

Quality Assurance Project Plan Former Fort Ord, California Volume I, Appendix A

Final Revision 11 Groundwater Remedies and Monitoring at Sites 2 and 12, Operable Unit 2, and Operable Unit Carbon Tetrachloride Plume



Prepared for:
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USACE Contract No. W91238-19-C-0027
Task No. 8

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Report Date: **November 2023**
Report Version: **Final**

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- E Analytical Laboratory Certifications
- F Responses to USEPA Comments on the Draft QAPP
- G Responses to DTSC Comments on the Draft QAPP
- H Responses to CCRWQCB Comments on the Draft QAPP
- I Responses to FOCAG Comments on the Draft QAPP

Acronyms and Abbreviations

%	percent
°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
ACL	Aquifer Cleanup Level
ADR	Automated Data Review
Ahtna	Ahtna Global, LLC
Army	U.S. Department of the Army
BCT	BRAC Cleanup Team
BEC	BRAC Environmental Coordinator
BFB	4-bromofluorobenzene
bgs	below ground surface
BRAC	Base Realignment and Closure
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
CQM	Construction Quality Management
CPR	cardiopulmonary resuscitation
CRF	Cooler Receipt Form
CT	carbon tetrachloride
DCL	discharge limit
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 <i>in situ</i> bioremediation
ELAP	Environmental Laboratory Accreditation Program

Acronyms and Abbreviations (continued)

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
H&S	health and safety
HACCP	Hazard Analysis & Critical Control Points
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCl	hydrochloric acid
HDPE	high-density polyethylene
HNO ₃	nitric acid
IC	ion chromatography
ICAL	initial calibration
ICP	inductively coupled plasma
ICS	interference check sample
ICV	initial calibration verification
ID	identification
LCS	laboratory control samples
LCSD	LCS duplicate
LOD	limit of detection
LOQ	limit of quantitation
MC	methylene chloride
MCL	maximum contaminant level
MCWD	Marina Coast Water District
MEC	munitions and explosives of concern
mg/L	milligrams per liter
mL	milliliter
MNA	monitored natural attenuation
MS	matrix spike
MSD	matrix spike duplicate
MSL	mean sea level
N/A	not applicable
ND	non-detect

Acronyms and Abbreviations (continued)

NPL	National Priorities List
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
Pb	lead
PCE	tetrachloroethene
PDB	passive diffusion bag
PDS	post-digestion spike
PE	registered Professional Engineer
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QSM	Quality Systems Manual
RAWP	Remedial Action Work Plan
RI	Remedial Investigation
RF	response factor
ROD	Record of Decision
RPD	relative percent difference
RSD	relative standard deviation
Sb	antimony
SGS	SGS North America, Inc.
SIM	selected ion monitoring
Sites 2/12	Sites 2 and 12
SM	Standard Methods
SOP	standard operating procedure
SRF	Sample Receipt Form
TAT	turnaround time
TCE	trichloroethene
trans-1,2-DCE	trans-1,2-dichloroethene
UCL	upper confidence limit
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
VC	vinyl chloride
VOA	volatile organic analysis
VOC	volatile organic compound

1.0 Introduction

On behalf of the U.S. Army Corps of Engineers (USACE), Sacramento District, Ahtna Global, LLC (Ahtna) updated this Quality Assurance Project Plan (QAPP)¹ under Contract Number W91238-19-C-0027 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 samples collected on an annual basis (Table 1);
- Update the well sampling frequencies and SOPs listed in Worksheet #17c1 and update the associated sampling location map (Figure 2);
- Add a new well (MW-10-07-180) and update SOPs in Worksheet #17c2, and update the associated sampling location map (Figure 6);
- Add news wells (MW-40A-01-A, MW-40A-02-A, MW-BW-96-A, and MW-BW-97-A), update well sampling frequencies and SOPs in Worksheet #17c3, and update the associated sampling location map (Figure 9);
- Update the well sampling frequencies and SOPs in Worksheet #17c4, and update the associated sampling location map (Figure 11);
- Update the well sampling frequencies and SOPs in Worksheet #17c5, and update the associated sampling location map (Figure 12);
- Reflect recent changes in project personnel;
- Reference Department of Defense (DoD) Quality Systems Manual (QSM) for Environmental Laboratories, Version 5.4; and
- Revise worksheets for consistency with other former Fort Ord QAPPs.

This QAPP is the governing guidance document for groundwater and treatment system sampling associated with Sites 2 and 12 (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 groundwater treatment system (GWTS) and the groundwater monitoring program (GWMP). The QAPP ensures the data generated follow the data quality indicators (DQIs) of precision, accuracy, representativeness, comparability, completeness, and sensitivity (PARCCS parameters), and are of sufficient quality to support project decisions.

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.

2.0 Project Management

2.1 Worksheet #1 & 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 Final Revision 11, 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: Eric Schmidt, Ahtna
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Preparation Date: October 26, 2023

Project Role	Name Organization	Signature	Date
Investigative Organization's Project Manager	Derek Lieberman Ahtna		10/26/2023
Investigative Organization's Project Chemist	Eric Schmidt Ahtna		10/26/2023
Investigative Organization's QC Manager	Bruce Wilcer Ahtna		10/26/2023
Lead Organization's Technical Lead	Erin Corr USACE	CORR.ERIN.NICO LE.1609085602 <small>Digitally signed by CORR.ERIN.NICOLE.1609085602 Date: 2023.11.01 07:06:22 -07'00'</small>	
Lead Organization's Project Chemist	Kyle Bayliff USACE	BAYLIFF.KYLE.WE SLEY.1553766881 <small>Digitally signed by BAYLIFF.KYLE.WESLEY.1553766881 Date: 2023.11.07 10:22:55 -08'00'</small>	

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 Global, LLC

Contract Number: W91238-19-C-0027

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. DoD QSM for Environmental Laboratories, Version 5.4, 2021

Regulatory Program: CERCLA as amended by the Superfund Amendment and Reauthorization Act

Approval Entities: U.S. Environmental Protection Agency (EPA), California Department of Toxic Substance Control (DTSC), and Regional Water Quality Control Board, Central Coast Region (CCRWWQB)

Data Users: U.S. Department of the Army (Army), USACE, EPA (and its consultant TechLaw, Inc.), DTSC, CCRWWQB, 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 CCRWWQB (support agency)

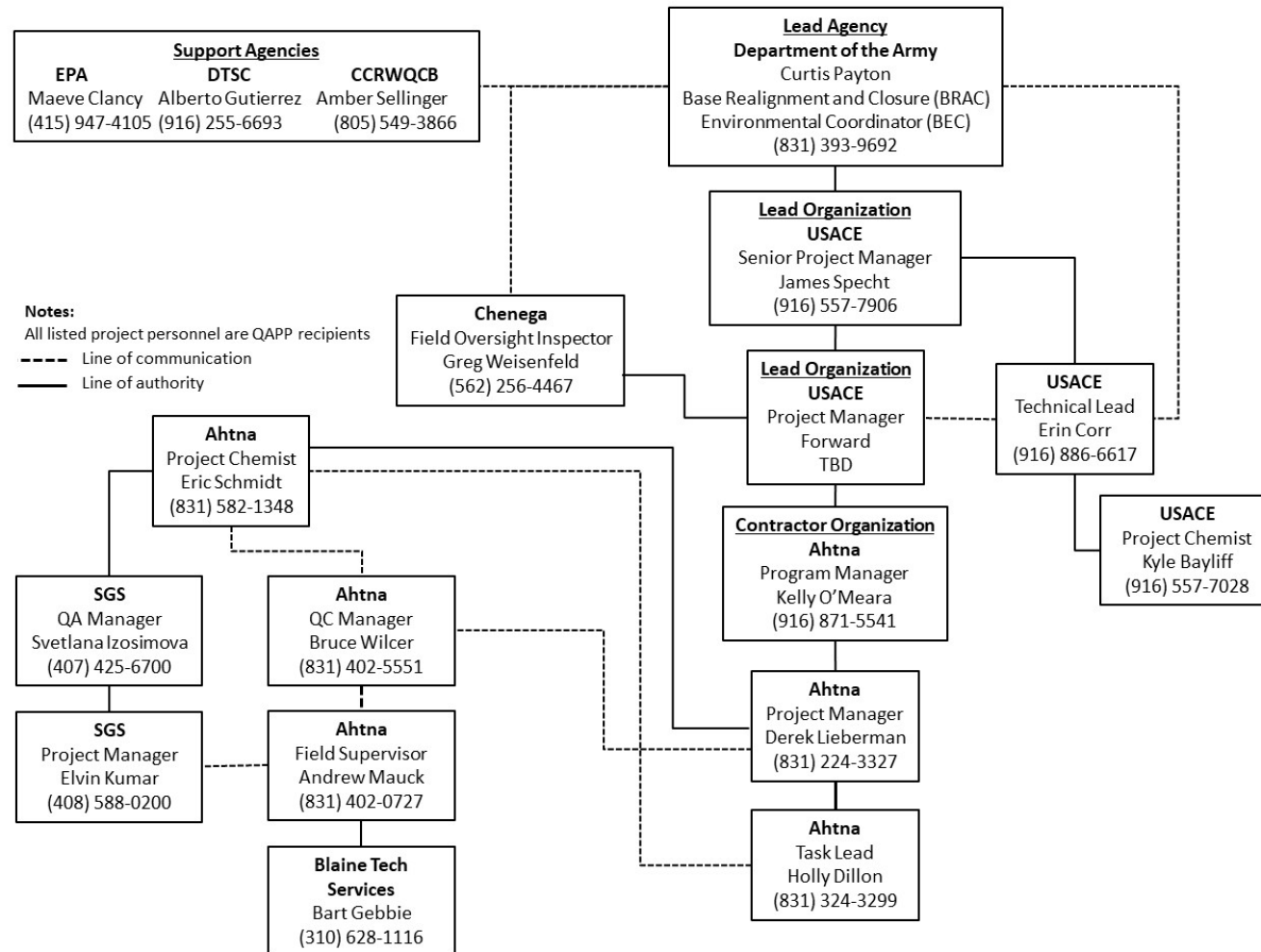
The QAPP is (select one): Generic: _____ Project-Specific: X

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

Title	Approval Date
<i>Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Revision 10</i>	March 2022
<i>Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Revision 9</i>	November 2021
<i>Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Revision 8</i>	February 2021
<i>Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Revision 7</i>	August 2019
<i>Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Revision 6</i>	March 2018
<i>Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Revision 5</i>	June 2017
<i>Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Revision 4</i>	March 2016
<i>Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Revision 3</i>	June 2015
<i>Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Revision 2</i>	February 2014
<i>Quality Assurance Project Plan, Superfund Response Actions, Former Fort Ord, California, Volume I, Groundwater, Appendix A, Final Revision 1</i>	December 21, 2012
<i>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</i>	May 31, 2011
<i>Draft Final, QAPP/CDQMP Groundwater Monitoring Program, Sites 2 and 12, OU2 and OUCTP</i>	January 20, 2010
<i>Final Sampling and Analysis Plan, Operable Unit 2 and Sites 2 and 12 Groundwater Treatment Systems, Former Fort Ord</i>	August 20, 2009









2.2 Worksheet #3 & 5: Project Organization and QAPP Distribution

Reporting relationships between organizations involved in the project, including the lead organization, contractors, and subcontractor organizations are identified below.



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

Organization: Ahtna

Name	Project Title/Role	Education/Experience	Specialized Training/Certifications ¹	Signature ²	Date
Kelly O'Meara	Program Manager	Resume on file	HAZWOPER		
Derek Lieberman	Project Manager	Resume on file	First aid, CPR, MEC, PE, H&S, HAZWOPER, CQM		
Eric Schmidt	Project Chemist	Resume on file	HAZWOPER, CQM		
Holly Dillon	Task Lead	Resume on file	First aid, CPR, MEC, H&S, HAZWOPER, CQM		
Andrew Mauck	Field Supervisor	Resume on file	First aid, CPR, MEC, HAZWOPER, CQM		
Bruce Wilcer	QC Manager	Resume on file	HAZWOPER, CQM		
Teri Farrell-Bage	Database Manager	Resume on file	Not applicable		
Andrew Mauck	GIS Manager	Resume on file	Not applicable		

Notes:

¹ 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

² Signatures indicate personnel have read and agree to implement this QAPP as written.

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

Organization: Blaine Tech Services, Inc.

Name	Project Title/Role	Education/ Experience	Specialized Training/ Certifications ¹	Signature ²	Date
Bart Gebbie	Project Manager/Field Coordinator	Resume on file	HAZWOPER, MEC		11/1/23

Notes:

¹ Specialized Training/Certifications Key:


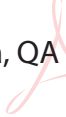
HAZWOPER: 40-hour and current 8-hour annual refresher Hazardous Waste Operations and Emergency Response

MEC: munitions and explosives of concern recognition and safety training

² Signatures indicate personnel have read and agree to implement this QAPP as written.

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

Organization: SGS North America, Inc. (SGS)

Name	Project Title/Role, Location	Education/Experience	Specialized Training/Certifications	Signature ¹	Date
Elvin Kumar	Project Manager, Florida	Resume on file	Not applicable		11/2/23
Svetlana Izosimova	QA Officer, Florida	Resume on file	Not applicable	Svetlana Izosimova, QA Officer  <small>Digitally signed by Svetlana Izosimova QA Officer DN: cn=Svetlana Izosimova, QA Officer, o=SGS North America, Inc., ou=SGS - Orlando, email=svetlana.izosimova@sgs.com, c=US Date: 2023.11.02 10:33:09 -04'00'</small>	

Notes:

¹Signatures indicate personnel have read and agree to implement this QAPP as written.

2.4 Worksheet #6: Communication Pathways

Communication Driver	Organization	Name and Position	Contact Information	Procedure (timing, pathways, documentation, etc.)
Regulatory agency interface	Army	Curtis Payton, BEC	(831) 393-9692 r.c.payton.civ@army.mil	Materials and information regarding the project will be forwarded by email to the regulatory agencies through the Army BEC for review at scheduled Base Realignment and Closure (BRAC) Cleanup Team meetings.
Army BRAC Office interface	USACE	Erin Corr, Technical Lead	(916) 886-6617 Erin.N.Corr@usace.army.mil	Materials and information regarding the project will be forwarded by email to the Army BRAC Office through USACE Technical Lead for review at scheduled Army Internal Progress Meetings.
Lead Organization Project Manager interface	Ahtna	Derek Lieberman, Project Manager	(831) 224-3327 dlieberman@ahtna.net	Materials and information regarding the project will be forwarded by email to USACE by the Ahtna Project Manager for review at weekly status meetings.
Field progress reports	Ahtna	Andrew Mauck, Field Supervisor	(831) 402-0727 amauck@ahtna.net	Ahtna Field Supervisor will report fieldwork progress by email to Ahtna Project Manager daily.
Stop work due to safety issues	Ahtna	Holly Dillon, Site Safety and Health Officer	(831) 324-3299 hdillon@ahtna.net	All onsite Personnel have authority and responsibility to stop work on the site if an imminent hazard is observed. The Site Safety and Health Officer will be consulted by phone immediately for further recommendations.

Communication Driver	Organization	Name and Position	Contact Information	Procedure (timing, pathways, documentation, etc.)
QAPP changes prior to fieldwork	Ahtna	Derek Lieberman, Project Manager	(831) 224-3327 dlieberman@ahtna.net	Significant changes to the QAPP must approved by the Ahtna Project Manager, USACE Technical Lead, and USACE Project Chemist, and submitted to the regulatory agencies for review and comment via email (where the subject of the email is "QAPP Change") prior to implementation.
QAPP changes during project execution	Ahtna	Derek Lieberman, Project Manager	(831) 224-3327 dlieberman@ahtna.net	Field changes to the QAPP must be approved by the Ahtna Project Manager, USACE Technical Lead, and USACE Project Chemist by phone or email (where the subject of the email is "Field Change Request") prior to implementation.
Field corrective actions ¹	Ahtna	Andrew Mauck, Field Supervisor	(831) 402-0727 amauck@ahtna.net	Ahtna Field Supervisor will determine the need for corrective action and will report field issues to Ahtna Project Manager daily. Ahtna Project Manager will notify the Ahtna QC Manager of issues within one business day and will respond to the request for corrective action within 24 hours.
Sample receipt variances	SGS	Izosimova, Svetlana, QA Officer	(407) 425 6700 Svetlana.Izosimova@sgs.com	Discrepancies or non-compliance are documented immediately on the Sample Receipt Confirmation Form, which is automatically emailed to the SGS Project Manager, who will immediately contact the Ahtna Project Chemist for resolution.
Laboratory QC variances	Ahtna	Eric Schmidt, Project Chemist	(831) 582-1348 eschmidt@ahtna.net	Ahtna Project Chemist will report laboratory QC issues to USACE Technical Lead and USACE Project Manager by email within two business days of the occurrence.

Communication Driver	Organization	Name and Position	Contact Information	Procedure (timing, pathways, documentation, etc.)
Analytical corrective actions ¹	Ahtna	Eric Schmidt, Project Chemist	(831) 582-1348 eschmidt@ahtna.net	Ahtna Project Chemist will determine the need for corrective action and will report nonconformance and QC issues to the Ahtna Project Manager and USACE Project Chemist by email within two business days of the occurrence.
Data verification issues	Ahtna	Eric Schmidt, Project Chemist	(831) 582-1348 eschmidt@ahtna.net	Ahtna Project Chemist will report incomplete records issues to USACE Technical Lead and USACE Project Manager by email within five business days of completing data verification (Worksheet #35).
Data validation issues	Ahtna	Eric Schmidt, Project Chemist	(831) 582-1348 eschmidt@ahtna.net	Ahtna Project Chemist will report non-compliance with procedures to USACE Technical Lead and USACE Project Manager by email within five business days of receiving data validation reports.
Data usability issues	Ahtna	Eric Schmidt, Project Chemist	(831) 582-1348 eschmidt@ahtna.net	Ahtna Project Chemist will report data quality issues that could impact data usability to USACE Technical Lead/USACE Project Chemist within five business days of completing the usability assessment (Worksheet #37).
Data review corrective actions	Ahtna	Eric Schmidt, Project Chemist	(831) 582-1348 eschmidt@ahtna.net	Ahtna Project Chemist will determine the need for corrective action and will provide recommendations to the Ahtna Project Manager and USACE Technical Lead by email within five business days of completing the data review.
Release of analytical data	Ahtna	Eric Schmidt, Project Chemist	(831) 582-1348 eschmidt@ahtna.net	Analytical data will not be released until review or validation is completed, as appropriate. The Ahtna Project Chemist will approve the release of data to the Ahtna Project Manager.

Communication Driver	Organization	Name and Position	Contact Information	Procedure (timing, pathways, documentation, etc.)
Data import and export	Ahtna	Teri Farrell-Bage, Database Manager	(925) 915-6255 tbage@ahtna.net	The Ahtna Database Manager coordinates with the Ahtna Field Supervisor and SGS Project Manager to obtain data for electronic upload/manual entry into the data management system, QC review of the entered data, and preparation of the required tables and plots of the data. Coordinates with the Ahtna Project Chemist for QC purposes and forwards deliverables to the Project Manager.

Notes:

¹In the event significant corrective action is required for field or laboratory activities, information concerning the corrective action will be provided to the regulatory agencies by the Army within 30 days of the event or the next scheduled meeting of the BRAC Cleanup Team, whichever is sooner.

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: December 1, 2022 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) 287-5258	dlieberman@ahтна.net
Eric Schmidt	Project Chemist	Ahtna	(831) 287-5254	eschmidt@ahтна.net
Holly Dillon	Task Lead	Ahtna	(831) 287-5240	hdillon@ahтна.net

Planning Session Summary:

Reviewed contract to determine QAPP requirements and reviewed QAPP Revision 9 for potential updates needed.

Action Items:

Based on this review, Ahtna will:

- Initiate QAPP Revision 11 update.
- After review of the previous four quarters of data (Fourth Quarter 2021 through Third Quarter 2022) 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.
- Review changes to QAPP proposed by SGS.
- Replace Dana Gentry with James Specht
- Replace William Collins with Curtis Payton
- Replace Bridget Floyd with Erin Corr
- Replace Cindy Chain-Britton with Alberto Gutierrez
- Replace Chuck Holman with Kelly O'Meara
- Add new monitoring wells that were installed in 2022 (MW-10-07-180, MW-40A-01-A, MW-40A-02-A, MW-BW-96-A, and MW-BW-97-A)

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 covers 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 beachfront 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),² 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 BRAC Act.³ 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

Sites 2/12

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.

