	EPA 6020A/B	Aluminum
ICP/MS	EPA 6020A/B	Antimony
ICP/MS	EPA 6020A/B	Arsenic
ICP/MS	EPA 6020A/B	Barium
ICP/MS	EPA 6020A/B	Beryllium
ICP/MS	EPA 6020A/B	Cadmium
ICP/MS	EPA 6020A/B	Calcium
ICP/MS	EPA 6020A/B	Chromium
ICP/MS	EPA 6020A/B	Cobalt
ICP/MS	EPA 6020A/B	Copper
ICP/MS	EPA 6020A/B	Iron
ICP/MS	EPA 6020A/B	Lead
ICP/MS	EPA 6020A/B	Magnesium
ICP/MS	EPA 6020A/B	Manganese
ICP/MS	EPA 6020A/B	Molybdenum
ICP/MS	EPA 6020A/B	Nickel
ICP/MS	EPA 6020A/B	Potassium
ICP/MS	EPA 6020A/B	Selenium
ICP/MS	EPA 6020A/B	Silver
ICP/MS	EPA 6020A/B	Sodium
ICP/MS	EPA 6020A/B	Strontium
ICP/MS	EPA 6020A/B	Thallium
ICP/MS	EPA 6020A/B	Tin
ICP/MS	EPA 6020A/B	Titanium
ICP/MS	EPA 6020A/B	Vanadium

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
ICP/MS	EPA 6020A/B	Zinc
CVAA	EPA 7471B	Mercury
UV/VIS	EPA 7196A	Hexavalent Chromium (Cr6+)
UV/VIS	EPA 9012B	Cyanide (Total)
IC	EPA 9056A	Bromide
IC	EPA 9056A	Chloride
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Nitrate
IC	EPA 9056A	Nitrite
IC	EPA 9056A	Sulfate
IC	EPA 9056A	Total nitrate-nitrite
Gravimetric Methods	SM 2540G	% solids
Electrometric Methods	EPA 9045D	Hydrogen Ion (pH)
Ignitability	EPA 1010A MOD	Flash Point
Waste Characterization	EPA Ch.7	Reactive Cyanide and Reactive Sulfide
Waste Characterization	EPA Section 7.3	Reactive Cyanide
Waste Characterization	EPA Section 7.3	Reactive Sulfide
Preparation	**Method**	**Type**
Organics Preparation	EPA 3510C	Separatory Funnel Liquid-Liquid Extraction; Leachates
TCLP Preparation	EPA 1311	Toxicity Characteristic Leaching Procedure
SPLP Preparation	EPA 1312	Synthetic Precipitation Leaching Procedure
Organics Preparation	EPA 8011	Microextraction
Organics Preparation	EPA 3546	Microwave Extraction
Organics Preparation	EPA 3550C	Ultrasonic Extraction
Organics Preparation	EPA 3580A	Waste Dilution for Extractable Organics
Organics Preparation	EPA 8330A; EPA 8332	Ultrasonic Extraction
Organics Preparation	EPA 8330B	Shaker Table Extraction
Volatile Organics Preparation	EPA 3585	Waste Dilution for Volatile Organics
Volatile Organics Preparation	EPA 5030A	Closed System Purge and Trap; Bulk Soils
Volatile Organics Preparation	EPA 5030B	Closed System Purge and Trap; Leachates and Methanol Extracts
Volatile Organics Preparation	EPA 5035; EPA 5035A	Closed System Purge and Trap
Organics Cleanup	EPA 3660B	Sulfur Cleanup

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
Organics Cleanup	EPA 3665A	Sulfuric Acid Cleanup
Lachat MicroDistillation	EPA 9012B	Cyanide MicroDistillation; proprietary method
Inorganic Preparation	EPA 3010A	Metals Acid Digestion by Hotblock; Leachates
Inorganic Preparation	EPA 3050B	Metals Acid Digestion by Hotblock
Inorganic Preparation	EPA 3060A	Alkaline Digestion, Cr6+
Inorganic Preparation	EPA 7470A	CVAA Digestion by Hotblock; Leachates
Inorganic Preparation	EPA 7471B	CVAA Digestion by Hotblock