OU2

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).

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.

² 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.

³ 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.

3.1.3 Known Contaminants

Known contaminants, or COCs, were identified during Remedial Investigations (RI) 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, 2022a).

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, 2022b).

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
- Volatilization: loss of chemical vapor to the atmosphere

VOCs naturally undergo biochemical 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). Additionally, degradation of compounds is dependent on the biochemical pathway available.

Groundwater contamination at OU2 affected the A-Aquifer and the Upper 180-Foot Aquifer (Army, 1994). In the vicinity of OU2, the tops of these aquifers typically are first encountered at depths of about 60 feet below ground surface (bgs) and 150 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.

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

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. The plume migrated through the vadose zone beneath the vicinity of this facility and into the 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 through the FO-SVA 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).⁴ Chloroform is a biodegradation product of CT and its 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, 2022c).

3.1.5 Potential Receptors and Exposure Pathways

Groundwater at Sites 2/12, OU2, and OUCTP is not currently used for domestic household purposes by residents within the Fort Ord area. 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, and Monterey County restricts installation of new supply wells in this zone. 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. Volumes III and IV of the Basewide Remedial Investigation/Feasibility Study (HLA, 1995) provide details on the potential receptors and exposure pathways.

3.1.6 Land Use Considerations

Sites 2/12

The Site 12 area was redeveloped into a commercial retail area identified as The Dunes on Monterey Bay, which included construction of several big-box stores, a movie theater complex, food services, and a large parking area.

The Site 2 area 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

⁴ There have been no detectable concentrations of PCE and TCE breakdown products (i.e., cis-1,2-DCE and vinyl chloride) to indicate biodegradation of PCE and TCE in the source area.

later as a desalination plant (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 land that is undeveloped other than use as a landfill, as well as mixed-use residential, commercial, and undeveloped areas. The Army currently uses Fort Ord Landfills Area E for disposal of contaminated soil from the Site 39 Inland Ranges. The Fort Ord Landfills are the apparent historical source of the OU2 groundwater COC plume, which extends across an area bounded by 3rd Avenue, Abrams Drive, Bunker Hill Drive, and Inter-Garrison Road.

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. The groundwater COC 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 older Pleistocene-age 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 (Figure 2). 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 due predominantly to agricultural pumping. 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 Upper 180-Foot Aquifer
- OU2 A-Aquifer and Upper 180-Foot Aquifer
- OUCTP A-Aquifer
- OUCTP Upper 180-Foot Aquifer
- OUCTP Lower 180-Foot Aquifer

During cleanup, a site can be divided into a number of distinct areas depending on the complexity of the problems associated with the site. These areas, or OUs, may address geographic areas of a site, specific site problems, or areas where a specific action is required. For Sites 2/12 and OU2, the same remedy is applied to all affected aquifers; however, for OUCTP, each affected aquifer has a distinct remedy.

3.2.1 Step 1: State the Problem

Concentrations of VOCs (primarily PCE, TCE, CT, and related breakdown products) 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).

Sites 2/12

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, 2019). 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, 2022a).

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.

OU2

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 5 and 6 show the OU2 monitoring and extraction well locations by sampling schedule, Figure 7 shows the OU2 GWTS configuration with current extraction well status, and Figure 8 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. 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.

OUCTP A-Aquifer

Improper disposal of CT (used as a cleaning solvent for activities conducted in this area) led 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 was completed in 2012 at Deployment Areas 1 and 2. Post-treatment and long-term groundwater monitoring have been conducted since 2012 (AES, 2014). Figure 9 shows the OUCTP A-Aquifer monitoring well locations by sampling schedule.

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 9) and construction of EISB Deployment Area 3 was recommended, as shown in Figure 10. 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* (AES, 2014).

The effectiveness of EISB treatment is determined through periodic monitoring and reporting of groundwater quality parameters in specific wells (Worksheet #17c3) and VOC concentrations (Worksheet #15a) to the CCRWQCB, DTSC, EPA, and USACE. Groundwater quality parameters include dissolved oxygen (DO) and oxidation-reduction potential (ORP).

OUCTP Upper 180-Foot Aquifer

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 11 shows the OUCTP Upper 180-Foot Aquifer monitoring well locations by sampling schedule. Figure 7 shows the location of the OUCTP Upper 180-Foot Aquifer extraction well, EW-OU2-09-180.

OUCTP Lower 180-Foot Aquifer

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 12 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, 2022c).⁵

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.

Sites 2/12 and OU2 GWTs

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.

Sites 2/12, OU2, 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?

⁵ TCE is not a COC for OUCTP in the Lower 180-Foot Aquifer; however, TCE concentrations are monitored to evaluate potential impacts to downgradient Fort Ord supply wells FO-29, FO-30, and FO-31 (Figure 10C), and the applicability of OU2 and OUCTP decision documents with respect to TCE in the Lower 180-Foot Aquifer will be addressed in the next Five Year Review.

- 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?⁶
- 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

Sites 2/12 and OU2 GWTSs

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.

Sites 2/12, OU2, and OUCTP GWMP

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

⁶ 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).

- 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,⁷ 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 10.8.1 (ESRI, 2020) 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 are 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

⁷ Now the Marina Municipal Airport.

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 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 13 and 14).

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 15, 16, and 17).

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 GWTs and GWMP.

Sites 2/12 and OU2 GWTs

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 chloride⁸ is not met, then a confirmation sample will be collected and analyzed with a 24-hour turnaround time (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-

⁸ 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.

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:

- 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 Revision 4, Former Fort Ord* (OU2 GWTP O&M Manual; Ahtna, 2022d) 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 GWTSs 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 the 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.⁹
- 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.

⁹ 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.

- 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.

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,¹⁰ 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),¹¹ then water quality parameter monitoring may be reduced to an annual frequency at the well.

¹⁰ 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)

¹¹ As presented in the OUCTP RAWP RD Addendum (AES, 2014).

- 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,¹² 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.

Completion of Groundwater Restoration Remedial Actions¹³

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.¹⁴
- 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 statistical analysis was used, then the remediation monitoring phase is complete in the well.

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

¹³ Adapted from EPA, 2014a and EPA, 2014b.

¹⁴ 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).

- If a well has completed the remediation monitoring phase, then the well will enter the attainment monitoring phase.¹⁵
- 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.
 - If all COCs in the well are less than or equal to their respective ACLs for eight consecutive sampling events, and 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 a 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, the 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*,

¹⁵ 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).

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

Sites 2/12 and OU2 GWTSs

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 detection limit [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.

Sites 2/12, OU2, and OUCTP GWMP

VOCs in groundwater at the former Fort Ord range in concentration from ND to 11.2 micrograms per liter ($\mu\text{g/L}$) PCE (at Sites 2/12), 17.8 $\mu\text{g/L}$ TCE (at site OU2), and 5.5 $\mu\text{g/L}$ CT (at OUCTP), the primary COCs at these sites (as measured in the Third Quarter 2022 GWMP event).

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 the 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 Worksheets #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 following sections provide measurement performance criteria for the fixed laboratory methods.

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)

Data Quality Indicator	QC Sample or Measurement Performance Activity	Measurement Performance Criteria	
Precision	Field Duplicates	RPD < 30%	
Precision	Laboratory Duplicate (LCS/LCSD) / Matrix Spike (MS)/Matrix Spike Duplicate (MSD)	RPD < 20%	
Accuracy	Surrogate	1,2-Dichloroethane-d4	81-118%
		Toluene-d8	89-112%
Accuracy	LCS/LCSD and MS/MSD	1,1-DCA	77-125%
		1,1-DCE	71-131%
		1,2-DCA	73-128%
		1,2-DCE (total)	79-121%
		1,2-DCPA	78-122%
		1,3-DCPE (total)	77-123%
		Benzene	79-120%
		CT	72-136%
		Chloroform	79-124%
		cis-1,2-DCE	78-123%
		MC	74-124%
		PCE	74-129%
		TCE	79-123%
		VC	58-137%
Representativeness	Cooler Temperature Blank	> 0°C ≤ 6°C	
	Measure pH of samples after analysis	Samples preserved to pH < 2.0	
Completeness	Data Assessment	≥ 90%	
Comparability	Historical data	Reasonableness	
	LCS/LCSD and MS/MSD	Qualitative measure for field sampling procedures	
Bias/Sensitivity	Method blank, field blank, and trip blank	No analytes detected > ½ LOQ or > ⅓ the amount measured in any	

Data Quality Indicator	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
		sample or $> \frac{1}{10}$ the regulatory limit, whichever is greater. Common contaminants must not be detected $> \text{LOQ}$. ¹
	LCS, ICAL, CCAL	Evidence of shift in instrument response or zero setting
	LOQ studies	Limit of quantitation

Notes:

¹See Worksheet #15 for LOQs and project action limits

<: 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

cis-1,2-DCE: cis-1,2-dichloroethene

CT: carbon tetrachloride

ICAL: initial calibration

LCS: laboratory control samples

LCSD: laboratory control sample duplicate

LOQ: limit of quantitation

MC: methylene chloride

MS: matrix spike

MSD: matrix spike duplicate

PCE: tetrachloroethene

QC: quality control

RPD: relative percent difference

SIM: selected ion monitoring

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)

Data Quality Indicator	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field Duplicate	RPD \leq 30%
	LCS/LCSD and MS/MSD	RPD \leq 20%
Accuracy / Bias	LCS and MS	Antimony 88-113% Copper 86-114% Lead 86-113%
	Method blank and field blank	The absolute values of all analytes must be $< \frac{1}{2}$ LOQ or $< \frac{1}{10}$ the amount measured in any sample or $\frac{1}{10}$ the regulatory limit, whichever is greater.
Representativeness	Measure pH of samples upon receipt	Samples preserved to pH < 2.0
	Cooler temperature blank	$> 0^{\circ}\text{C} \leq 6^{\circ}\text{C}$
Comparability	Historical data	Reasonableness
	LCS/LCSD and MS/MSD	Qualitative measure for field sampling procedures
Completeness	Number of samples collected out of total samples planned	$\geq 95\%$ field completeness
	Evaluation of number of unqualified results out of the total results reported ¹⁶	$\geq 90\%$ analytical completeness
Sensitivity	LCS, ICAL, CCAL	Evidence of shift in instrument response or zero setting
	LOQ studies	Limit of quantitation

Notes:

\leq : less than or equal to

\geq : greater than or equal to

$^{\circ}\text{C}$: degrees Celsius

CCAL: continuing calibration

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

¹⁶ Results qualified as estimated due to detected quantities between the LOQ and LOD will not be counted in the analytical completeness quantity assessment.

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)

Data Quality Indicator	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision	Field Duplicate	RPD \leq 30%
	Laboratory duplicates and MS/MSD (chloride only)	\leq 15%
Accuracy / Bias	LCS and MS (chloride only)	90-110%
	Method blank and field blank	No analytes detected $> \frac{1}{2}$ LOQ or $> \frac{1}{10}$ the amount measured in any sample or $> \frac{1}{10}$ the regulatory limit, whichever is greater. Common contaminants must not be detected $>$ LOQ.
Representativeness	Cooler Temperature Blank	$> 0^{\circ}\text{C} \leq 6^{\circ}\text{C}$
Comparability	Historical data	Reasonableness
	LCS/LCSD and MS/MSD	Qualitative measure for field sampling procedures
Completeness	Number of samples collected out of total samples planned	\geq 95% field completeness
	Evaluation of number of unqualified results out of the total results reported ¹⁷	\geq 90% analytical completeness
Sensitivity	LCS, ICAL, CCAL	Evidence of shift in instrument response or zero setting
	LOQ studies	Limit of quantitation

Notes:

\leq : less than or equal to

\geq : greater than or equal to

$^{\circ}\text{C}$: degrees Celsius

CCAL: continuing calibration

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

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

3.4 Worksheet #13: Secondary Data Uses and Limitations

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 used as appropriate.

Data Type	Data Source (originating organization, report title and date)	Data Uses Relative to Current Project	Factors Affecting the Reliability of Data and Limitations on Data Use
Groundwater Monitoring Reports, Figures, Analytical Data	<i>Final Sites 2 and 12 Fourth Quarter 2020 through Third Quarter 2021 Groundwater and Soil Gas Monitoring and Treatment System Report, Former Fort Ord, California (Ahtna, 2022e)</i>	Historical data used to evaluate GWTS performance over time	None
Groundwater Monitoring Reports, Figures, Analytical Data	<i>Final Operable Unit 2 Remedy Monitoring and Operations and Maintenance Fourth Quarter 2020 through Third Quarter 2021, Former Fort Ord, California (Ahtna, 2022f)</i>	Historical data used to evaluate GWTS performance over time	None
Groundwater Monitoring Reports, Figures, Analytical Data	<i>Final Operable Unit Carbon Tetrachloride Plume Fourth Quarter 2020 through Third Quarter 2021 Groundwater Monitoring Report, Former Fort Ord, California (Ahtna, 2022c)</i>	Historical data used to evaluate concentration trends	None

3.5 Worksheet #14 & 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 Sites 2/12 or OU2 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

Field SOPs will be implemented and field QC samples will be collected at the frequency indicated in Worksheet #20. Samples will be analyzed by the laboratory in accordance with this QAPP, DoD QSM, and the stated method. 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:

Task Manager. 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 Project Chemist/Task Manager at the beginning of the data evaluation task. 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 Task Manager 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 database (EQuIS™) to store and analyze project data submissions. EQuIS™ is a front-end user interface for data management using a back-end SQL Server™ database. Servers that house the database are stored and managed by Earthsoft, Inc. Secure database access is performed through EQuIS™ or SQL Server Management Studio software. Data validation is performed by Laboratory Data Consultants, Inc. and validation information is ultimately stored in the EQuIS™ database.

Access and privileges are provided to database support staff on an as-needed basis by the Ahtna Data Manager. This protects the database from unauthorized access and any data modification. Privileges may range from read-only to loading, modifying, or querying the database.

Backups of the primary database are performed by Earthsoft, Inc. to ensure no data loss.

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 (as required).

3.5.10 Geographic Information System Description

A project geodatabase will be set up prior to sampling by the Task Manager and GIS Manager. 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 Data Management Documentation

Documentation of data management activities is critical because it demonstrates that data is being managed in a consistent and organized fashion. EQuIS™ software developed by Earthsoft, Inc. is an industry standard for the management of environmental data. EQuIS software is the user interface that accesses data stored in a SQL Server database. This database is managed and housed by Earthsoft. All SQL Server updates, database backups, and customer support are provided to Ahtna by Earthsoft. Earthsoft also has an extensive community group and documentation regarding their application.

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 Worksheet #31, 32, & 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 Laboratory Data Consultants, Inc. 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 through #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 OU2 GWTP field office. Field forms are shown in Attachment B.

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 60 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)								Achievable Laboratory Limits ² (µg/L)		
		Sites 2/12		OU2		OUCTP				DL	LOD	LOQ
						A-Aquifer	Upper 180-Foot Aquifer		Lower 180-Foot Aquifer			
							ACL	DCL	ACL			
1,1-Dichloroethane	75-34-3	-	-	5	5 ⁴	-	-	-	-	0.10	0.25	0.50
1,1-Dichloroethene	75-35-4	6	6	-	-	6	-	-	-	0.10	0.25	0.50
1,2-Dichloroethane	107-06-2	0.5	0.5	0.5	0.5	-	-	-	0.5	0.10	0.25	0.50
1,2-Dichloroethene (total) ⁵	540-59-0	-	-	-	-	6	-	-	-	0.10	0.25	0.50
1,2-Dichloropropane	78-87-5	-	-	1	0.5	-	-	-	-	0.10	0.25	0.50
1,3-Dichloropropene (total) ⁵	542-75-6	0.5	0.5	-	-	-	-	-	-	0.10	0.25	0.50
Benzene	71-43-2	-	-	1	0.5	-	-	-	-	0.10	0.25	0.50
Carbon Tetrachloride	56-23-5	-	-	0.5	0.5	0.5	0.5	0.5	0.5	0.10	0.25	0.50
Chloroform	67-66-3	2	2	2	2 ⁴	2	-	-	-	0.10	0.25	0.50
cis-1,2-Dichloroethene	156-59-2	6	6	6	6 ⁴	-	-	-	-	0.10	0.25	0.50
Methylene chloride	75-09-2	-	-	5	0.5	5	-	-	-	0.50	0.50	2.0
Tetrachloroethene	127-18-4	5	5	3	0.5	5	-	-	-	0.10	0.25	0.50
Trichloroethene	79-01-6	5	5	5	0.5	5	-	-	5	0.10	0.25	0.50
Vinyl Chloride	75-01-4	0.1	0.1	0.1	0.1	0.1	-	-	-	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

OU: Operable Unit

OUCTP: Operable Unit Carbon Tetrachloride Plume

-: not applicable

¹ACLs and DCLs are site-specific and identified in the relevant decision documents (Army, 1994; Army, 1995, Army, 1997; Army, 2008; and Army, 2016) except for trichloroethene at OUCTP in the Lower 180-Foot Aquifer, which is the MCL for drinking water.

²Achievable 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").

³Discharge limit for the applicable groundwater treatment system using groundwater extraction and treatment with GAC. For Sites 2/12 GWTS, discharge to areas overlying the contaminated groundwater plume need only meet ACLs (HLA, 1999).

⁴Discharge limit revised to ACL for this COC to optimize GAC usage (HLA, 1999).

⁵Total 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	Achievable Laboratory Limits ² (mg/L)		
			DL	LOD	LOQ
Chloride	16887-00-6	250	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

¹Project Action Limits are National Secondary MCLs for Drinking Water Quality.

²Achievable 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	Achievable Laboratory Limits ² (µg/L)		
			DL	LOD	LOQ
Antimony	7440-36-0	6.0	1.0	5.0	6.0
Copper	7440-50-8	1,000	1.0	2.0	25
Lead	7439-92-1	15	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

¹Project 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.

²Achievable 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-12-07-180M ³				
EW-12-08-180U ³				

Notes:

COC: chemical of concern

EFF: effluent

EW: extraction well

GAC: granular activated carbon

INF: influent

INJ: injection

TS: treatment system sampling port

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 #10.

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 #10).

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									
Sample Point	Weeks after GAC change-out ⁴								
	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*				
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).	

Sampling Location	Activity	Test Methods	Comments/Rationale ³	SOP Reference
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-OU2-16-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				
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 #10.

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.

<u>New Name</u>	<u>Former Name</u>
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 (Ahtna, 2022d) 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.

Sampling Point	Weeks after GAC change-out ⁵										
	0	8	16	24	28	32	36	40	44	48	52
TS-OU2-INF-01		x	x	x	x	x	x	x	x	x	x
TS-OU2-INF-02		xx	xx	xx	xx	xx	x	xx	x	x	xx
Primary Vessel 1 ¹		x	x	x	x	x	x	x	x	x	x
Primary Vessel 2 ¹		x	x	x	x	x	x	x	x	x	x
Secondary Vessel 1 ²		x		x		x			x		x
Secondary Vessel 2 ²		x		x		x			x		x
Polishing Vessel 1 ³		x		x		x			x		x
Polishing Vessel 2 ³		x		x		x			x		x
TS-OU2-INJ-01	x ⁴	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-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 point to be immediately downstream of the second GAC vessel in series.

³ Sample point to be immediately downstream of the third GAC vessel in series.

⁴ Sample collected no less than 2 hours after bringing a newly repacked GAC vessel online.

⁵ If GAC change-out is not indicated by Week 52, further sampling will be performed biweekly or at a frequency determined by the direction of the Project Manager.

4.1.5 Worksheet #17c1: Sites 2/12 GWMP

Well Name	CI	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale ¹
EW-12-03-180M		A	Q	PDB/SOP #2, #5	RI Sites ROD/ESD
EW-12-05-180M	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-02-13-180M	A	Q	Q	HydraSleeve™, PDB/ SOP #2, #3, #5	RI Sites ROD/ESD
MW-12-09R-180		Q	Q	PDB/SOP #2, #5	RI Sites ROD/ESD
MW-12-14-180M		Q	Q	PDB/SOP #2, #5	RI Sites ROD/ESD
MW-12-15-180M		Q	Q	PDB/SOP #2, #5	RI Sites ROD/ESD
MW-12-16-180M		Q	Q	PDB/SOP #2, #5	RI Sites ROD/ESD
MW-12-20-180U		Q	Q	PDB/SOP #2, #5	RI Sites ROD/ESD
MW-12-21-180U		A	Q	PDB/SOP #2, #5	RI Sites ROD/ESD
MW-12-22-180U		A	Q	PDB/SOP #2, #5	RI Sites ROD/ESD
MW-12-24-180U		Q	Q	PDB/SOP #2, #5	RI Sites ROD/ESD
MW-12-28-180U		A	Q	PDB/SOP #2, #5	RI Sites ROD/ESD
MW-12-29-180U		Q	Q	PDB/SOP #2, #5	RI Sites ROD/ESD
MW-12-30-180U		A	Q	PDB/SOP #2, #5	RI Sites ROD/ESD
MW-12-32-180U		A	Q	PDB/SOP #2, #5	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
EW-12-04-180U			Q	SOP #5	Groundwater elevation trend analysis
MW-12-01-180			Q	SOP #5	Groundwater elevation trend analysis
MW-02-05-180			Q	SOP #5	Groundwater elevation trend analysis

Well Name	CI	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale ¹
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-12-05-180			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-12-18-180U			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-12-25-180U			Q	SOP #5	Groundwater elevation trend analysis
MW-12-26-180U			Q	SOP #5	Groundwater elevation trend analysis
MW-12-27-180U			Q	SOP #5	Groundwater elevation trend analysis
MW-12-31-180M			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

RI/FS: Remedial Investigation/Feasibility Study

ROD: Record of Decision

SIM: selected ion monitoring

SOP: standard operating procedure

VOCs: volatile organic compounds

¹The 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, #5	OU2 ESD
EW-OU2-02-180R		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	Sampling Port/SOP #2,5	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		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		Q	Q	Pump Spigot/SOP #5	OU2 GWTP Relocation
EW-OU2-11-AR		Q	Q	Pump Spigot/SOP #5	OU2 GWTP Relocation
EW-OU2-12-180		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-OU2-15-A		Q	Q	PDB/SOP #2, #5	OU2 ESD
EW-OU2-16-A		Q	Q	Pump Spigot/SOP #5	OU2 ROD
EW-OU2-17-A		Q	Q	Pump Spigot/SOP #5	OU2 GWTP Relocation
EW-OU2-18-A		Q	Q	Pump Spigot/SOP #5	OU2 GWTP Relocation
EW-OU2-19-A		Q	Q	Pump Spigot/SOP #5	OU2 GWTP Relocation
EW-OU2-20-A		Q	Q	Pump Spigot/SOP #5	OU2 GWTP Relocation
MW-BW-13-A		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-BW-14-180		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-BW-71-A		Q	Q	PDB/SOP #2, #5	OU2 ROD

Well Name	Cu, Pb, Sb (6010D)	VOCs (8260- SIM)	Water Levels	Sampling Methods/SOP	Rationale ¹
MW-BW-50-A		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-OU2-01-A	A	Q	Q	HydraSleeve™, PDB/ SOP #2, #3, #5	OU2 ROD
MW-OU2-02-A	A	Q	Q	HydraSleeve™, PDB/ SOP #2, #3, #5	OU2 ROD
MW-OU2-04-A		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-OU2-05-AR		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-06-180R2		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-06-AR		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-OU2-07-A		Q	Q	Pump Spigot/SOP #5	OU2 ROD
MW-OU2-08-A		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-OU2-12-A		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-OU2-20-180		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-OU2-23-180		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-24-180		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-25-A		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-OU2-27-A		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-OU2-28-180		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-28-A		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-OU2-39-180		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-40-A		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-OU2-43-180		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-44-A		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-44-180		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-45-A		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-OU2-46-A		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-OU2-46-180		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-47-180		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-50-180		Q	Q	PDB/SOP #2, #5	OU2 ESD

Well Name	Cu, Pb, Sb (6010D)	VOCs (8260- SIM)	Water Levels	Sampling Methods/SOP	Rationale ¹
MW-OU2-51-180		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-53-180		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-56-180		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-61-180		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-62-180		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-63-180		A	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-73-A	A	Q	Q	HydraSleeve™, PDB/ SOP #2, #3, #5	OU2 ROD
MW-OU2-74-A	A	Q	Q	HydraSleeve™, PDB/ SOP #2, #3, #5	OU2 ROD
MW-OU2-75-A		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-OU2-76-A		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-OU2-79-A		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-80-A		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-OU2-81-A		Q	Q	PDB/SOP #2, #5	OU2 ROD
MW-OU2-81-180		Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-83-A		Q	Q	PDB/SOP #2, #5	Well Install Completion Report (AEI, 2019)
MW-OU2-84-180		Q	Q	PDB/SOP #2, #5	OU2 ESD
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
MW-10-07-180			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-02-180			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

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-OU2-21-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-OU2-34-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-OU2-77-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	PDB: passive diffusion bag	SIM: selected ion monitoring
Cu: copper	Q: sampled on a quarterly basis	SOP: standard operating procedures
ESD: Explanation of Significant Differences	ROD: Record of Decision	VOCs: volatile organic compounds
Pb: lead	Sb: antimony	

¹The 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.

4.1.7 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, #5	OUCTP ROD
EISB-EW-09		Q	Q	PDB/SOP #2, #5	OUCTP ROD
EISB-EW-12	Q		Q	PTM/SOP #5, #6, #7	OUCTP ROD
EISB-EW-15	Q		Q	PTM/SOP #5, #6, #7	OUCTP ROD
EW-BW-109-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
EW-BW-124-A	Q	Q	Q	PTM/SOP #5, #6, #7; PDB/SOP #2	OUCTP ROD
EW-BW-129-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
EW-BW-135-A	Q	Q	Q	PTM/SOP #5, #6, #7; PDB/SOP #2	OUCTP ROD
EW-BW-140-A		A	Q	PDB/SOP #2, #5	OUCTP ROD
EW-BW-144-A	Q	A	Q	PTM/SOP #5, #6, #7	OUCTP ROD
EW-BW-149-A	Q	A	Q	PTM/SOP #5, #6, #7; PDB/SOP #2	OUCTP ROD
EW-BW-155-A	Q	Q	Q	PTM/SOP #5, #6, #7; PDB/SOP #2	OUCTP ROD
EW-BW-159-A	Q		Q	PTM/SOP #5, #6, #7	OUCTP ROD
EW-BW-160-A	Q	Q	Q	PTM/SOP #5, #6, #7; PDB/SOP #2	OUCTP ROD
EW-BW-161-A	Q		Q	PTM SOP #5, #6, #7	OUCTP ROD
EW-BW-164-A	Q		Q	PTM SOP #5, #6, #7	OUCTP ROD
EW-BW-165-A		A	Q	PDB/SOP #2, #5	OUCTP ROD
EW-BW-166-A	Q		Q	PTM SOP #5, #6, #7	OUCTP ROD
EW-BW-169-A		A	Q	PDB/SOP #2, #5	OUCTP ROD
MW-40-01-A		A	Q	PDB/SOP #2, #5	OUCTP ROD
MW-B-12-A		A	Q	PDB/SOP #2, #5	OUCTP ROD
MW-B-14-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-15-A		A	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-17-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-26-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-27-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-28-A		A	Q	PDB/SOP #2, #5	OUCTP ROD

Well Name	DO ORP	VOCs (8260- SIM)	Water Levels	Sampling Methods/SOP	Rationale ¹
MW-BW-30-A		A	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-31-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-32-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-35-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-36-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-44-A		A	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-48-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-49-A		A	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-56-A		A	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-58-A		A	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-65-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-66-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-74-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-75-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-77-A		A	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-78-A		A	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-79-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-80-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-81-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-82-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-83-A		A	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-85-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-87-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-88-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-89-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-90-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-91-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-92-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD

Well Name	DO ORP	VOCs (8260- SIM)	Water Levels	Sampling Methods/SOP	Rationale ¹
MW-BW-93-A		Q	Q	PDB/SOP #2, #5	Well Install Completion Report (AEI, 2019)
MW-BW-94-AR		Q	Q	PDB/SOP #2, #5	Well Install Completion Report (AEI, 2019)
MW-BW-95-A		Q	Q	PDB/SOP #2, #5	Well Install Completion Report (AEI, 2019)
MW-BW-96-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-97-A		Q	Q	PDB/SOP #2, #5	OUCTP ROD
The Following Wells Are Measured for Groundwater Elevation Data Only:					
EISB-EW-02			Q	SOP #5	Groundwater elevation trend analysis
EISB-MW-01			Q	SOP #5	Groundwater elevation trend analysis
EW-BW-119-A			Q	SOP #5	Groundwater elevation trend analysis
EW-BW-132-A			Q	SOP #5	Groundwater elevation trend analysis
EW-BW-150-A			Q	SOP #5	Groundwater elevation trend analysis
EW-BW-167-A			Q	SOP #5	Groundwater elevation trend analysis
EW-BW-168-A			Q	SOP #5	Groundwater elevation trend analysis
MP-BW-46-080			Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-46-095			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-40A-01-A			Q	SOP #5	Groundwater elevation trend analysis
MW-40A-02-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-16-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-18-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-24-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-25-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-34-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-38-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-39-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-41-A			Q	SOP #5	Groundwater elevation trend analysis
MW-BW-42-A			Q	SOP #5	Groundwater elevation trend analysis

Well Name	DO ORP	VOCs (8260- SIM)	Water Levels	Sampling Methods/SOP	Rationale ¹
MW-BW-43-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-48-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-60-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-86-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-33-272	Q	Q	Westbay Port /SOP #1	OUCTP ROD
MP-BW-46-170	Q	Q	Westbay Port/SOP #1	OUCTP ROD
MW-BW-21-180	Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-43-180	Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-52-180	Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-BW-57-180	A	Q	PDB/SOP #2, #5	Well Install Completion Report (AEI, 2019)
MW-BW-58-180	A	Q	PDB/SOP #2, #5	Well Install Completion Report (AEI, 2019)
MW-OU2-30-180	A	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-64-180	Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-OU2-67-180	Q	Q	PDB/SOP #2, #5	OUCTP ROD
MW-OU2-70-180	A	Q	PDB/SOP #2, #5	OUCTP ROD
The Following Wells Are Measured for Groundwater Elevation Data Only:				
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-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-41-231		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-42-215		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MW-B-05-180		Q	SOP #5	Groundwater elevation trend analysis
MW-BW-26-180		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

Well Name	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale ¹
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

¹The 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
EW-OU2-07-180	Q	Q	PDB/SOP #2, #5	OUCTP ROD
FO-29 ²	Q		Sampling Port/SOP #4	OUCTP ROD
FO-30 ²	Q		Sampling Port/SOP #4	OUCTP ROD
FO-31 ²	Q		Sampling Port/SOP #4	OUCTP ROD
MP-BW-41-318	A	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, #5	OUCTP ROD
MW-BW-59-180	Q	Q	PDB/SOP #2, #5	Well Install Completion Report (AEI, 2019)
MW-OU2-66-180	Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-69-180	Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-72-180	Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-78-180	Q	Q	PDB/SOP #2, #5	OU2 ESD
MW-OU2-82-180	Q	Q	PDB/SOP #2, #5	OU2 ESD
The Following Wells Are Measured for Groundwater Elevation Data Only:				
Airfield		Q	PDB/SOP #2	Groundwater elevation trend analysis
MP-BW-30-397		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-31-407		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-32-412		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-33-352		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis

Well Name	VOCs (8260-SIM)	Water Levels	Sampling Methods/SOP	Rationale ¹
MP-BW-34-422		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-35-402		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-37-368		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-38-353		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-39-330		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-40-353		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MP-BW-52-363		Q	Westbay Port /SOP #1	Groundwater elevation trend analysis
MW-OU2-07-400		Q	SOP #7	Groundwater elevation trend analysis
Test 2		Q	SOP #7	Groundwater elevation trend analysis

Notes:

A: sampled on an annual basis

MCWD: Marina Coast Water District collects data

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

¹The 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.

²Well owned by MCWD

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 Worksheet #19 & 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	One 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 250-mL HDPE bottle	Sample temp > 0°C ≤ 6°C	28 days	

Notes:

°C: degrees Celsius

HCl: hydrochloric acid

HDPE: high-density polyethylene

HNO₃: 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)	Two per preparatory batch as feasible or a minimum of 10% of project samples	1 set per cooler /day	1 per sampling day	1 per sampling event (Westbay sampling only ¹)	One per preparatory batch of 20 samples
	Metals (6010D)	Two per preparatory batch as feasible or a minimum of 10% of project samples	N/A	N/A	N/A	One per preparatory batch of 20 samples
	Cl (9056A)	Two per preparatory batch as feasible or a minimum of 10% of project samples	N/A	N/A	N/A	One per preparatory batch of 20 samples

Notes:

Cl: chloride

MS/MSD: matrix spike/matrix spike duplicate

N/A: not applicable

VOCs: volatile organic compounds

¹Sampling 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, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? Y/N	Comments
SOP #1	Westbay MOSDAX Sampler Probe – Model 2531 Operations Manual	Schlumberger	Westbay Multi-port Wells	N	
SOP #2	PDB Sampling Protocol	U.S. Geological Survey (USGS)	PDBs	Y	Project-specific procedures are appended to USGS User's Guide
SOP #3	HydraSleeve Field Manual	GeoInsight	HydraSleeve	N	
SOP #4	Supply and Irrigation Well Sampling Protocol	Ahtna	Sampling Ports	Y	GWMP project-specific procedures
SOP #5	OU2 and Sites 2/12 GWTs and OUCTP EISB Extraction Well Sample Handling and Custody Requirements	Ahtna	Sampling Ports	Y	GWTS project-specific procedures
SOP #6	Low Flow Groundwater Quality Parameter Collection	Ahtna	Horiba Multi-Meter and Low Flow Pump	Y	OUCTP GWMP project-specific procedures
SOP #7	Downhole Meter Groundwater Quality Parameter Collection	Ahtna	YSI Sonde Downhole Meter	Y	OUCTP GWMP project-specific procedures
SOP #8	Horiba U-50 series instruction manual	Horiba	Horiba Multi-Meter	N	
SOP #9	Trimble Catalyst DA2	Trimble	GPS	N	
FSOP-001	Fieldwork Documentation	Ahtna	NA	N	
FSOP-002	Sample Management	Ahtna	NA	N	

SOP Reference Number	Title, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? Y/N	Comments
FSOP-802	Investigation Derived Waste Management	Ahtna	None	N	

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
Trimble Catalyst DA2	Depending upon desired accuracy (sub centimeter, 20 cm, etc).	NA; unless there are unexpected readings	Proper links to applications on handheld devices	Before use for any physical damage	Before/After use	Effective link to iPhone/iPad via Bluetooth, effective satellites link	Send to factory for repair	Field Supervisor	SOP #9
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
Horiba U-50 Series multi-meter	Simultaneous Auto Calibration of DO, pH, conductivity, and turbidity with standard pH 4 solution	Maintain in proper working order, store in a secure location, decon after each use	Check battery prior to use	Inspect tape for damage prior to use	Quarterly prior to use	pH: 4.0 Conductivity: 4.49 DO: 8.92 mg/L Turbidity: 0 NTU	Send into factory for repair	Field Supervisor	SOP #8

Field Equipment	Calibration Activity	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
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 to 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 = $0^{\circ}\text{C} \pm 1^{\circ}\text{C}$	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 the 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 of certifications, including the specifically referenced methods, are included in Attachment E.

Data will be evaluated based on the guidance provided in the DoD QSM Version 5.4 (DoD, 2021a), the published methods, and the laboratory QA Manual.

SOP Reference Number	Title	Organization	Revision Date	Equipment Type	Modified for Project Work? Y/N
SGS SOP# MS010.10	Analysis of Volatile Organics by GC/MS Select Ion Monitoring (SIM) (VOCs by 8260 SIM)	SGS	March, 2022	Analytical Instruments	N
SGS SOP# MET108.06	Metals by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP) (Metals by 6010D)	SGS	April 5, 2022	Analytical Instruments	N
SGS SOP# GN237-03	Determination of Inorganic Anions by Ion Chromatography (Chloride by 9056A)	SGS	April, 2023	Analytical Instruments	N
SGS SOP# SAM101.22	Sample Receipt and Storage	SGS	July, 2023	None	N
SGS SOP# SAM108.11	Sample and Laboratory Waste Disposal	SGS	Aug 24, 2020	None	N

6.2 Worksheet #24: Analytical Instrument Calibration

Instrument/ Analysis	Calibration Requirements	Frequency of Calibration	Acceptance Criteria	Corrective Action	Responsible Person	SOP References
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 samples.	GC/MS Analyst	SGS SOP# MS010.9
	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 $\leq 15\%$ Option 2: linear least squares regression $r^2 \geq 0.99$ Option 3: non-linear regression – 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	SGS SOP# MS010.9
	Second Source – ICV Standard	Once after each ICAL	Analytes within $\pm 20\%$ 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	SGS SOP# MS010.9

Instrument/ Analysis	Calibration Requirements	Frequency of Calibration	Acceptance Criteria	Corrective Action	Responsible Person	SOP References
GC/MS – VOCs by EPA Method 8260-SIM (continued)	Instrument blanks and method blanks	After initial calibration and daily, prior to sample analysis (instrument blank) and with each batch of samples (method blank)	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	Re-analyze blank Clean system Re-analyze affected samples	GC/MS Analyst	SGS SOP# MS010.9
	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	SGS SOP# MS010.9
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	SGS SOP# MET108.06
	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	SGS SOP# MET108.06

Instrument/ Analysis	Calibration Requirements	Frequency of Calibration	Acceptance Criteria	Corrective Action	Responsible Person	SOP References
ICP Metals by EPA Method 6010D (continued)	CCV	After analysis of every 10 samples and at the end of the analytical sequence	Within $\pm 10\%$ 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	SGS SOP# MET108.06
	Low-level calibration check standard (LOQ low point standard from calibration)	Daily, following one point ICAL	Within $\pm 20\%$ of true value	Correct problem, then re- analyze.	ICP Analyst	SGS SOP# MET108.06
	ICS (interference check sample)	After ICAL and prior to sample analysis	ICS-A: Absolute value of concentration for all non- spiked project analytes < $\frac{1}{2}$ 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	SGS SOP# MET108.06
	Calibration blanks	Immediately after the ICV and Immediately after every CCV	The absolute values of all analytes must be < $\frac{1}{2}$ LOQ or < $\frac{1}{10}$ 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	SGS SOP# MET108.06
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	SGS SOP# GN237-01

Instrument/ Analysis	Calibration Requirements	Frequency of Calibration	Acceptance Criteria	Corrective Action	Responsible Person	SOP References
Ion Chromatography – Chloride by EPA Method 9056A (continued)	ICV	After each ICAL and prior to sample analysis	Analytes within $\pm 10\%$ 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	SGS SOP# GN237-01
	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	SGS SOP# GN237-01
	CCV	After ICAL, after every ten samples, and at end of run	Analytes within established retention time windows and within \pm 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	SGS SOP# GN237-01

Notes:

BFB: 4-bromofluorobenzene

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

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

ICS-A: interference check standard A

ICV: initial calibration verification

LOQ: limit of quantitation

RF: response factor

RSD: relative standard deviation

SIM: selected ion monitoring

VOCs: volatile organic compounds

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

Instrument/ Equipment	Maintenance Activity ¹	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP ² Reference
GC/MS VOC	Change Trap	Analyze ICV, CCV, or sensitivity check	Daily	When responses start to drop	ICV, CCV, or sensitivity check passes criteria	Re-bake trap, replace trap, reanalyze ICV, CCV, or sensitivity check, recalibrate	Analyst or Department Manager	SGS SOP# MS010.9
	Backflush Purge and Trap Lines	Analyze ICV, CCV, or sensitivity check	Daily	ICV, CCV, or sensitivity check will not pass, high level sample analyzed	ICV, CCV, or sensitivity check passes criteria, Blank clean	Backflush lines again, replace lines, recalibrate	Analyst or Department Manager	SGS SOP# MS010.9
	Change septa and liner, clean injection port, clip column	Analyze ICV, CCV, or sensitivity check	Daily	After high level sample analyzed	ICV, CCV, or sensitivity check passes criteria	Re-inspect injection port, cut additional column, reanalyze ICV, CCV, or sensitivity check, recalibrate instrument	Analyst or Department Manager	SGS SOP# MS010.9
ICP Metals	Change the pump tubing Clean the filter on the recirculating pump once a month Clean or replace the nebulizer, torch assembly, and injector tube	Analyze ICAL,ICV, CCV	Visual and data related. Check connections, Instrument performance and sensitivity	Maintenance is ongoing and performed as needed	Successful daily instrument calibration per requiremen ts	Replace tubing, inspect injector, reanalyze Maintenance activities are documented in Instrument Maintenance logbooks.	Analyst or Department Manager	SGS SOP# MET108.0 6

Instrument/ Equipment	Maintenance Activity ¹	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP ² Reference
	Change the sample tip Clean the recirculating pump lines and internal sock filter every 3 months Clean the radial view quartz surface weekly							
IC Chloride	Clean the suppressor Change in-line filters Change guard and analytical columns Update Data System	Analyze ICAL,ICV, CCV	Visual and data related. Check connections, Instrument performance and sensitivity	Maintenance is ongoing and performed as needed	Successful daily instrument calibration per requirements	Check connections for leaks, clean and/or replacing tubing, replace columns, monitor and record the pressure Maintenance activities are documented in Instrument Maintenance logbooks.	Analyst or Department Manager	SGS SOP# GN237-01

Notes:

¹When appropriate per method

²Laboratory SOPs are subject to revision and updates during the duration of the project. The laboratory will use the most current revision of the SOP at the time of analysis (Attachment A).