Note:

1. This scope is formatted as part of a single document including Certificate of Accreditation No. L2229
2. Not compliant with QSM V5.1.1 Table B-15

Vice President

ATTACHMENT G

Response to Comments on the Draft QAPP

Responses to Comments submitted by the Central Coast Regional Water Quality Control Board (CCRWQCB)[1]

SPECIFIC COMMENT 1: Section 3.1.3 Known Contaminants and Section 3.6.1 – Worksheet #15a: VOCs by EPA Method 8260-SIM: Section 3.1.3 indicates that known contaminants, or contaminants of concern (COCs), were identified during Remedial Investigations at the sites and documented in the decision documents for each site. The COCs for each site are listed in Section 3.6.1, Worksheet #15a. Based on a review of groundwater analytical data for the site, it appears that select wells were historically sampled and analyzed for 1,2,3-trichloropropane (1,2,3-TCP). This constituent was ruled out as a potential COC however, the detection limits were above the California Maximum Contaminant Level (MCL) of 0.005 micrograms per liter (µg/L) that was adopted in 2017. Therefore, the Water Board recommends selecting one key groundwater monitoring well (i.e.: the well with the highest concentrations of a known COC) at each of the OU2, Sites 2/12, and OUCTP Areas to sample and analyze for 1,2,3-TCP to confirm non-detectable results using a detection limit below the MCL. In 2018, the municipal water supply wells in the former Fort Ord Area (FO-29 through FO-31) were sampled and analyzed for 1,2,3-TCP using a detection limit below 0.005 µg/L. 1,2,3-TCP was not detected in the samples collected from the municipal water supply wells.

RESPONSE TO SPECIFIC COMMENT 1: *It is acknowledged the analytical detection limits for groundwater samples historically collected at the former Fort Ord are higher than the current California MCL, but additional sampling and analysis for 1,2,3-TCP is not warranted based on the following lines of evidence:*

- *Common uses of 1,2,3-TCP included use as a paint and varnish remover, and a cleaning and degreasing agent.[2] These uses would be consistent with historical uses of other solvents, including carbon tetrachloride (CT), tetrachloroethene (PCE), and trichloroethene (TCE), at the former Fort Ord when it was an active military installation. However, while CT, PCE, and TCE have historically been detected in groundwater, soil, and soil gas at the former Fort Ord at concentrations exceeding MCLs or screening levels by several orders of magnitude, there have been no corresponding detections of 1,2,3-TCP, indicating there was no significant usage of this compound.*
- *The vapor pressure of 1,2,3-TCP (3.1 mmHg at 25°C) and the calculated Henry's law constant (3.17×10^{-4} atm-m^3/mol at 25°C) suggest volatilization from either dry or moist soil to the atmosphere will be a significant environmental process.[3] Therefore, if there was any release of 1,2,3-TCP to the ground surface, it is likely most or all of it would have volatilized to the atmosphere before it could leach to groundwater.*
- *Other media, including soil and soil gas, have been sampled and analyzed for 1,2,3-TCP at various sites across the former Fort Ord, including OU1, OU2, OUCTP, and Sites 2/12, and 1,2,3-TCP has never been detected, further indicating no significant usage of this compound at the former Fort Ord.*

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[1] In a letter dated March 22, 2019 (see Administrative Record No. BW-2785G.4).

[2] Agency for Toxic Substances and Disease Registry: Toxicological Profile for 1,2,3-Trichloropropane, May 2019: https://www.atsdr.cdc.gov/toxprofiles/tp57.pdf

[3] Ibid.

- *CT and TCE have historically been detected in municipal water supply wells FO-29, FO-30, and FO-31, and these compounds are associated with identified upgradient operable units; however, as noted in the comment, 1,2,3-TCP has not been detected in these wells. Because 1,2,3-TCP is a chlorinated solvent with high mobility, it would be expected to be present concurrently with CT and TCE; however, its absence indicates there is no upgradient source.*

SPECIFIC COMMENT 2: Section 3.1.4 – Fate and Transport Considerations, OU2 and OUCTP: The subsections for OU2 and OUCTP indicate the aquifers that are impacted by COCs. In the subsection for Sites 2/12 please add the aquifer(s) impacted by COCs.