CCV = continuing calibration verification

GC/MS = gas chromatography/mass spectrometry

IC = Ion Chromatograph

ICV = initial calibration verification

SOP = standard operating procedure

VOC = volatile organic compound

6.4 Worksheet #26 & 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 5.4 (DoD, 2021a). Chain of custody procedures will be performed in accordance with Worksheet #29.

Sample organization: Ahtna

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/ Blaine Tech Field Technicians	SOP #5
Chain of custody form completion	Ahtna/ Blaine Tech Field Technicians	SOP #5
Packaging	Ahtna/ Blaine Tech Field Technicians	SOP #5
Shipping coordination	Ahtna/ Blaine Tech Field Technicians	SOP #5
Sample receipt, inspection, & log-in	SGS Sample Management Supervisor	SOP #SAM101.21
Sample custody and storage	SGS Sample Management Supervisor	SOP #SAM101.21
Sample disposal	SGS Sample Management Supervisor	SOP #SAM108.11

Notes:

N/A: not applicable

O&M: operations 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 > ⅓ ₁₀ the amount measured in any sample or ⅓ ₁₀ the regulatory limit, whichever is greater. Common contaminants must not be detected > LOQ.	DoD QSM 5.4 App B Table B-4	Re-analyze method blank. If it fails, clean the 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.	<table><thead><tr><th>Analyte</th><th>Recovery</th><th>RPD</th></tr></thead><tbody><tr><td>1,1-DCA</td><td>77-125%</td><td>≤ 20%</td></tr><tr><td>1,1-DCE</td><td>71-131%</td><td>≤ 20%</td></tr><tr><td>1,2-DCA</td><td>73-128%</td><td>≤ 20%</td></tr><tr><td>1,2-DCE (total)</td><td>79-121%</td><td>≤ 20%</td></tr><tr><td>1,2-DCPA</td><td>78-122%</td><td>≤ 20%</td></tr><tr><td>1,3-DCPE (total)</td><td>77-123%</td><td>≤ 20%</td></tr><tr><td>Benzene</td><td>79-120%</td><td>≤ 20%</td></tr><tr><td>CT</td><td>72-136%</td><td>≤ 20%</td></tr><tr><td>Chloroform</td><td>79-124%</td><td>≤ 20%</td></tr><tr><td>cis-1,2-DCE</td><td>78-123%</td><td>≤ 20%</td></tr><tr><td>MC</td><td>74-124%</td><td>≤ 20%</td></tr><tr><td>PCE</td><td>74-129%</td><td>≤ 20%</td></tr><tr><td>TCE</td><td>79-123%</td><td>≤ 20%</td></tr><tr><td>VC</td><td>58-137%</td><td>≤ 20%</td></tr></tbody></table>	Analyte	Recovery	RPD	1,1-DCA	77-125%	≤ 20%	1,1-DCE	71-131%	≤ 20%	1,2-DCA	73-128%	≤ 20%	1,2-DCE (total)	79-121%	≤ 20%	1,2-DCPA	78-122%	≤ 20%	1,3-DCPE (total)	77-123%	≤ 20%	Benzene	79-120%	≤ 20%	CT	72-136%	≤ 20%	Chloroform	79-124%	≤ 20%	cis-1,2-DCE	78-123%	≤ 20%	MC	74-124%	≤ 20%	PCE	74-129%	≤ 20%	TCE	79-123%	≤ 20%	VC	58-137%	≤ 20%	DoD QSM 5.4 App C Table C-24	Re-prepare and re-analyze LCS/LCSD and associated batch samples	GC/MS Analyst	Bias Accuracy/ Precision
Analyte	Recovery	RPD																																																	
1,1-DCA	77-125%	≤ 20%																																																	
1,1-DCE	71-131%	≤ 20%																																																	
1,2-DCA	73-128%	≤ 20%																																																	
1,2-DCE (total)	79-121%	≤ 20%																																																	
1,2-DCPA	78-122%	≤ 20%																																																	
1,3-DCPE (total)	77-123%	≤ 20%																																																	
Benzene	79-120%	≤ 20%																																																	
CT	72-136%	≤ 20%																																																	
Chloroform	79-124%	≤ 20%																																																	
cis-1,2-DCE	78-123%	≤ 20%																																																	
MC	74-124%	≤ 20%																																																	
PCE	74-129%	≤ 20%																																																	
TCE	79-123%	≤ 20%																																																	
VC	58-137%	≤ 20%																																																	

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	<p>If MS results are outside 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.</p> <p>If the concentration in parent sample is > 4x the spiked amount, include in case narrative. No corrective action required.</p>	GC/MS Analyst	Bias/Precision
Surrogates	Field samples and laboratory QC	1,2-Dichloroethane-d4 81-118% Toluene-d8 89-112%	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 5.4 App B Table B-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

CCV: continuing calibration verification

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 < ⅓ ₁₀ the amount measured in any sample or ⅓ ₁₀ the regulatory limit, whichever is greater.	DoD QSM 5.4 App B Table B-8	Correct problem. Re-prepare and re-analyze method blank and affected samples	ICP Analyst	Accuracy/Bias Contamination												
LCS	1 per analytical batch. Spike target compounds	<table><tr><td><u>Analyte</u></td><td><u>Recovery</u></td></tr><tr><td>Antimony</td><td>88-113%</td></tr><tr><td>Copper</td><td>86-114%</td></tr><tr><td>Lead</td><td>86-113%</td></tr></table>	<u>Analyte</u>	<u>Recovery</u>	Antimony	88-113%	Copper	86-114%	Lead	86-113%	DoD QSM 5.4 App B Table B-8 and App C Table C-4	Re-prepare and re-analyze LCS and associated batch samples	ICP Analyst	Bias Accuracy/Precision				
<u>Analyte</u>	<u>Recovery</u>																	
Antimony	88-113%																	
Copper	86-114%																	
Lead	86-113%																	
Laboratory Duplicate Sample	1 per analytical batch	≤ 20%	DoD QSM 5.4 App B Table C-4	Narrate outliers in case narrative. No CA	ICP Analyst	Precision												
MS/MSD	1 per analytical batch	<table><tr><td><u>Analyte</u></td><td><u>Recovery</u></td><td><u>RPD</u></td></tr><tr><td>Antimony</td><td>88-113%</td><td>≤20%</td></tr><tr><td>Copper</td><td>86-114%</td><td>≤20%</td></tr><tr><td>Lead</td><td>86-113%</td><td>≤20%</td></tr></table>	<u>Analyte</u>	<u>Recovery</u>	<u>RPD</u>	Antimony	88-113%	≤20%	Copper	86-114%	≤20%	Lead	86-113%	≤20%	DoD QSM 5.4 App C Table C-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
<u>Analyte</u>	<u>Recovery</u>	<u>RPD</u>																
Antimony	88-113%	≤20%																
Copper	86-114%	≤20%																
Lead	86-113%	≤20%																
Dilution Test	1 per prep batch	5-fold dilution must agree within ± 10% of the original measurement	DoD QSM 5.4 App B Table B-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 5.4 App B Table B-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-prepare and re-analyze method blank and affected samples.	Wet Chemistry Analyst	Accuracy/Bias Contamination
LCS	1 per analytical batch.	90-110%	Laboratory performance-based limits	Re-prepare 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 ±15%	Lab performance-based limit	Re-prepare 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

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

Sample Collection and Field Records			
Record	Generation	Verification	Storage location/archive
Field notes/logbook	Field Team Lead	Project Manager	Project File ¹
Chain of custody forms	Field Team Lead	Project Manager	Project File
Laboratory raw data package	SGS	Project Chemist	Project File
PDF copy of analytical data	SGS	Project Chemist	Fort Ord Administrative Record
Audit/assessment checklists/reports	Field Team Lead/Project Chemist	Project Manager	Project File
Corrective action reports	Field Team Lead/Project Chemist	Project Manager	Project File
Laboratory sample custody log	SGS	Project Chemist	Project File
Laboratory equipment calibration logs	SGS	Project Chemist	Project File
Sample preparation logs	SGS	Project Chemist	Project File
Run logs	SGS	Project Chemist	Project File
Sample disposal records	SGS	Project Chemist	Project File
Electronic Validated data/Manual Validated data/Data Validation Reports	Data Validation Subcontractor	Project Chemist	Fort Ord Data Integration System (FODIS) chemistry database
Quarterly/Annual Reports	Task Manager	USACE Project Manager	Fort Ord Administrative Record

Notes:

¹ The Project File is maintained on a secure server accessible at the Monterey Project Office

7.2 Worksheet #31, 32 & 33: Assessments and Corrective Action

Planned project assessments will be completed for the work conducted using the Three Phase Quality Control Process, which consists of the following:

- Preparatory Phase: Activities and assessments during the preparatory phase are conducted prior to the start of a definable feature of work and are performed to ensure technical requirements and work prerequisites are completed prior to the start of the feature of work. Discrepancies will be resolved and corrective actions implemented and verified prior to the start of work.
- Initial Phase: Activities and assessments during the initial phase are performed during the first day of the definable feature of work and are conducted 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 C. 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 and Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title and 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, Project Manager, Ahtna	One week

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title and Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title and Organization)	Timeframe for Response
Planning document (QAPP) sign-off by field staff, subcontractors, and laboratory	Memo	Holly Dillon, Groundwater Monitoring Task Lead Andrew Mauck, Field Supervisor, Ahtna Elvin Kumar, Project Manager, SGS	Prior to the start of field activities	Obtain sign-off that document has been read and understood by field and laboratory personnel	Derek Lieberman, Project Manager, Ahtna	One week
Preliminary work activities performed	Memo	Holly Dillon, Groundwater Monitoring Task Lead	Prior to the start of field activities	Provide clearance forms, permit forms, site access communications	Derek Lieberman, Project Manager, Ahtna	Prior to the start of field activities
Review of lab and field staff readiness	Memo	Andrew Mauck, Field Supervisor, Ahtna Holly Dillon, Groundwater Monitoring Task Lead Elvin Kumar, Project Manager, SGS	Prior to the start of field activities	Provide kick-off meeting notes from field and laboratory meetings	Derek Lieberman, Project Manager, Ahtna	One week
Review of field equipment	Memo	Andrew Mauck, Field Supervisor, Ahtna Holly Dillon, Groundwater Monitoring Task Lead Elvin Kumar, Project Manager, SGS	Prior to the start of field activities	Provide checklist documenting field equipment is available and in good working order	Derek Lieberman, Project Manager, Ahtna	Prior to the start of field activities.

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title and Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title and Organization)	Timeframe for Response
Phase II – Initial Phase						
Work performed according to project plans	Memo	Andrew Mauck, Field Supervisor, Ahtna Holly Dillon, SSHO/Groundwater Monitoring Task Lead Derek Lieberman, Project Manager, Ahtna Bruce Wilcer, QC Manager, Ahtna	Within 24 hours of observation	Communications with USACE	Erin Corr, Technical Lead, USACE James Specht, Project Manager, USACE Curtis Payton, Project Manager Forward, USACE	One week
Field and laboratory audit	Field and Lab audit report	Andrew Mauck, Field Supervisor, Ahtna Elvin Kumar, Project Manager, SGS Eric Schmidt, Project Chemist, Ahtna Derek Lieberman, Project Manager, Ahtna Holly Dillon, Groundwater Monitoring Task Lead	Within 48 hours of audits	Field and laboratory to issue formal response to audit findings requiring corrective action	Derek Lieberman, Project Manager, Ahtna Bruce Wilcer, QC Manager, Ahtna	One week

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title and Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title and Organization)	Timeframe for Response
Review of CQCRs	Memo	Andrew Mauck, Field Supervisor, Ahtna Holly Dillon, Groundwater Monitoring Task Lead	Within 48 hours of review	Revision of CQCRs as needed	Derek Lieberman, Project Manager, Ahtna Erin Corr, Technical Lead, USACE James Specht, Project Manager, USACE Curtis Payton, Project Manager Forward, USACE	One week
Review of project plans to reflect current site or lab activities	Memo	Andrew Mauck, Field Supervisor, Ahtna Elvin Kumar, Project Manager, SGS Derek Lieberman, Project Manager, Ahtna Holly Dillon, Groundwater Monitoring Task Lead	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 laboratory protocol to be in accordance with project plans	Derek Lieberman, Project Manager, Ahtna Erin Corr, Technical Lead, USACE James Specht, Project Manager, USACE Curtis Payton, Project Manager Forward, USACE	Prior to next scheduled sampling event.

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title and Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title and Organization)	Timeframe for Response
Field and laboratory audit	Field and Lab audit report	Andrew Mauck, Field Supervisor, Ahtna Elvin Kumar, Project Manager, SGS Eric Schmidt, Project Chemist, Ahtna Derek Lieberman, Project Manager, Ahtna Holly Dillon, Groundwater Monitoring Task Lead	Within 48 hours of audits	Field and laboratory to issue formal response to audit findings requiring corrective action	Derek Lieberman, Project Manager, Ahtna Bruce Wilcer, QC Manager, Ahtna	One week
Phase III – Follow up and Reporting Phase						
Data reports prepared in accordance with project plans	Internal comments from staff	Document Author	Prior to issuance of report	Provide response to comments and revise report as needed	Commenting staff Derek Lieberman, Project Manager, Ahtna	Prior to issuance of report

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (Name, Title and Organization)	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response (Name, Title and Organization)	Timeframe for Response
Report meets client and regulatory agency requirements	External comments from client and regulatory agencies	Document Author Derek Lieberman, Project Manager, Ahtna	Within 30 days of receipt of report	Provide response to comments and revise report as needed	Commenting Client and or Agencies Derek Lieberman, Project Manager, Ahtna Erin Corr, Technical Lead, USACE James Specht, Project Manager, USACE Curtis Payton, Project Manager Forward, USACE	30 days
Other definable features of work completed	Memo	Derek Lieberman, Project Manager, Ahtna	Before end of contract period	Complete definable features of work	Derek Lieberman, Project Manager, Ahtna Erin Corr, Technical Lead, USACE James Specht, Project Manager, USACE Curtis Payton, Project Manager Forward, USACE	Before end of contract period

7.2.2 QA Management

Type of Report	Frequency (daily, weekly, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (name, title and organization)	Report Recipient(s) (name, title and organization)
Daily CQCR Field Report	Daily	At the end of each day of fieldwork. Original field reports will be kept on-site in the project file.	Andrew Mauck, Field Supervisor, Ahtna Andrew Mauck, Soil Gas Monitoring Task Lead	Derek Lieberman, Project Manager, Ahtna Bruce Wilcer, QC Manager, Ahtna James Specht, Project Manager, USACE Curtis Payton, Project Manager Forward, USACE Erin Corr, Technical Lead, USACE Christian Herrmann, Chenega
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 final report.	Andrew Mauck, Field Supervisor, Ahtna Holly Dillon, Groundwater Monitoring Task Lead	James Specht, Project Manager, USACE Curtis Payton, Project Manager Forward, USACE Derek Lieberman, Project Manager, Ahtna Eric Schmidt, Project Chemist, Ahtna Erin Corr, Technical Lead, USACE
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 final report.	Andrew Mauck, Field Supervisor, Ahtna Holly Dillon, Groundwater Monitoring Task Lead	James Specht, Project Manager, USACE Curtis Payton, Project Manager Forward, USACE Derek Lieberman, Project Manager, Ahtna Eric Schmidt, Project Chemist, Ahtna Erin Corr, Technical Lead, USACE

7.3 Worksheet #34: Data Verification and Validation Inputs

This worksheet lists the inputs that will be used during data verification and validation. Inputs include planning documents, field records, and laboratory records. Data verification is a check that all specified activities involved in collecting and analyzing samples have been completed and documented and that the necessary records (objective evidence) are available to proceed to data validation. Data validation is the evaluation of conformance to stated requirements, including those in the contract, methods, SOPs, and the QAPP.

Item	Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records			
1	Approved QAPP	X	
2	Contract	X	
4	Field SOPs	X	
5	Laboratory SOPs	X	
Field Records			
6	Field Logbooks	X	X
7	Equipment Calibration Records	X	X
8	Chain of Custody Forms	X	X
9	Sampling Diagrams/Surveys	X	X
10	Relevant Correspondence	X	X
11	Change Orders/Deviations	X	X
12	Field Audit Reports	X	X
13	Field Corrective Action Reports	X	X
Analytical Data Package			
14	Cover Sheet (laboratory identifying information)	X	X
15	Case Narrative	X	X
16	Sample Chronology (e.g., dates and times of receipt, preparation, and analysis)	X	X
17	LOD/LOQ Establishment and Verification	X	X
18	Standards Traceability	X	X
19	Instrument Calibration Records	X	X
20	Definition of Laboratory Qualifiers	X	X
21	Results Reporting Forms	X	X
22	QC Sample Results	X	X

Item	Description	Verification (completeness)	Validation (conformance to specifications)
23	CA Reports	X	X
24	Raw Data	X	X
25	Chromatograms	X	X
26	Electronic Data Deliverable	X	X

7.4 Worksheet #35: Data Verification Procedures

Records Reviewed	Requirement Documents	Process Description	Responsible Person, Organization
Methods	QAPP, SOP	Records support implementation of the SOP-sampling and analysis.	Project Chemist, Ahtna
Performance Requirements	QAPP, SOP	Verify laboratory method SOPs are sufficient to satisfy DQOs.	Project Chemist, Ahtna
Sampling Locations, Number of Samples	QAPP, SOP	Verify that sample locations and quantities will be sufficient to satisfy DQOs.	Project Chemist, Ahtna
Three-phase inspection forms and Other Field Documentation	QAPP, SOP	Review daily sampling activity reports including pertinent field sampling data.	Project Chemist, Ahtna
Chain of Custody	QAPP, SOP	Examine traceability of data from sample collection to generation of project reported data.	Project Chemist, Ahtna
Deviations	QAPP, SOP	Determine impacts of any deviations from methods.	Project Chemist, Ahtna
Sensitivity	QAPP, SOP	Verify that LODs and LOQs are achieved as outlined in the QAPP and that the laboratory successfully analyzed a standard at the LOD.	Project Chemist, Ahtna
Precision	QAPP, SOP	Review data against performance criteria and determine impact of any result out of criteria.	Project Chemist, Ahtna
Accuracy	QAPP, SOP	Review data against performance criteria and determine impact of any result out of criteria.	Project Chemist, Ahtna
QC samples	QAPP, SOP	Ensure that a sufficient number of QC samples are analyzed, as outlined in the QAPP, to meet DQOs.	Project Chemist, Ahtna
Field Change Requests	QAPP, SOP	Review any change request or corrective action documentation. Determine impact to project objectives.	Project/Program Chemist, Ahtna
Electronic Data Deliverables (EDDs)	QAPP	Verify that acceptable EDDs have been qualified. The Laboratory Data Consultants Automated Data Review (LDC ADR) EDD format files will be uploaded into the FODIS chemistry database, EDD files will be submitted to USACE. EDD File Specifications are provided in Attachment D.	Project Chemist, Ahtna

7.5 Worksheet #36: Data Validation Procedures

Analytical Group/Method:	VOCs – EPA Method 8260-SIM	Metals - EPA Method 6010D	Chloride – EPA Method 9056A
Data deliverable requirements:	LDC ADR	LDC ADR	LDC ADR
Analytical specifications:	Worksheet #28	Worksheet #28	Worksheet #28
Measurement performance criteria:	Worksheet #12	Worksheet #12	Worksheet #12
Percent of data packages to be validated:	100% Stage 2B	100% Stage 2B	100% Stage 2B
Percent of raw data reviewed:	10% Stage 4	10% Stage 4	10% Stage 4
Percent of results to be recalculated:	10% Stage 4	10% Stage 4	10% Stage 4
Validation procedure:	DoD Data Validation Guidelines	DoD Data Validation Guidelines	DoD Data Validation Guidelines
Validation qualifiers:	See table below	See table below	See table below
Electronic validation program:	LDC ADR	LDC ADR	LDC ADR

Notes:

DoD Data Validation Guidelines = Department of Defense General Data Validation Guidelines Environmental Data Quality Workgroup, Revision 1 (DoD, 2019), Data Validation Guidelines Module 1: Data Validation Procedure for Organic Analysis by GC/MS (DoD, 2020a), Data Validation Guidelines Module 2: Data Validation Procedure for Metals by ICP-OES (DoD, 2020b), and Data Validation Guidelines Module 1, 2, and 4 Revised Blank Qualification Table (DoD, 2021b)

LDC ADR = Laboratory Data Consultants Automated Data Review format

Summary of Data Qualifiers

Qualifier	Definition
U	The analyte was not detected and was reported as less than the LOD or as defined by the customer. The LOD has been adjusted for any dilution or concentration of the sample.
J	The reported result was an estimated value with an unknown bias.

Qualifier	Definition
J+	The result was an estimated quantity, but the result may be biased high.
J-	The result was an estimated quantity, but the result may be biased low.
N	The analysis indicates the presence of an analyte for which there was presumptive evidence to make a "tentative identification."
NJ	The analyte has been "tentatively identified" or "presumptively identified" as present and the associated numerical value was the estimated concentration in the sample.
UJ	The analyte was not detected and was reported as less than the LOD or as defined by the customer. However, the associated numerical value is approximate.
X	The sample results (including non-detects) were affected by serious deficiencies in the ability to analyze the sample and to meet published method and project quality control criteria. The presence or absence of the analyte cannot be substantiated by the data provided. Acceptance or rejection of the data should be decided by the project team (which should include a project chemist), but exclusion of the data is recommended.

7.6 Worksheet #37: Data Usability Assessment

The procedures, methods, and activities that will be used to determine whether data are of the right type, quality, and quantity to support project decisions are described below. Also described is how data quality issues will be addressed and how limitations on the use of the data will be handled.

The suitability of the environmental data collected for its intended use will be assessed by the Ahtna Project Chemist in consultation with the Project Manager. 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. 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 QSM Version 5.4 (DoD, 2021a) 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 drawn based on their results:

<p>Step 1</p>	<p>Review the project's objectives and sampling design</p> <p>The goal for O&M activities at Fort Ord is to implement remedies as necessary to protect human health and the environment while maximizing the number of site closures or advance sites as close to site closure as practicable during the Period of Performance in a cost-effective manner. The site-specific QAPPs will indicate the project objectives and sampling design. To that end, the usability assessment will incorporate the activities listed below.</p> <p>Field Certification</p> <p>Field personnel will generate field forms, maps, and notes describing the daily procedures. The three-phase inspection forms (Attachment C), generated during sampling, will discuss any successes and/or deviations from the QAPP. The Task Lead will review all field documentation as it is generated for consistency and errors. Any anomalies identified will be discussed with the project team to determine if any changes to the sampling design are needed. Any changes will be documented in a QAPP amendment.</p> <p>Data Quality Indicators: Precision, Accuracy, Representativeness, Comparability, Completeness, and Sensitivity (PARCCS)</p> <p>The PARCCS parameters will be used to help identify deficiencies in the sample data that would affect the achievement of the project DQOs. Laboratory limits and QC samples will be used as part of the PARCCS assessment to detect anomalies in the dataset. In addition, the laboratory will create trend charts to track variability in laboratory processes and establish in-house precision and accuracy criteria.</p> <p>Laboratory limits used in the sensitivity review consist of the LOD and LOQ. Laboratory QC samples consist of method blanks, LCSs, surrogates, and laboratory duplicates. All samples will be spiked with surrogate compounds where recommended or required by the method.</p>
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<p>Precision</p> <p>Precision is defined as the degree of mutual agreement between individual measurements of the same property under similar conditions and provides a measurement of the reproducibility of an analytical result. Precision will be evaluated through the analysis of field duplicate samples and LCSs. Field duplicate samples will be collected at a frequency of one per 10 field samples of a given matrix. The duplicate sample will not be reanalyzed when the RPD criteria are not met. Discussion of QC failures will be documented in the laboratory case narrative. The Project Chemist will work with the laboratory to determine the cause of the failure and to determine if any of the QC failures are due to matrix or sampling error and if the failures have an impact on the project objectives.</p> <p>The variance between the samples, in terms of RPD, is calculated according to the following equation:</p> $RPD = \frac{ A - B }{(A + B)/2} \times 100\%$ <p>where:</p> <p>A = First duplicate concentration</p> <p>B = Second duplicate concentration</p> <p>For this project, the goal for precision of field duplicates is listed in Worksheet #12. If both of the duplicate sample results are less than the LOD, the RPD will not be calculated.</p> <p>Accuracy</p> <p>Accuracy is the degree of agreement between an analytical measurement and a reference accepted as a true value. The accuracy of a measurement system can be affected by errors introduced by field contamination, sample preservation, sample handling, sample preparation, or analytical techniques. A program of sample spiking will be conducted to evaluate laboratory accuracy. Accuracy will be evaluated by the percent recovery of the spiked compounds in the LCSs, surrogates, and proficiency samples (if requested by the PM). LCSs and surrogates will be spiked prior to extraction. LCS samples will be spiked with the method target compounds indicated in this QAPP, and surrogates will be added to every sample and spike. Proficiency samples will be taken through the entire sample preparation and analysis process. LCS or blank spike samples will be analyzed at a frequency of 5%, or one per sample delivery group/analytical batch (sample sets can be up to 20 field samples). Proficiency samples will be analyzed once per sampling event if required. The results of the spiked and proficiency samples are used to calculate the percent recovery for evaluating accuracy, using the following equation:</p> $\text{Percent Recovery} = \frac{S - C}{T} \times 100$ <p>where:</p> <p>S = Measured spike sample concentration</p> <p>C = Sample concentration</p> <p>T = True or actual concentration of the spike or proficiency</p>

	<p>Worksheet #12 presents accuracy goals for this investigation based on the percent recovery of LCSs and surrogate spikes. The data reviewer will use the accuracy results to help determine if any of the QC failures are due to matrix or sampling error and if the failures have an impact on the project objectives.</p> <p>The presence of high levels of target compounds in the sample chosen for spiking may necessitate a dilution of the sample or may otherwise result in errors in spiked compound recovery. Discussion of laboratory QC failures will be documented in the laboratory case narrative. The Project Chemist will work with the laboratory to determine the cause of the failure and to determine if any of the QC failures are due to matrix or sampling error and if the failures have an impact on the project objectives.</p> <p>Representativeness</p> <p>Representativeness expresses the degree to which sample data accurately and precisely represent the characteristics of a population, variations in a parameter at a sampling point, or an environmental condition that the data are intended to represent. For this project, representative data will be obtained through careful selection of sampling locations and analytical parameters, through proper collection and handling of samples to avoid interference and minimize cross-contamination, and through consistent application of the appropriate established field and laboratory procedures.</p> <p>To aid in evaluating the representativeness of the sample results, laboratory blank samples will be evaluated for the presence of contaminants. Laboratory procedures will be reviewed to verify that SOPs were followed, and method requirements were met during the analysis of project samples. Laboratory sample storage practices, holding times, sub-sampling procedures, and method blanks will be assessed for potential impacts on the representativeness of the data. Data determined to be non-representative will be used only if accompanied by appropriate qualifiers and limits of uncertainty.</p> <p>Representativeness (as it relates to field procedures) refers to the collection of samples that allow accurate conclusions to be made regarding the composition of the sample media at the entire site. Representativeness will be assessed qualitatively by evaluating whether the procedures described in this QAPP were followed.</p> <p>Completeness</p> <p>Completeness is a measure of the percentage of project-specific data that are valid. Valid data are obtained when samples are collected and analyzed in accordance with the procedures outlined in this QAPP and when none of the QC criteria used to determine the usability of the data is critically exceeded to the point of rejection.</p> <p>When data validation is completed, the percent completeness value will be calculated by dividing the number of usable sample results by the total number of sample results planned for this investigation. The evaluation of completeness will help determine whether any critical deficiencies identified during the validation process resulted in non-attainment of project objectives.</p> <p>Completeness will be evaluated by reviewing the tasks that contribute to the sampling event, such as sample handling and storage procedures, chain of custody procedures, analytical procedures, and data validation procedures. The procedures and determined</p>
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<p>impact on the sample results will be used to identify any problems along the data path that will render the decision-making process useless and the data set incomplete. The completeness goal for this project that still allows for attainment of the project objectives is 90%.</p> $\frac{\text{Number of possible analyte results} - \text{Number of rejected and unreported results} \times 100}{\text{Possible number of analyte results}}$ <p>The project team may determine that an individual sampling point or area is more critical than others for decision-making. Any sampling locations identified as such will have a completeness goal of 95% as determined by the validation process.</p> <p>Comparability</p> <p>Comparability expresses the confidence with which one dataset can be compared with another. Comparability of data will be achieved by following standard field and laboratory procedures outlined in SOPs and published methods. In addition, standard units of measurement will be used in reporting analytical and field data. Analytical and field methods selected for this investigation are consistent with the methods used during previous investigations of this type. Oversight by experienced team members will ensure that the procedures are conducted in a manner appropriate to attaining the project objectives. Any deviations from field or laboratory methods will be documented on a change request form. The project team will review the change request to determine if the change will impact the comparability of the data.</p> <p>Sensitivity</p> <p>The LOD and LOQ will be evaluated by the project team prior to sample analysis to determine if the laboratory is able to attain the sensitivity required for the project. If project decision limits are too sensitive, it will be determined prior to sample analysis whether a sensitivity variance will be issued to the laboratory based on the method chosen and the technology available.</p> <p>The LOD is the minimum quantity of an analyte that can be reliably detected for a specific analytical method at a 99% confidence level that the value is not a false negative. The LOQ represents the smallest quantity of an analyte that can be quantified accurately and reproducibly in a given sample matrix (e.g., three to five times the LOD). The LOD and/or the LOQ shall be sensitive enough to meet the project decision limits. The LOD and LOQ will be evaluated after sample analysis to determine if there were any matrix effects, operator errors, or analytical process errors that interfered with the ability to compare the results to the project decision limits. The LOD will be used to determine if detectable amounts of analytes are present. If no detectable amounts are reported, and all data are acceptable (as determined by the verification and validation process), then the data are usable. The LOD will be used to determine if any detectable amounts of contaminants of concern are present. If detectable amounts are reported and the verification and validation are acceptable, then the data are usable. Any detections falling between the LOD and LOQ will be qualified as estimated. If anomalies in sensitivity are present, the rationale for use or non-use of the affected samples will be discussed in the data validation reports. Worksheet #15 presents the laboratory LODs and LOQs for the selected analytical method(s) used to support the project decision limits.</p>

Step 2	<p>Review the data verification and data validation outputs</p> <p>The outputs from the verification and validation process will be used to determine data usability. Data validation reports and three phase inspection forms will be reviewed. Data will be summarized as necessary using graphs, maps, and/or tables. The entire project team is responsible for assessing whether the data meet the project objectives. Personnel at all levels will generate data and documentation that will be reviewed to identify trends, relationships, and/or anomalies in the dataset.</p>
Step 3	<p>Implement the statistical method</p> <p>For each analytical method, the laboratory will use the LCS data to track and analyze trends in the laboratory. From these trends, they can recognize deficiencies in the method and create in-house acceptance criteria. For this project, the limits are based on laboratory control limits. The precision and accuracy of the entire dataset will be used to determine if any systemic problems have occurred during the sampling event that will result in deficiencies in the dataset. The occurrence of systemic problems and the resulting consequences will be discussed in the data validation report. The data reviewer will make every effort to identify any critical elements or trends that would result in non-usability of data as early as possible.</p>
Step 4	<p>Document data usability and draw conclusions</p> <p>Again, the entire project team is responsible for assessing whether the data meet the project objectives. The site-sampling layout, including sampling locations, frequency of sampling, and timing of sampling activities, will be reviewed by the project team. Data usability will be assessed in accordance with the guidance provided in QSM Version 5.4 (DoD, 2021a) and additional applicable USACE and EPA guidance as well as the professional experience of the decision-maker during data validation. The conclusions will be discussed in the final annual report. If the data indicate anomalies, the impacted data will be qualified as described in DoD Data Validation Guidelines (DoD, 2019), Data Validation Guidelines Module 1 (DoD, 2020a), Data Validation Guidelines Module 2: Data Validation Procedure for Metals by ICP-OES (DoD, 2020b), and Data Validation Guidelines Module 1, 2, and 4 Revised Blank Qualification Table (DoD, 2021b). The impact will be documented along with the rationale for limited use of the data.</p>

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¹⁸ 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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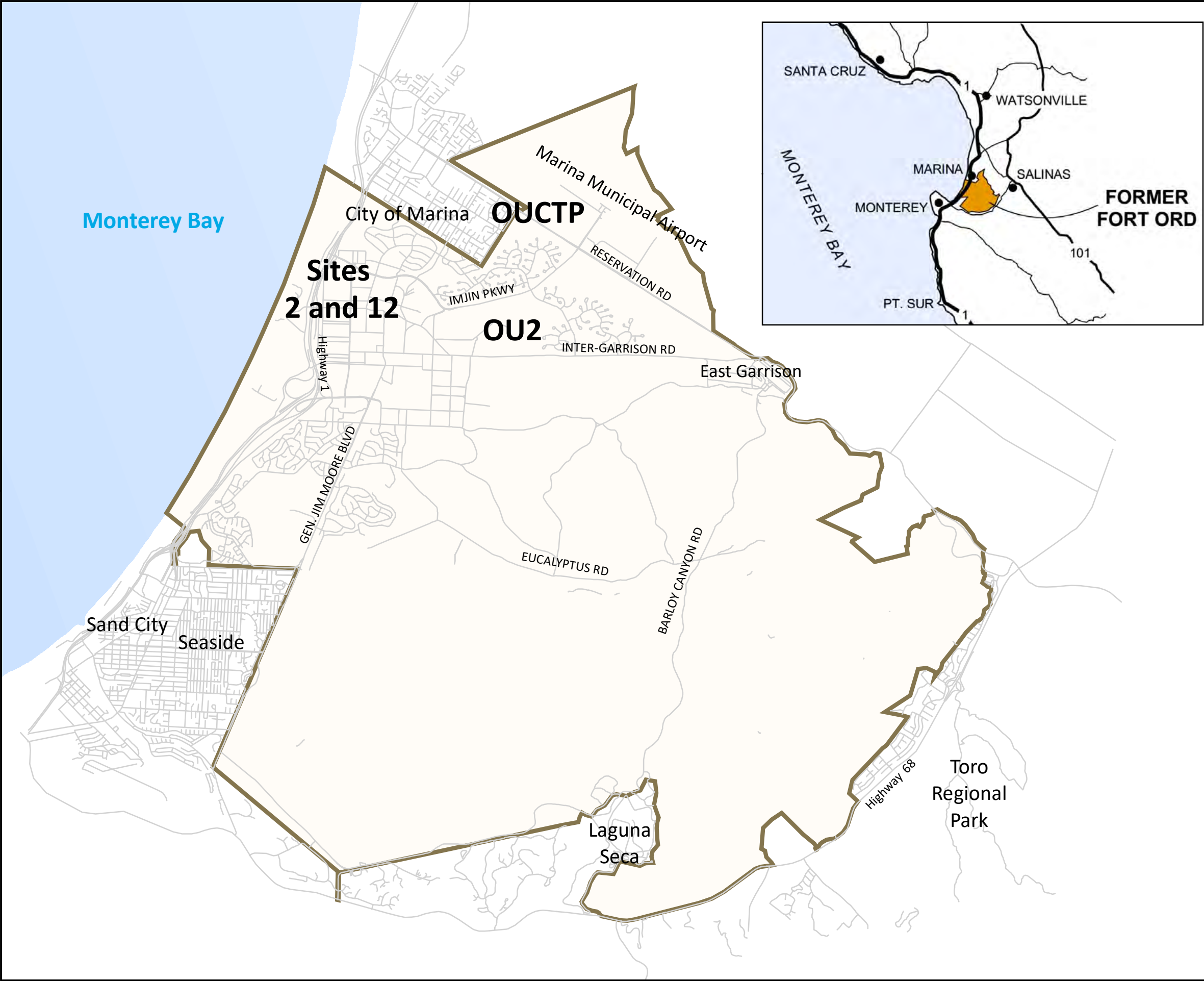
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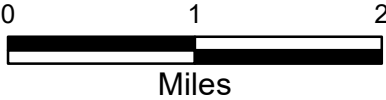
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FIGURES



EXPLANATION

- Roads
- ▭ Former Fort Ord Boundary



Former Fort Ord
Location Map
Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 11
Groundwater Remedies and Monitoring at Operable Unit 2,
Sites 2 and 12, and Operable Unit Carbon Tetrachloride.



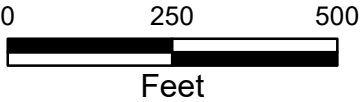
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Figure: **1**



EXPLANATION

- Well Type and Sample Schedule
- Extraction well - Quarterly VOCs
 - Monitoring well - Quarterly VOCs
 - Extraction well - Annual VOCs
 - Monitoring well - Annual VOCs
 - Extraction well - Water-level only
 - Monitoring well - Water-level only



Sites 2 and 12
Groundwater Monitoring Program
Sampling Locations
Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 11
Groundwater Remedies and Monitoring at Operable Unit 2,
Sites 2 and 12, and Operable Unit Carbon Tetrachloride.