RESPONSE TO SPECIFIC COMMENT 2: *The text was revised per the comment.*

SPECIFIC COMMENT 3: Section 3.1.4 – Fate and Transport Considerations, OU2 and OUCTP: In the subsection for OUCTP consider adding the following discussion related to TCE in the Lower 180-Foot Aquifer: *Due to the lateral discontinuity in the Intermediate 180-Foot Aquitard between the Upper and Lower 180-Foot Aquifers, existing TCE data for the A-Aquifer in the OU2 Area and for the Upper and Lower 180-Foot Aquifers in the OUCTP and OU2 Areas will be reviewed and evaluated to determine the source of TCE concentrations above the California MCL of 5 µg/L in the Lower 180-Foot Aquifer.* Please cite reference documents that include information on the discontinuity of the Intermediate 180-Foot Aquitard, as appropriate.

RESPONSE TO SPECIFIC COMMENT 3: *Text was added to Section 3.1.4 to provide more detail about the migration of CT in the affected aquifers at OUCTP, and to note the presence of TCE in the Lower 180-Foot Aquifer and its possible association with OU2. However, the Quality Assurance Project Plan (QAPP) is a guidance document for groundwater sampling and analysis activities at the former Fort Ord; therefore, the suggested discussion would be more appropriately included in the "Suggested Monitoring Modifications" section of the OUCTP Fourth Quarter 2018 through Third Quarter 2019 Groundwater Monitoring Report.*

SPECIFIC COMMENT 4: Section 3.1.8 – Geology and Hydrogeology: This section indicated that the aquifers consist predominantly of fine to coarse-grained sands which are separated by silty clay or clayey fine-grained sand aquitards. Please consider including additional information on the aquitards such as that the Fort Ord Salinas Valley Aquitard pinches out to the west towards the Pacific Ocean and that the Intermediate 180-Foot Aquitard that separates the Upper 180-Foot Aquifer and Lower 180-Foot Aquifer appears to be laterally discontinuous in the eastern portion of the former Fort Ord near the OU2 and OUCTP Areas. Additionally, please cite reference documents that include information on the aquitards, as appropriate.

RESPONSE TO SPECIFIC COMMENT 4: *The text was revised per the comment.*

SPECIFIC COMMENT 5: Section 3.2.1 – Step 1: State the Problem, OUCTP Lower 180-Foot Aquifer: Consider adding the following discussion related to TCE detections in the Lower 180-Foot Aquifer: *Due to the lateral discontinuity in the Intermediate 180-Foot Aquitard between the Upper and Lower 180-Foot Aquifers, existing TCE data for the A-Aquifer in the OU2 Area and for the Upper and Lower 180-Foot Aquifers in the OUCTP and OU2 Areas will be reviewed and evaluated to determine the source of recent detections of TCE above the California MCL of 5 µg/L in the Lower 180-Foot Aquifer. Please cite reference* *documents that include information on the discontinuity of the Intermediate 180-Foot Aquitard, as appropriate.*

RESPONSE TO SPECIFIC COMMENT 5: *Consistent with the response to Specific Comment 3, text was added to the OUCTP Lower 180-Foot Aquifer subsection of Section 3.2.1 to note the presence of TCE in the Lower 180-Foot Aquifer and its possible association with OU2. Accordingly, Section 3.2.2 was revised to identify additional study goals to address the revised problem statement.*

SPECIFIC COMMENT 6: Section 3.2.6 – Step 6: Specify Performance or Acceptance Criteria, OU2, Sites 2/12, and OUCTP GWMP: This section includes the following information: VOCs in groundwater at the former Fort Ord range in concentration from ND to 27.4 micrograms per liter (µg/L) PCE (at Sites 2/12), 19.6 µg/L TCE (at site OU2), and 6.5 µg/L CT (at OUCTP), the primary COCs at these sites (as measured in the Third Quarter 2016 GWMP). Please update the ranges in concentrations of VOCs in groundwater with the concentrations measured in the Third Quarter 2017 GWMP.

RESPONSE TO SPECIFIC COMMENT 6: *The data was updated with Third Quarter 2018 GWMP information in the OU2, Sites 2/12, and OUCTP GWMP subsection of Section 3.2.6.*

SPECIFIC COMMENT 7: Section 3.5.16 – Project Schedule: In the table for the general project schedule under the activity column OU2 GWMP is listed twice. It appears that Sites 2/12 GWMP is missing from the list. Please modify the activity list as appropriate.

RESPONSE TO SPECIFIC COMMENT 7: *The table was revised per the comment.*

SPECIFIC COMMENT 8: Section 4.1.5 – Worksheet #17c1: Sites 2/12 GWMP and Figure 2: Following submittal of the Draft QAPP for review, Ahtna requested a modification to the Sites 2/12 GWMP in an email on February 25, 2019 and the Water Board approved the modifications by email on February 28, 2019. Provided that the United States Environmental Protection Agency (USEPA) and Department of Toxic Substances Control (DTSC) concur, please update the sampling frequency for well MW-12-26-180U from quarterly to annual on Worksheet #17c1 and Figure 2.

RESPONSE TO SPECIFIC COMMENT 8: *Worksheet #17c1 and Figure 2 were edited to move MW-12-26-180U from quarterly to annual monitoring frequency.*

SPECIFIC COMMENT 9: Section 4.1.7 – Worksheet #17c3: OUCTP A-Aquifer GWMP and Figure 8A: Following submittal of the draft QAPP for review, Ahtna requested modifications to the OUCTP A-Aquifer GWMP in an email on February 25, 2019 and the Water Board approved the modifications by email on February 28, 2019. Provided that the EPA and DTSC concur, please update the following on Worksheet #17c3 and Figure 8A:

- Modify the sampling frequency for wells EW-BW-132-A, EW-BW-163-A, EW-BW-167-A, EW-BW-168-A, and EW-BW-169-A from quarterly to annual.
- Remove wells EW-BW-161-A, EW-BW-162-A, EW-BW-164-A, EW-BW-165-A, MW-BW-16-A, and MW-BW-57-A from the sampling program.
- Include quarterly DO/ORP monitoring at wells MW-BW-87-A and MW-BW-91-A.

RESPONSE TO SPECIFIC COMMENT 9: *Worksheet #17c3 and Figure 8A were edited to change the frequency of monitored wells as described above, with the following exceptions:*

- *EW-BW-163-A is removed from the program.*
- *EW-BW-165-A sampling frequency is reduced from quarterly to annual.*
- *MW-BW-87-A and MW-BW-91-A casing diameters are too small for the DO/ORP meter; therefore, they were substituted with EW-BW-161-A and EW-BW-164-A for DO/ORP monitoring.*
- *MW-BW-30-A sampling frequency was increased to annual.*

Responses to Comments submitted by the Fort Ord Community Advisory Group (FOCAG)[1]

COMMENT 1: To begin, please reference and review previous responses found on the Administrative Record
BW-2327E.1
OU2-630F
And this from the CCRWQCB dated December 19, 1986 http://docs.fortordcleanup.com/ar_pdfs/AR-OU2-019//ou2-019.pdf. To quote a portion: "The plan does not fully address the extent of contamination in the deeper aquifers. For example, Marina's Well No. 10 is perforated solely in the 900 foot aquifer. The well has shown Trichloroethane contamination. The source of the contamination is most likely from the shallower aquifers. This should be addressed in your sampling plan."

The current document, Version 7, does not address VOC contamination in the Marina Coast Water District supply wells that draw water from the 900-foot aquifer. How often are these wells tested for VOCs? Have the sources of the contamination been determined? Is the water being pumped from these three 900-foot deep wells still being blended to meet State water quality standards?