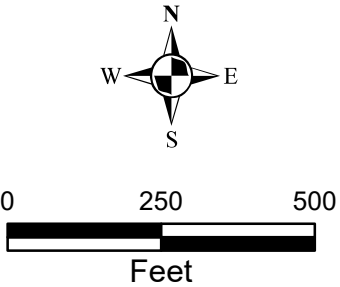
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Figure: 2



EXPLANATION

- Sites 2/12 Groundwater Treatment Plant
- Former Fort Ord Boundary
- Well Type and Use**
 - Extraction Well - Operated
 - Extraction Well - Not Operated
 - Extraction Well - Not Operated - No Pump
- Groundwater Pipeline**
 - Sites 2/12 Groundwater Collection Pipeline
 - OU2 Treated Water Injection Pipeline
 - Combined Treatment Water Discharge
- Discharge Structures**
 - Infiltration Well
 - Injection Well

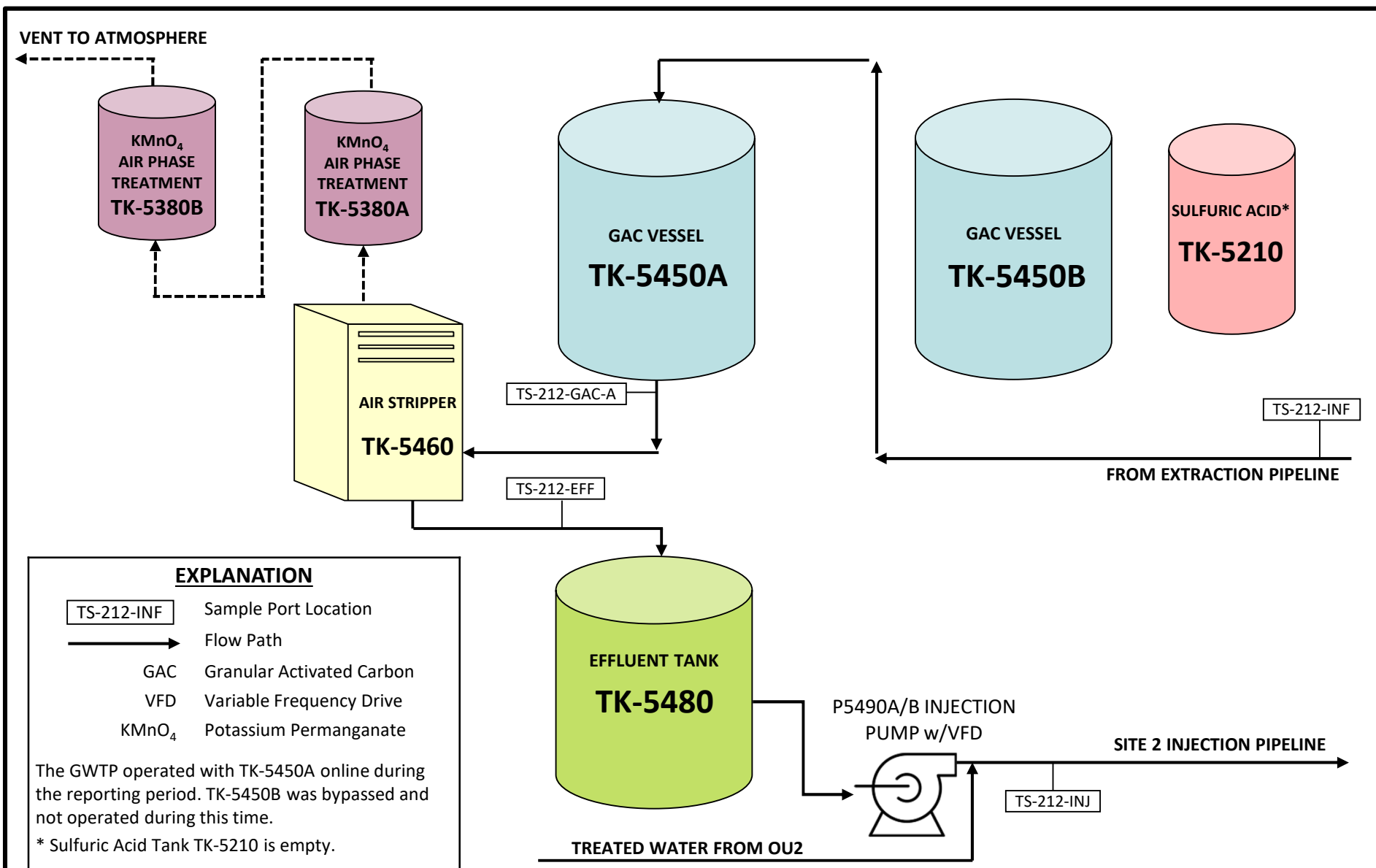


Sites 2 and 12
Groundwater Remedy Map
Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 11
Groundwater Remedies and Monitoring at Operable Unit 2,
Sites 2 and 12, and Operable Unit Carbon Tetrachloride.

Ahtna

Date: 8/15/2023

Figure: 3



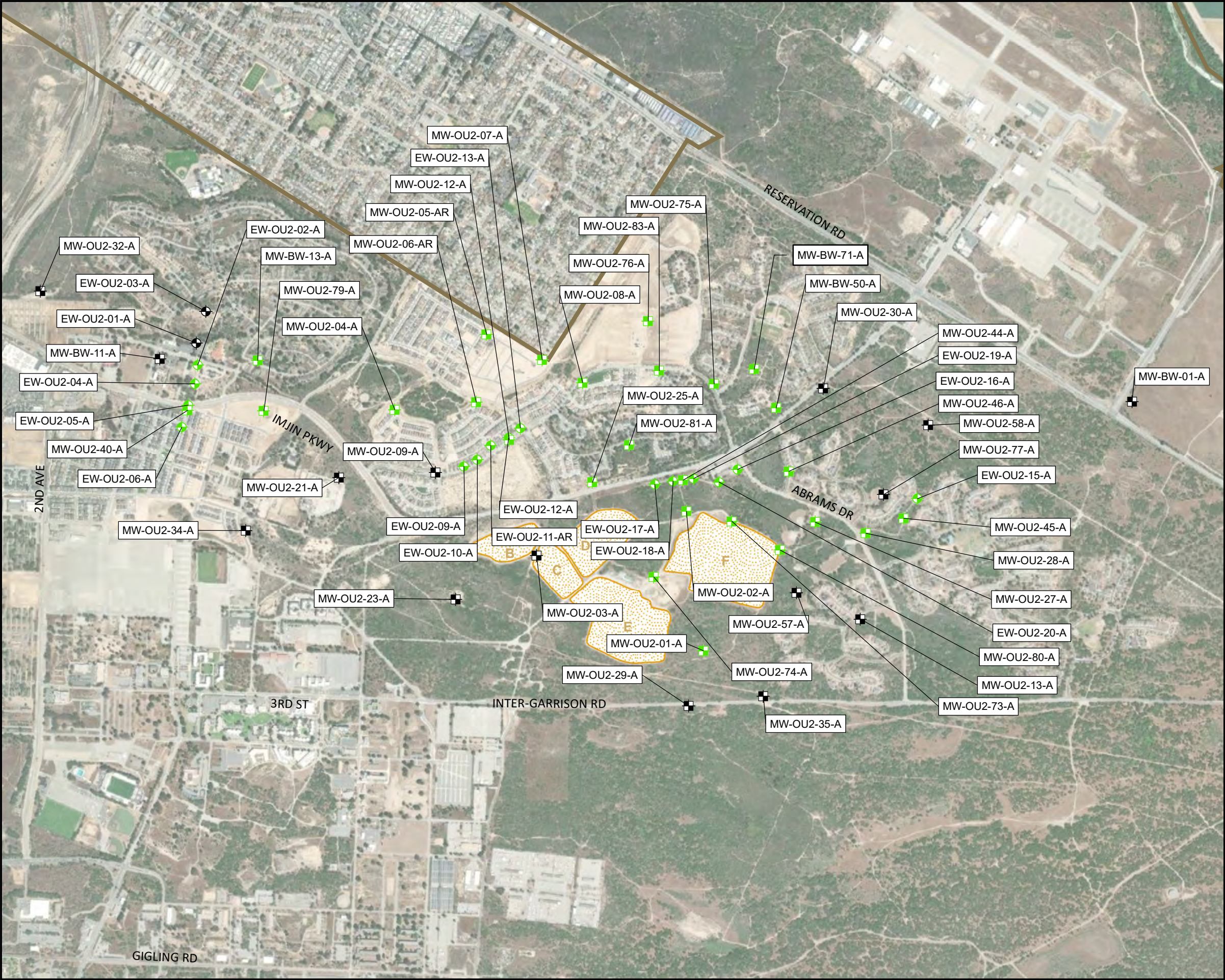
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Sites 2 and 12 Groundwater Treatment Plant Schematic

Quality Assurance Project Plan, Former Fort Ord, California, Volume 1, Appendix A, Revision 11
Groundwater Remedies and Monitoring at Operable Unit 2, Sites 2 and 12, and
Operable Unit Carbon Tetrachloride Plume

Figure:

4



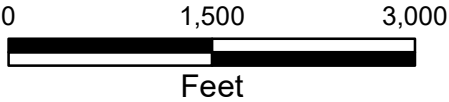
EXPLANATION

Approximate extent of landfill areas (Areas B - F)

Former Fort Ord Boundary

Well Type and Sample Schedule

- Extraction well - Quarterly VOCs
- Monitoring well - Quarterly VOCs
- Extraction well - Water-level only
- Monitoring well - Water-level only



OU2 A-Aquifer
Groundwater Monitoring Program
Sampling Locations
Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 11
Groundwater Remedies and Monitoring at Operable Unit 2.



Date: 8/15/2023

Figure: 5

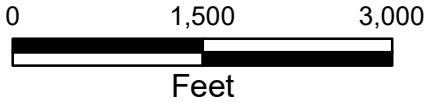


EXPLANATION

- Approximate extent of landfill areas (Areas B - F)
- Former Fort Ord Boundary

Sample Type and Sample Schedule

- Extraction well - Quarterly VOCs
- Monitoring well - Quarterly VOCs
- Monitoring well - Annual VOCs
- Extraction well - Water-level only
- Monitoring well - Water-level only

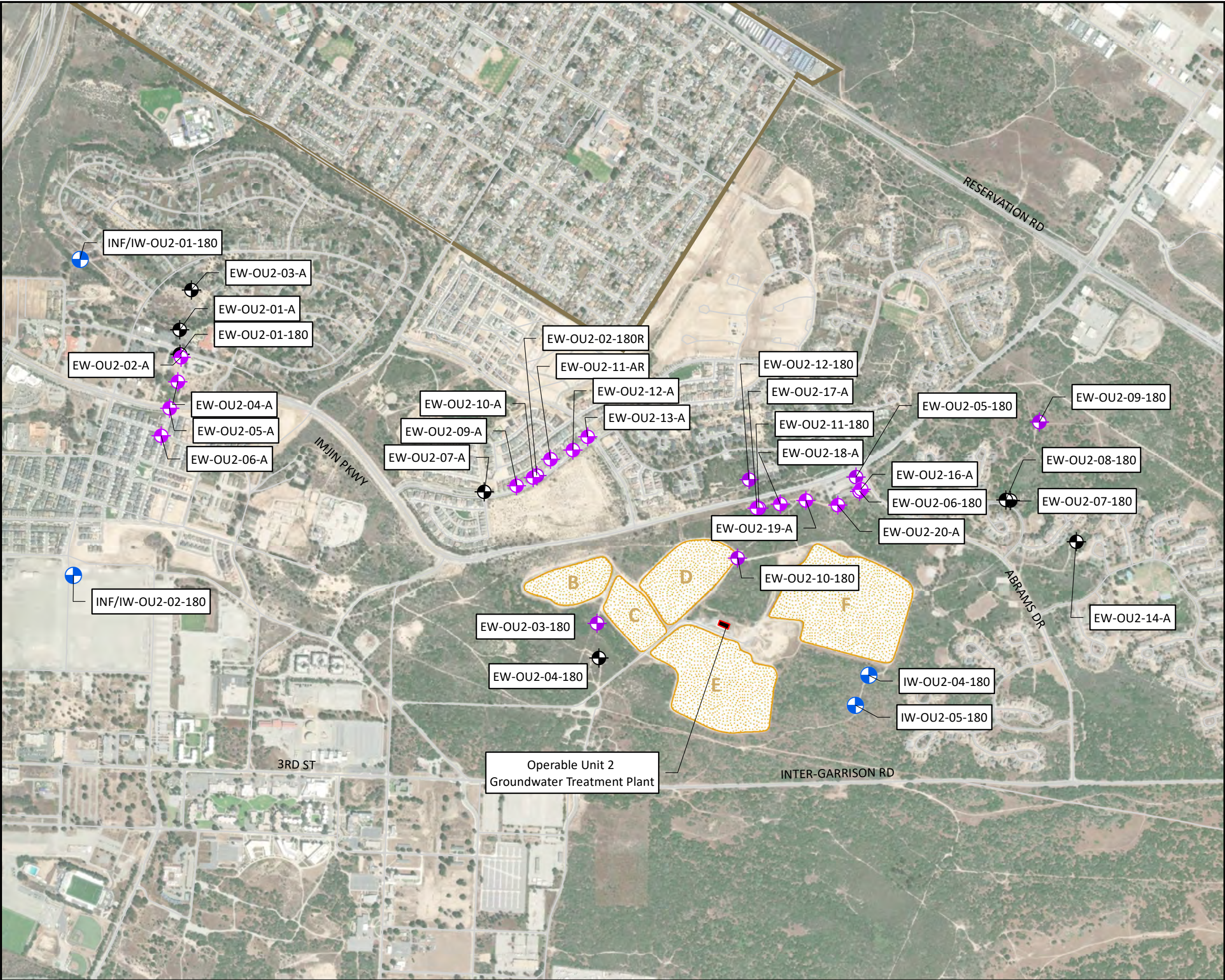


OU2 Upper 180-Foot Aquifer
Groundwater Monitoring Program
Sampling Locations
Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 11
Groundwater Remedies and Monitoring at Operable Unit 2,
Sites 2 and 12, and Operable Unit Carbon Tetrachloride.



Date: 8/15/2023

Figure: 6



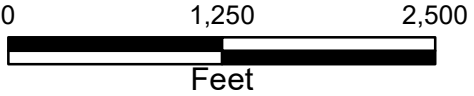
EXPLANATION

Approximate extent of landfill areas (Areas B - F)

Former Fort Ord Boundary

Well Type and Operational Status

- Extraction well - Operated
- Extraction well - Not operated - No pump - Low COCs
- Injection Well - Operated

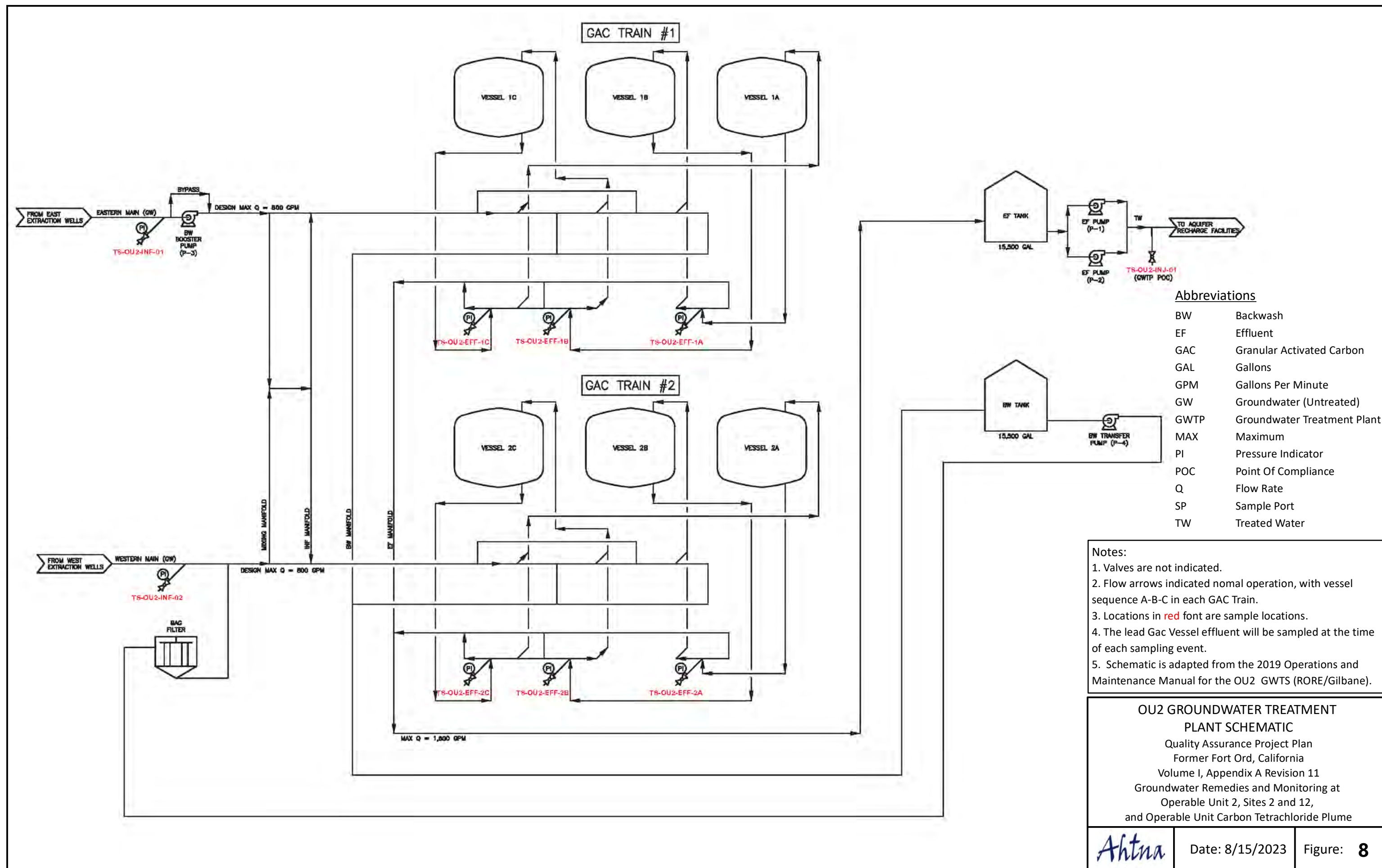


OU2 Groundwater Remedy and OUCTP Upper 180-Foot Aquifer Groundwater Remedy Map
Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 11
Groundwater Remedies and Monitoring at Operable Unit 2, Sites 2 and 12, and Operable Unit Carbon Tetrachloride.

Ahtna

Date: 8/15/2023

Figure: 7

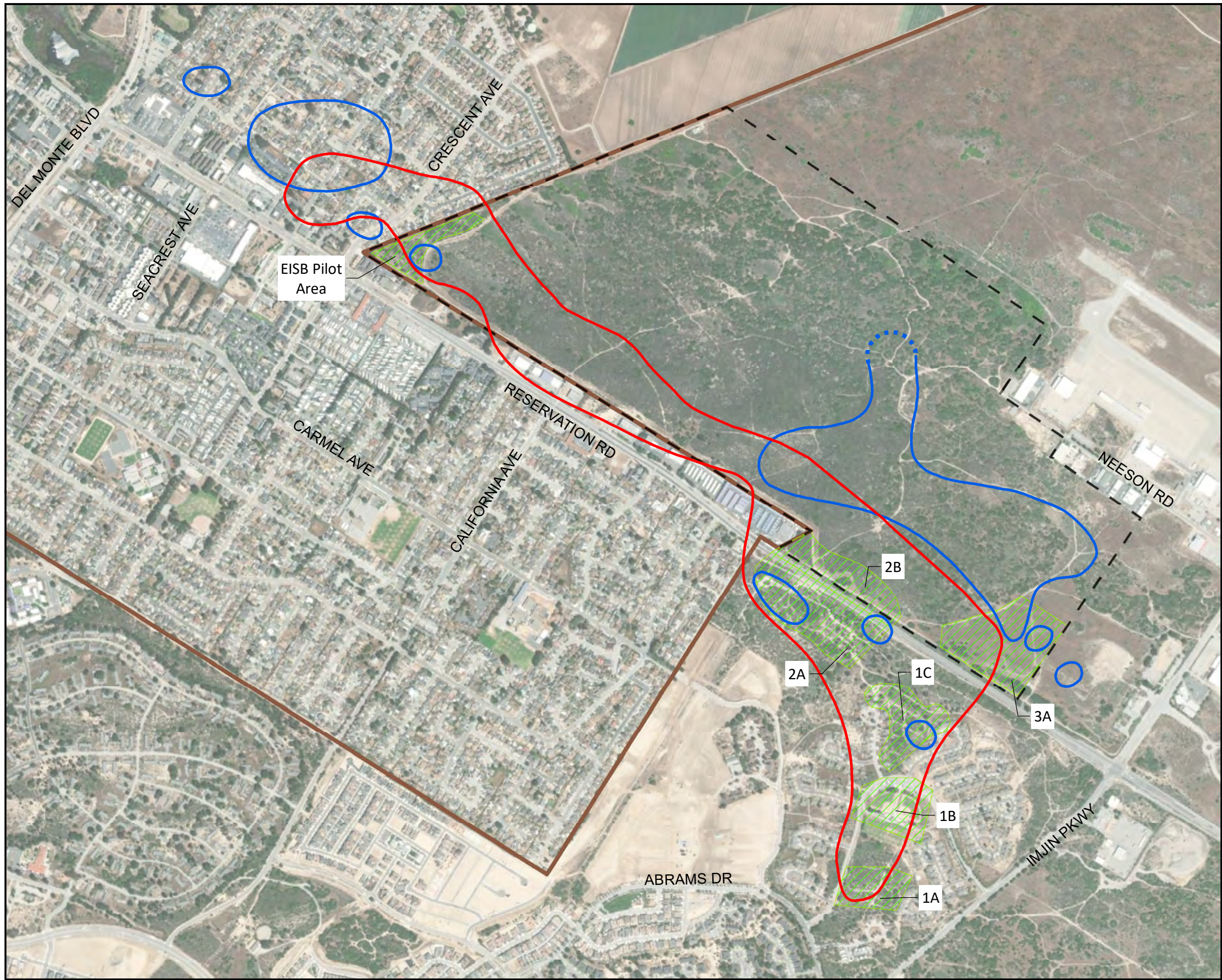


Abbreviations







BW	Backwash
EF	Effluent
GAC	Granular Activated Carbon
GAL	Gallons
GPM	Gallons Per Minute
GW	Groundwater (Untreated)
GWTP	Groundwater Treatment Plant
MAX	Maximum
PI	Pressure Indicator
POC	Point Of Compliance
Q	Flow Rate
SP	Sample Port
TW	Treated Water

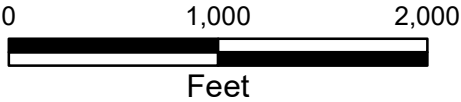
- Notes:**
1. Valves are not indicated.
 2. Flow arrows indicated nomal operation, with vessel sequence A-B-C in each GAC Train.
 3. Locations in **red** font are sample locations.
 4. The lead Gac Vessel effluent will be sampled at the time of each sampling event.
 5. Schematic is adapted from the 2019 Operations and Maintenance Manual for the OU2 GWTS (RORE/Gilbane).