RESPONSE TO COMMENT 1: *The U.S. Department of the Army (Army) conducted a basewide hydrogeologic evaluation and determined volatile organic compound (VOC) contamination in groundwater at the former Fort Ord does not impact the 400-Foot Aquifer and 900-Foot Aquifer.[2] Drinking water supplied by the Marina Coast Water District (MCWD) meets all Federal, State, and local regulatory standards. MCWD regularly tests drinking water quality and reports the results in an annual Consumer Confidence Report (CCR) found at www.mcwd.org. Water quality data and operational information are available at MCWD. Contact information for MCWD is available at https://mcwd.org/customer_service_contact.html.*

COMMENT 2: Large Army burns on the former Army Training Range lands called Site 39 was a common occurrence. The Army would extinguish these brush and ordnance fires. We ask, where are the test results for Perfluorooctanoic Acid and Perflorooctane Sulfanate in the groundwater beneath Site 39? Because a good portion of Site 39 sits directly atop the Seaside Groundwater Basin.

RESPONSE TO COMMENT 2: *The Army is currently conducting a basewide review of historical activities at the former Fort Ord that may have resulted in releases of PFOA/PFOS to soil and groundwater, and the results will be included in a report scheduled to be issued in summer 2019. Based on the preliminary results of this review, there is no suspected release of perfluorooctanoic acid (PFOA) or perfluorooctane sulfonate (PFOS) at Site 39. During prescribed burning at the former Fort Ord, fire foam or retardant may be used for pretreatment of the containment line around the burn unit, or to extinguish fires that have gone outside the containment line; however, these are Class A foams or retardants designed for use on combustible materials, such as wood, and not Class B foams designed for use on petroleum-based fires that may contain PFOA or PFOS. Additionally, the Fort Ord fire department historically used water tenders and not foam for fighting fires at Site 39.*

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[1] In a letter dated March 8, 2019 (see Administrative Record No. BW-2785G.2). The comments are reproduced here as provided to the Army and there have been no changes to spelling, grammar, or punctuation.
[2] See Administrative Record No. BW-1283A.

As required by the federal third Unregulated Contaminant Monitoring Rule, water systems in the vicinity of the former Fort Ord, including the MCWD and California American Water, collected and analyzed drinking water samples for PFOA and PFOS from 2013 to 2015 and there were no detections. Analytical results are available in a downloadable Microsoft Excel file at the State Water Resources Control Board (SWRCB) website under the heading "Findings in California Drinking Water:"

https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/PFOA_PFOS.html

The SWRCB has also issued orders to public water systems in the vicinity of the former Fort Ord requiring testing for PFOA and PFOS. The SWRCB will also prepare a map of the sampling completed to date by the end of summer 2019. The map, along with a spreadsheet of all available data, will be made available to the public.

COMMENT 3: Please have the document tell of the decision to create an unlined landfill and transfer contamination and waste from one cell to another new one across the road at OU2.

RESPONSE TO COMMENT 3: *When the Fort Ord Landfills were receiving waste from 1956 to 1987, the waste was placed in shallow unlined trenches; however, the remedial action for the Fort Ord Landfills does not include creating an unlined landfill, and no new landfill cells were created as part of the remedy for OU2. In accordance with the Record of Decision, Operable Unit 2, Fort Ord Landfills (OU2 ROD)[3] and OU2 Area A Explanation of Significant Differences (ESD),[4] waste was consolidated in the existing landfill areas south of Imjin Parkway and an engineered cover system, including a linear low-density polyethylene liner, was constructed over the top of the waste. With implementation of the remedy, the overall area of the Fort Ord Landfills decreased by approximately 20 percent.[5]*

Regardless, the information requested to be included in the Quality Assurance Project Plan (QAPP) is not relevant because the QAPP is a guidance document for groundwater sampling and analysis activities at the former Fort Ord; however, the OU2 Landfills QAPP is referenced in Section 3.1.3, and this document contains detailed information about the Fort Ord Landfills and the OU2 remedy.

COMMENT 4: Page 18, Section 3.1.8 Geology and Hydrology: The two paragraphs are insufficient. During the 1990's the Army BRAC held Community Involvement Workshops (C.I.W.). The community was informed that there was an impermeable clay aquitard that prevented contamination from flowing into the Lower 180-ft aquifer. Some community members expressed skepticism at the time. Later we learned that, Oops, guess there was a hole in the aquitard.