**OU2 GROUNDWATER TREATMENT
PLANT SCHEMATIC**
 Quality Assurance Project Plan
 Former Fort Ord, California
 Volume I, Appendix A Revision 11
 Groundwater Remedies and Monitoring at
 Operable Unit 2, Sites 2 and 12,
 and Operable Unit Carbon Tetrachloride Plume



EXPLANATION

-  Enhanced In-Situ Bioremediation (EISB) Deployment Areas
-  Fort Ord Natural Reserve
-  Former Fort Ord Boundary
- ACL Exceedance 2022-3Q**
 -  CT (0.5 µg/L)
 -  Estimated CT (0.5 µg/L)
- ACL Exceedance 2008-4Q**
 -  Carbon tetrachloride (CT) (0.5 µg/L)



OUCTP A-Aquifer
EISB Groundwater Remedy
Deployment Areas
Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 11
Groundwater Remedies and Monitoring at Operable Unit 2,
Sites 2 and 12, and Operable Unit Carbon Tetrachloride.

Ahtna

Date: 8/17/2023

Figure: **10**



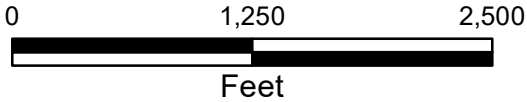
EXPLANATION

Approximate extent of landfill areas (Areas B - F)

Former Fort Ord Boundary

Well Type and Sampling Schedule

- Extraction well - Quarterly VOCs
- Monitoring well - Quarterly VOCs
- Multi-Port well - Quarterly VOCs
- Monitoring well - Annual VOCs
- Monitoring well - Water-level only
- Multi-Port well - Water-level only

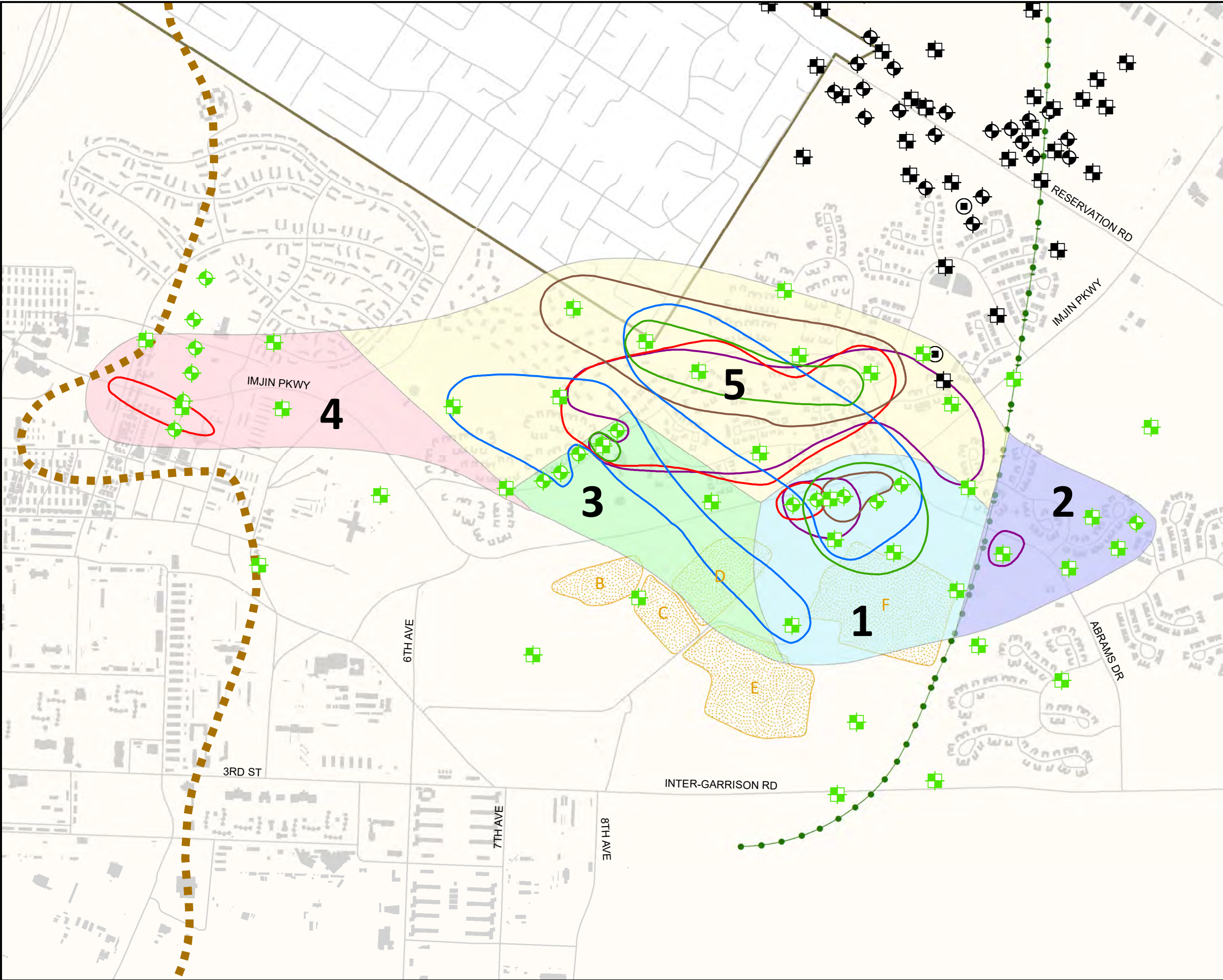


OUCTP Upper 180-Foot Aquifer
Groundwater Monitoring Program
Sampling Locations
Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 11
Groundwater Remedies and Monitoring at Operable Unit 2,
Sites 2 and 12, and Operable Unit Carbon Tetrachloride.

Ahtna

Date: 8/16/2023

Figure: 11



EXPLANATION

- Approximate location of the A-Aquifer groundwater divide
- Approximate edge of Fort Ord - Salinas Valley Aquitard (FO-SVA)
- Roads
- Approximate extent of landfill areas (Areas B through F)
- Facilities
- Former Fort Ord Boundary

Well Type and Site

- OU2-A Extraction well
- OU2- A Monitoring well
- OUCTP-A Extraction well
- OUCTP-A Monitoring well
- OUCTP-A Multi-Port well

3Q2022 Chemical of concern (COC) Aquifer Cleanup Level (ACL) Exceedance Contour in $\mu\text{g/L}$. Contour line is dashed when inferred.

- 5 Trichloroethene (TCE) plume extent
- 3 Tetrachloroethene (PCE) plume extent
- 5 1,1-Dichloroethane (1,1-DCA) plume extent
- 0.5 1,2-Dichloroethane (1,2-DCA) plume extent
- 0.1 Vinyl Chloride (VC) plume extent

OU2 A-Aquifer Hydraulic Zone

- 1
- 2
- 3
- 4
- 5

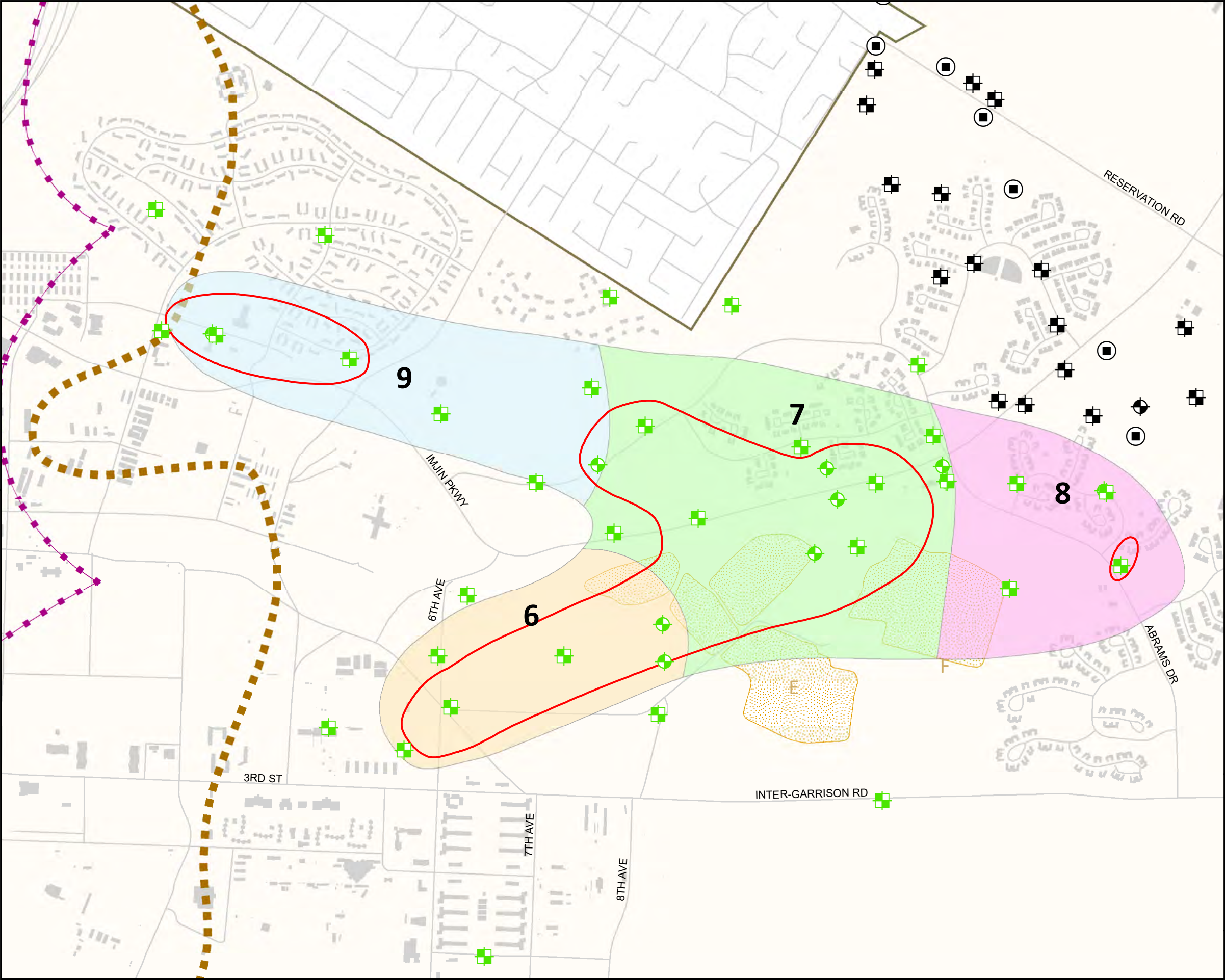
OU2 A-Aquifer Hydraulic Zone Map

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 11
Groundwater Remedies and Monitoring at Operable Unit 2, Sites 2 and 12, and Operable Unit Carbon Tetrachloride.

Ahtna

Date: 8/16/2023

Figure: **13**



EXPLANATION

- Approximate location of the Upper 180-Foot Aquifer groundwater divide
- Approximate edge of Fort Ord - Salinas Valley Aquitard (FO-SVA)
- Roads
- Approximate extent of landfill areas (Areas B through F)
- Facilities
- Former Fort Ord boundary

Well Type and Site

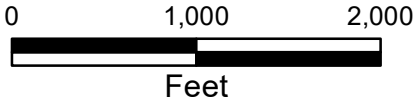
- OU2 Upper 180-Foot Aquifer - Monitoring well
- OU2 Upper 180-Foot Aquifer - Extraction well
- OUCTP Upper 180-Foot Aquifer - Extraction well
- OUCTP Upper 180-Foot Aquifer - Monitoring well
- OUCTP Upper 180-Foot Aquifer - Multi-Port well

3Q2022 Chemical of concern (COC) Aquifer Cleanup Level (ACL) Exceedance Contour in µg/L.

- 5 — Trichloroethene (TCE) plume extent

OU2 Upper 180-Foot Aquifer Hydraulic Zone

- 6
- 7
- 8
- 9



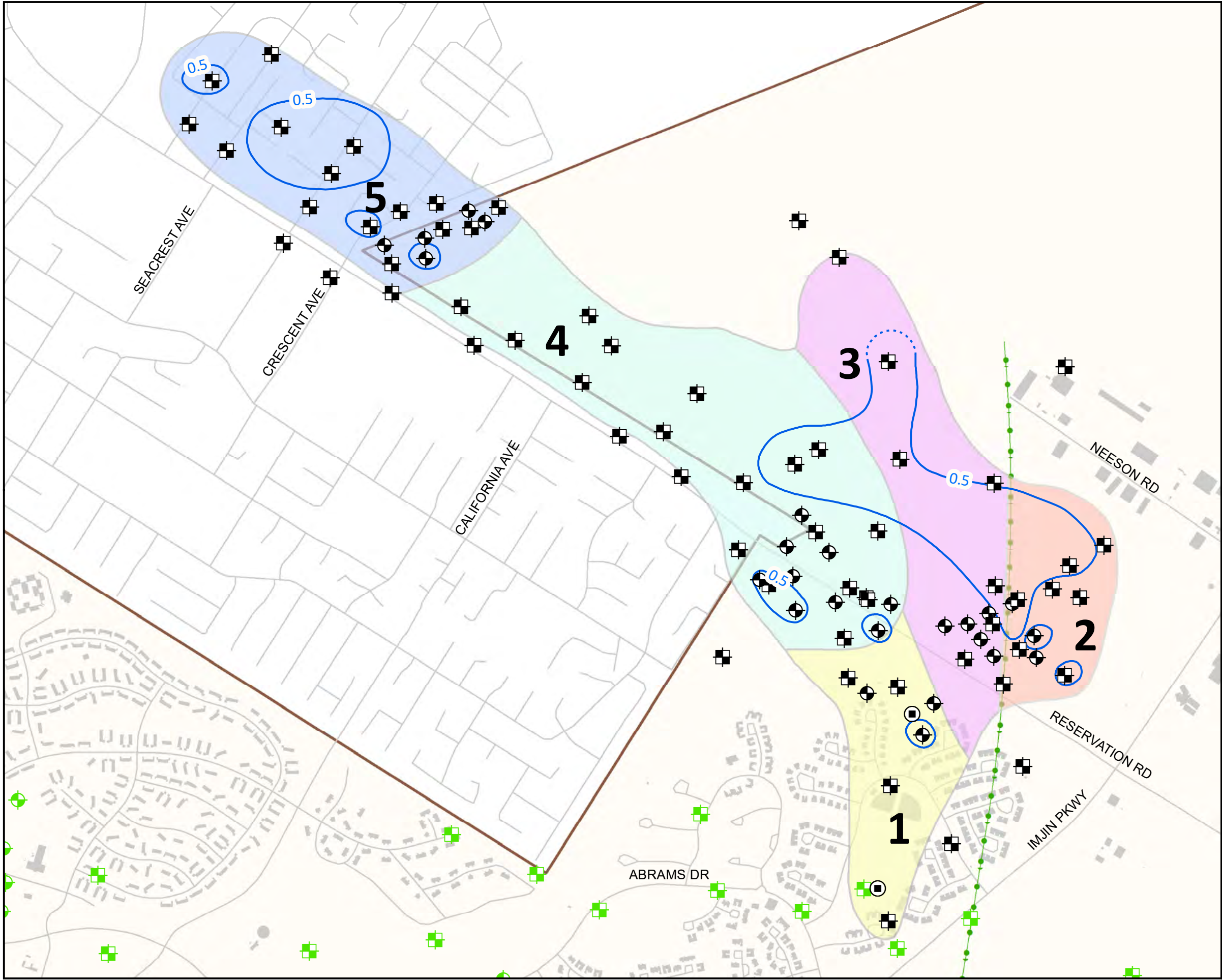
OU2 Upper 180-Foot Aquifer Hydraulic Zone Map

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 11
Groundwater Remedies and Monitoring at Operable Unit 2,
Sites 2 and 12, and Operable Unit Carbon Tetrachloride.



Date: 8/16/2023

Figure: **14**



EXPLANATION

- Approximate location of the A-Aquifer groundwater divide
- Roads
- Approximate extent of landfill areas (Areas B through F)
- Facilities
- Former Fort Ord boundary

Well Type and Site

- OUCTP-A Extraction well
- OUCTP-A Monitoring well
- OUCTP-A Multi-Port well
- OU2-A Extraction well
- OU2- A Monitoring well

3Q2022 Chemical of concern (COC) Aquifer Cleanup Level (ACL) Exceedance Contour in µg/L.

- 0.5 Carbon tetrachloride (CT) plume extent
- 0.5 CT plume extent inferred

OUCTP A-Aquifer Hydraulic Zone

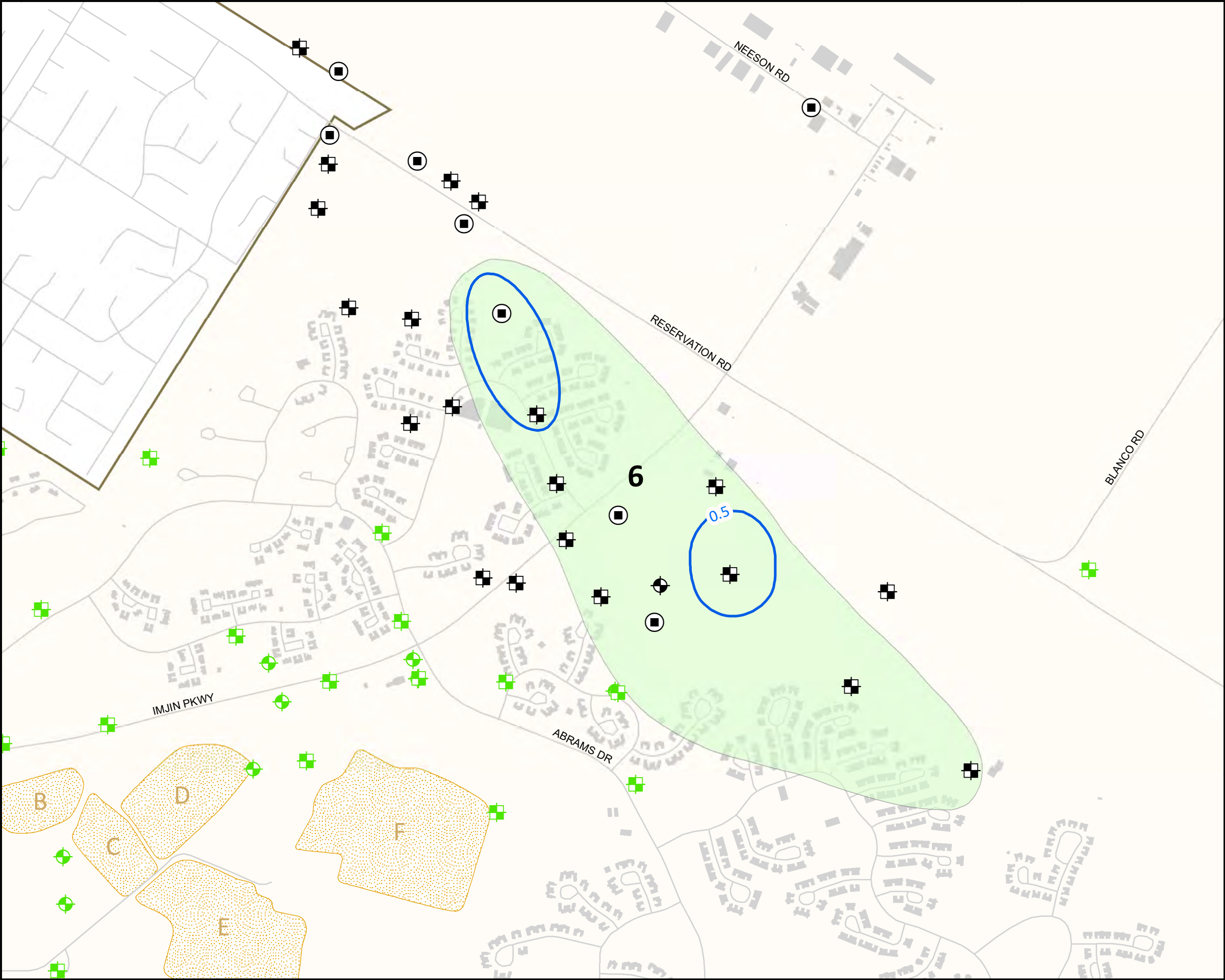
- 1
- 2
- 3
- 4
- 5

OUCTP A-Aquifer Hydraulic Zone Map

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 11
Groundwater Remedies and Monitoring at Operable Unit 2, Sites 2 and 12, and Operable Unit Carbon Tetrachloride.