RESPONSE TO COMMENT 4: *Additional information regarding the system of aquifers and aquitards at the former Fort Ord was added to Section 3.1.8.*

COMMENT 5: Page 19, Section 3.2.1 Step 1: State the Problem: We suggest that since water and VOC contaminants run downhill, that the 900-ft aquifer be studied, and reported on too.

RESPONSE TO COMMENT 5: *See response to Comment 1.*

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[3] See Administrative Record No. OU2-480.

[4] See Administrative Record No. OU2-458.

[5] See Administrative Record No. OU2-630B.

COMMENT 6: Was the source of the Meningitis outbreak among the troops training at Fort Ord in the 1962-1964 time frame ever determined?

RESPONSE TO COMMENT 6: *There was no determination of the source as noted in the following article: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1515912/.*

COMMENT 7: Page 19-20, Sites 2/12, second paragraph, regarding contamination of the groundwater by COC's and seawater intrusion. The FOCAG asks about a timeline here because initially wells had to be closed and moved inland and the reason given, at the time, was because of chloride concentrations (sea water).

RESPONSE TO COMMENT 7: *In 1940 and 1941 there were nine water supply wells constructed in the Main Garrison area (some in the vicinity of Sites 2/12). Two of these were never used and most of the others pumped sand and produced water with high chloride concentrations. Seven of the water supply wells were decommissioned in 1951 or 1952, and the last two were decommissioned in 1989. From 1942 until 1984, additional water supply wells were constructed further inland. Most of these have been decommissioned, with only FO-29, FO-30, and FO-31 remaining.*[6] *Wells constructed in the Sites 2/12 area since 1989 have been for groundwater monitoring and groundwater extraction and treatment, not for water supply. Because seawater intrusion can damage groundwater remediation equipment, the Army measures chloride concentrations annually at Sites 2/12 in select groundwater wells, as noted in QAPP Worksheet #17c1, to ensure groundwater extraction and treatment activities do not make seawater intrusion worse in this area.*

COMMENT 8: Page 20, OU2; Please make it clear that moving a portion of the landfill to an unlined landfill contributed to the migration of contaminants downward into the aquifers. Secondly, the three wells referenced; FO-29, FO-30, and FO-31, located near the OU2 area are the Marina Coast Water District's source wells. The MCWD currently serves residential and commercial service connections on former Fort Ord and the City of Marina.

RESPONSE TO COMMENT 8: *Excavating waste from Landfills Area A on the north side of Imjin Parkway and consolidating it with waste in Landfills Areas B through F on the south side of Imjin Parkway did not contribute to migration of COCs to groundwater. The remedy for the Fort Ord Landfills is functioning as designed and is protective of human health and the environment.*[7] *The engineered landfill cover system, constructed in accordance with the remedy identified in the OU2 ROD, is specifically designed to prevent migration of contaminants to the groundwater. Migration of contaminants from the Fort Ord Landfills to groundwater that occurred prior to construction of the engineered cover system has been mitigated through extraction and treatment of landfill gas and groundwater per the requirements of the OU2 ROD (see also the response to Comment 3).*

The text was revised to state that MCWD owns and operates FO-29, FO-30, and FO-31 as part of the water supply system for the former Fort Ord and the City of Marina.

COMMENT 9: Page 21, 3.2.2, Step 2: Identify the Goals of the Study: We call your attention to the second "bullet" below OU2 and Sites 2/12 GWTS. GWTS stands for Ground Water Treatment Systems. It

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[6] See Administrative Record No. BW-2002A.

[7] See Administrative Record No. OU2-480.

states here that, "Assess whether GWTS effluent meets discharge requirements before it is used for groundwater recharge or onsite for non-potable construction purposes (dust control, soil compaction, etc.)" We ask that you please expand this to include analysis of the goal of the Monterey Peninsula Water Management District's plan to inject treated sewer water, and water used for washing pesticides from produce, and other waste water, directly into the ground above a portion of the Seaside Groundwater Basin. This is a groundwater recharge effort, and we ask for clarification as to how much Fort Ord GWTS effluent might, or will, be mixed with this either intentionally or unintentionally?

RESPONSE TO COMMENT 9: *It is assumed the comment is referring to the Pure Water Monterey project, which includes replenishment of the Seaside Groundwater Basin with purified recycled water.*[8] *This type of analysis is not within the scope of the QAPP, which is a guidance document for groundwater sampling and analysis activities at the former Fort Ord. However, according to the* Final Engineering Report, Monterey One Water Pure Water Monterey Groundwater Replenishment Project*, replenishment is to occur via four injection wells that will recharge the Santa Margarita Aquifer and the Paso Robles Aquifer.*[9] *No mixing of purified recycled water and the Army's groundwater treatment systems (GWTS) treated effluent can occur because:*

- *The Santa Margarita Aquifer and the Paso Robles Aquifer are significantly deeper than, and not hydrologically connected to, the Upper 180-Foot Aquifer being recharged by the Army's GWTS.*
- *The northern boundary of the Seaside Groundwater Basin is at least 1.6 miles south of the Army's closest groundwater recharge structures.*
- *The general groundwater flow direction in the Seaside Groundwater Basin is to the west (i.e., parallel to flow in the Upper 180-Foot Aquifer).*

COMMENT 10: Bottom of page 22, Footnote 7 states, "Antimony, copper, and lead are the primary metals found in spent ammunition deposited in the Fort Ord landfills. MCL's are used to evaluate concentrations of these dissolved metals in groundwater near the Fort Ord Landfills; however, the groundwater being monitored is not intended for use as drinking water." The FOCAG asks for clarification of this footnote. Also, Army training involved dozens of chemicals. We understand the intent wasn't to drink it. But it is in the groundwater now, or headed there. Please reference the Administrative record for FOCAG document OTH-253 dated 01/02/2010.

RESPONSE TO COMMENT 10: *Footnote 7 was revised to clarify that:*

- *Detected concentrations of antimony, copper, and lead are compared to Federal and California Maximum Contaminant Levels (MCLs) because there are no Aquifer Cleanup Levels (ACLs) for these metals identified in the OU2 ROD.*
- *The groundwater being monitored is not intended for use as drinking water because it is within the Prohibition Zone of the Special Groundwater Protection Zone.*

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[8] At its public meeting on March 9, 2017, the Central Coast Regional Water Quality Control Board adopted waste discharge and water recycling requirements for the Pure Water Monterey Advanced Water Purification Facility and Groundwater Replenishment Project; a copy of the order is available at https://www.waterboards.ca.gov/centralcoast/board_decisions/adopted_orders/

[9] The Engineering Report is available at http://purewatermonterey.org/wp/wp-content/uploads/M1W-Final-Title-22-Engineering-Report-April-2019.pdf

Section 3.2.1 of the QAPP was also revised to clarify the rationale for monitoring for antimony, copper, and lead in groundwater near the Fort Ord Landfills. Results of the sampling for metals analysis described in QAPP Worksheet #17c2 are in the OU2 reports for Third Quarter groundwater monitoring events, which are included in the Administrative Record. Concentrations of these metals in groundwater samples are all below MCLs.

Based on the reference to Administrative Record No. OTH-253, it is assumed the comment is concerned with chemical warfare material (CWM) contaminating groundwater at the former Fort Ord. There is no evidence of CWM having been used at the former Fort Ord. A comprehensive search was conducted at Fort Ord and did not uncover any evidence in records, interviews, or other information sources to indicate that chemical weapons were ever stored, used, or buried at Fort Ord. Evidence indicates the only CWM used at the former Fort Ord were Chemical Agent Identification Sets, which were used to train soldiers to recognize and protect themselves from chemical agents. In addition, more than 13 million anomalies have been investigated and more than 300,000 cubic yards of contaminated soil have been excavated during investigations and removals at Fort Ord without any evidence of CWM.[10]

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[10] Technical Memorandum, CWM-Related Responses and Reports, Administrative Record No. OE-0726.