Date: 8/17/2023

Figure: **15**



EXPLANATION

- Roads
- Approximate Extent of Landfill Areas (Areas B through F)
- Facilities
- Former Fort Ord

Well Type and Site

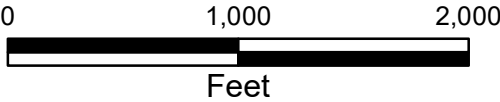
- OU2TP Upper 180-Foot Aquifer - Extraction well
- OU2TP Upper 180-Foot Aquifer - Monitoring well
- OU2TP Upper 180-Foot Aquifer - Multi-Port well
- OU2 Upper 180-Foot Aquifer - Monitoring well
- OU2 Upper 180-Foot Aquifer - Extraction well

3Q2022 Chemical of Concern (COC) Aquifer Cleanup Level (ACL) Exceedance Contour in µg/L

0.5 Carbon tetrachloride (CT) plume extent

OU2TP Upper 180-Foot Aquifer Hydraulic Zone

6



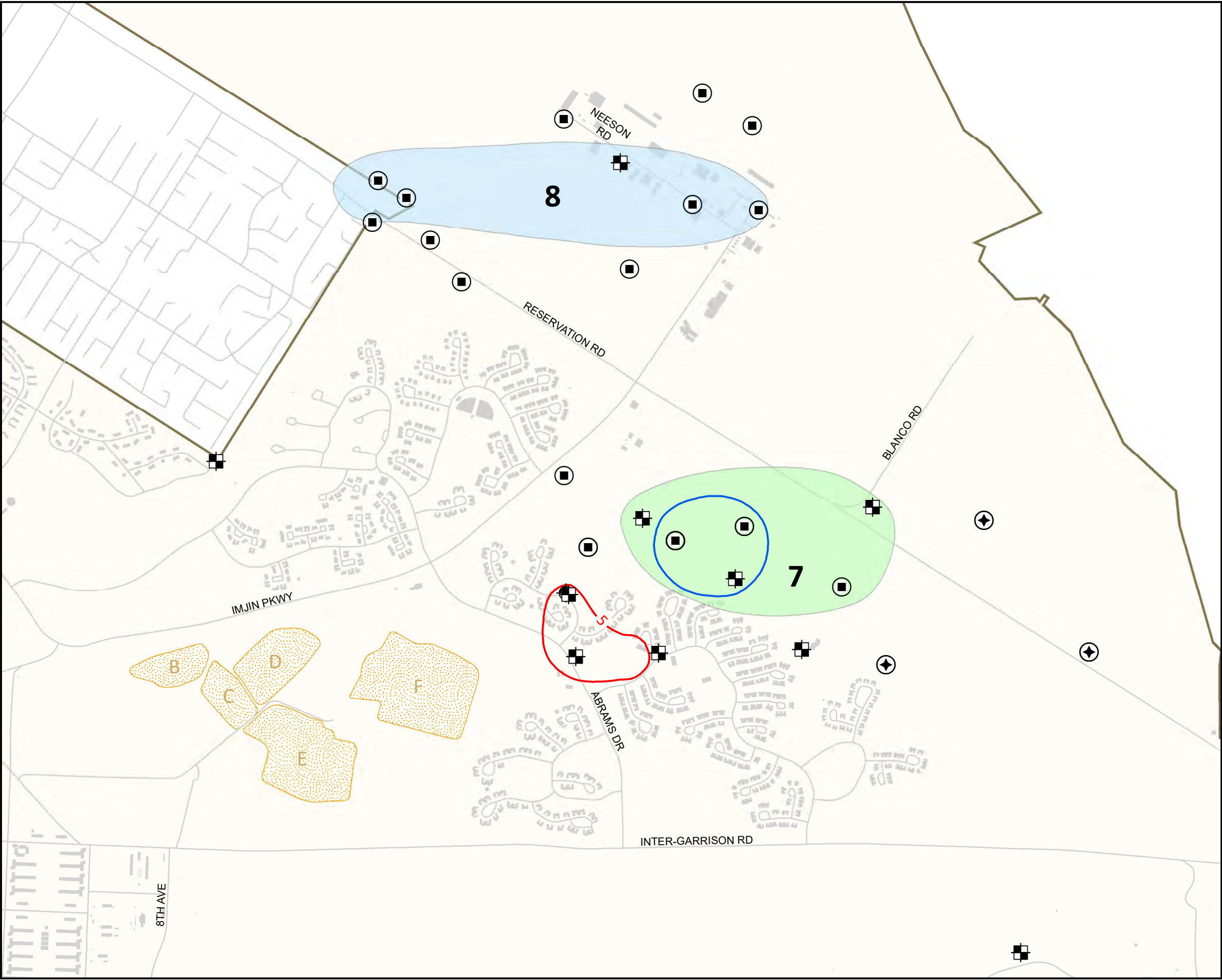
OU2TP Upper 180-Foot Aquifer Hydraulic Zone Map

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 11
Groundwater Remedies and Monitoring at Operable Unit 2,
Sites 2 and 12, and Operable Unit Carbon Tetrachloride.



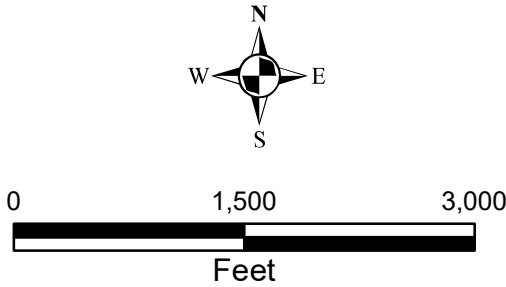
Date: 8/16/2023

Figure: 16



EXPLANATION

- Roads
- Approximate extent of landfill areas (Areas B through F)
- Facilities
- Former Fort Ord
- Well Type and Site**
 - OUCLTP Lower 180-Foot Aquifer - MCWD production well
 - OUCLTP Lower 180-Foot Aquifer - Extraction well
 - OUCLTP Lower 180-Foot Aquifer - Monitoring well
 - OUCLTP Lower 180-Foot Aquifer - Multi-Port well
- 3Q2022 Chemical of Concern (COC) Aquifer Cleanup Level (ACL) Exceedance Contour in µg/L**
 - 0.5 Carbon tetrachloride (CT) plume extent
 - 5 Trichloroethene (TCE) plume extent
- OUCLTP Lower 180-Foot Aquifer Hydraulic Zone**
 - 7
 - 8



OUCLTP Lower 180-Foot Aquifer Hydraulic Zone Map

Quality Assurance Project Plan
Former Fort Ord, California
Volume 1, Appendix A, Revision 11
Groundwater Remedies and Monitoring at Operable Unit 2, Sites 2 and 12, and Operable Unit Carbon Tetrachloride.

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	Average Well Depth ³ (feet)
Sites 2 and 12	A	0	0	0	0	0	0	0	NA
	Upper 180	37	37	16	10	6	21	51	107
	Lower 180	1	1	0	0	0	1	0	179
Subtotal		38	38	16	10	6	22	51	NA
Operable Unit 2	A	58	58	41	41	0	17	180	134
	Upper 180	43	43	29	28	1	14	124	222
	Lower 180	0	0	0	0	0	0	0	NA
Subtotal		101	101	70	69	1	31	304	NA
Operable Unit Carbon Tetrachloride Plume	A	92	92	51	33	18	41	165	101
	Upper 180	30	30	12	8	4	18	40	271
	Lower 180 ⁴	35	31	21	19	2	11	86	433
Subtotal		157	153	84	60	24	70	291	NA
Total Number of Samples Collected Annually									646

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.

³ Value provided is the average depth for the wells that are sampled at the site/aquifer specified. For multiport wells, one value was used - the deepest port sampled

⁴ The total number of wells includes three wells owned by Marina Coast Water District: FO-29, FO-30, and FO-31.

ATTACHMENTS

ATTACHMENT A

Standard Operating Procedures (SOPs)

Sampling SOPs

SOP Number	SOP Title
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 GWTs and OUCTP EISB Extraction Well Sample Handling and Custody Requirements
6	Low Flow Groundwater Quality Parameter Collection
7	Downhole Meter Groundwater Quality Parameter Collection
8	Horiba U-50 series instruction manual
9	Trimble Catalyst DA2
FSOP-001	Fieldwork Documentation
FSOP-002	Sample Management
FSOP-802	Investigation Derived Waste Management

OPERATIONS MANUAL

Westbay MOSDAX Sampler Probe - Model 2531



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: _____

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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). The arm assembly has to be held in place while replacing the face seal 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.

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.

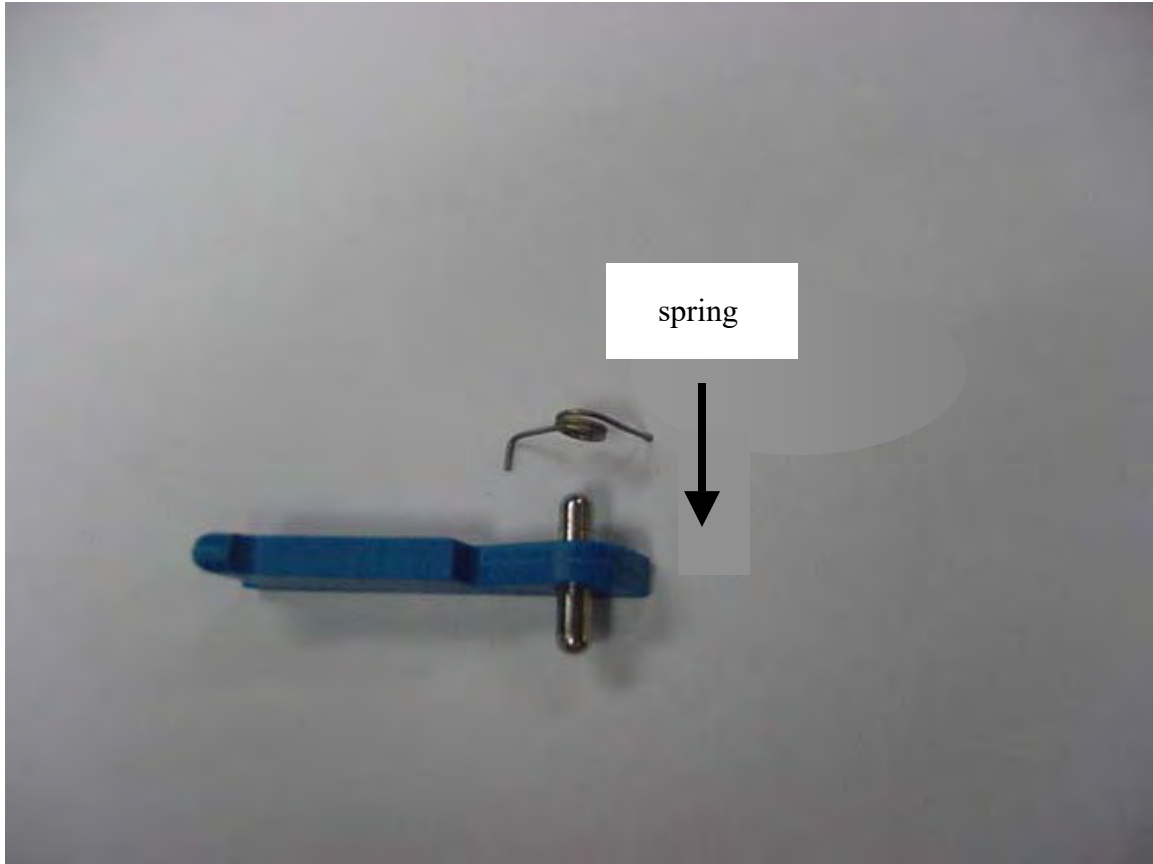


Figure C-2 - Position of spring and pivot in the arm.



Figure C-3 - Placement of arm assembly.

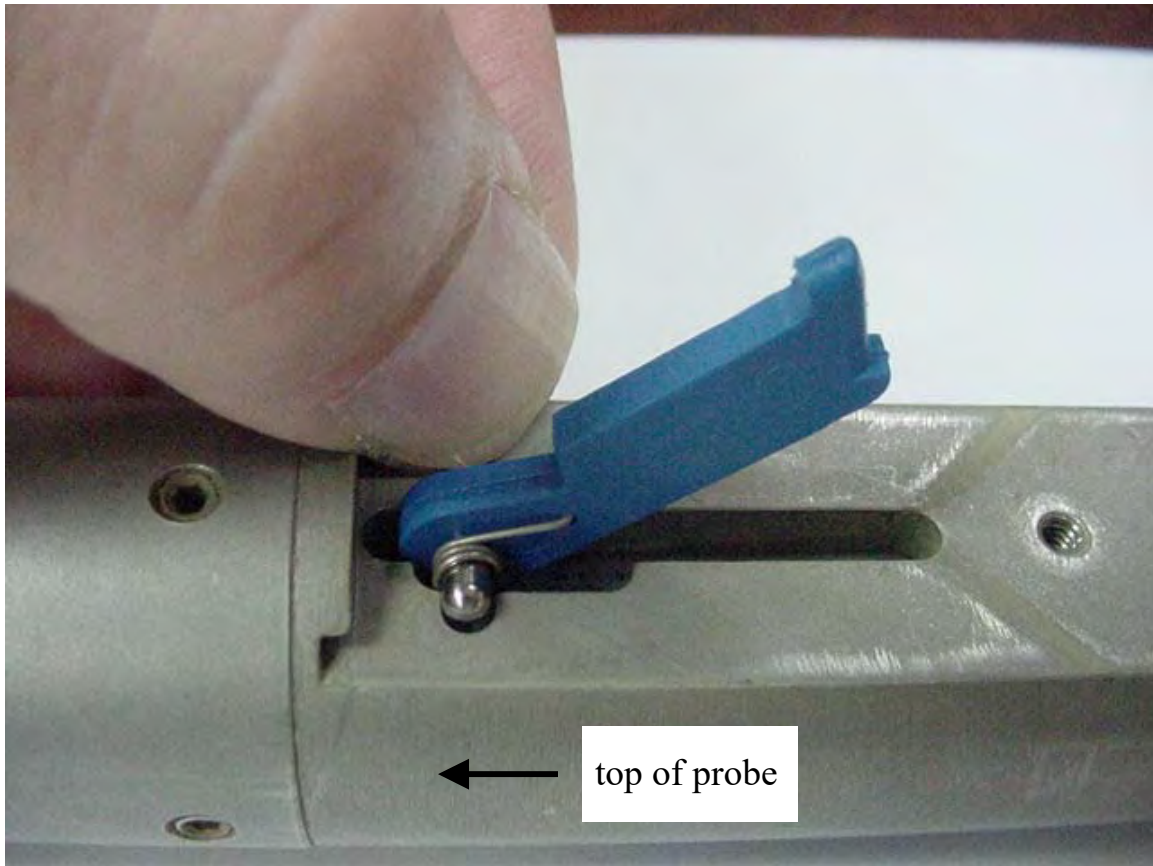
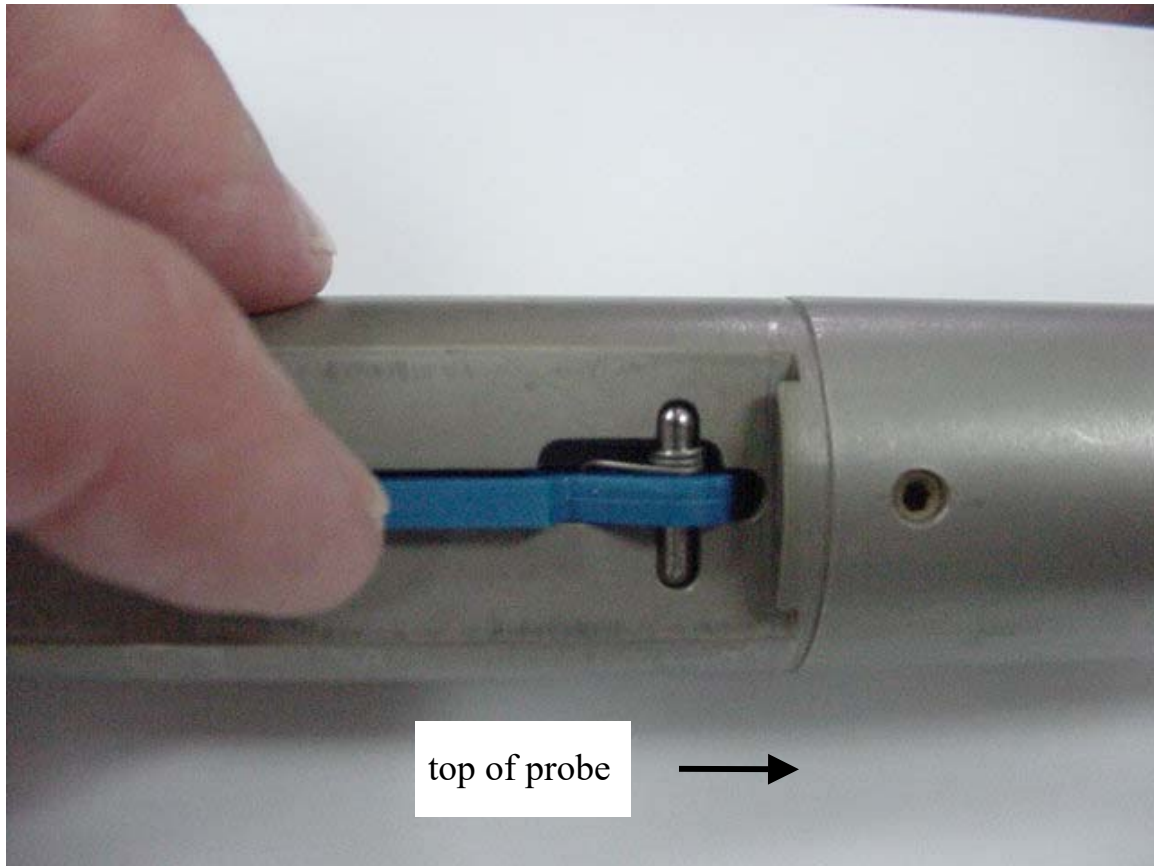


Figure C-4 - Top view of arm and spring placement.



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 MPC1 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.



Date: _____

Start Time: _____ Atm. Rdg: _____

End Time: _____ Atm. Rdg: _____

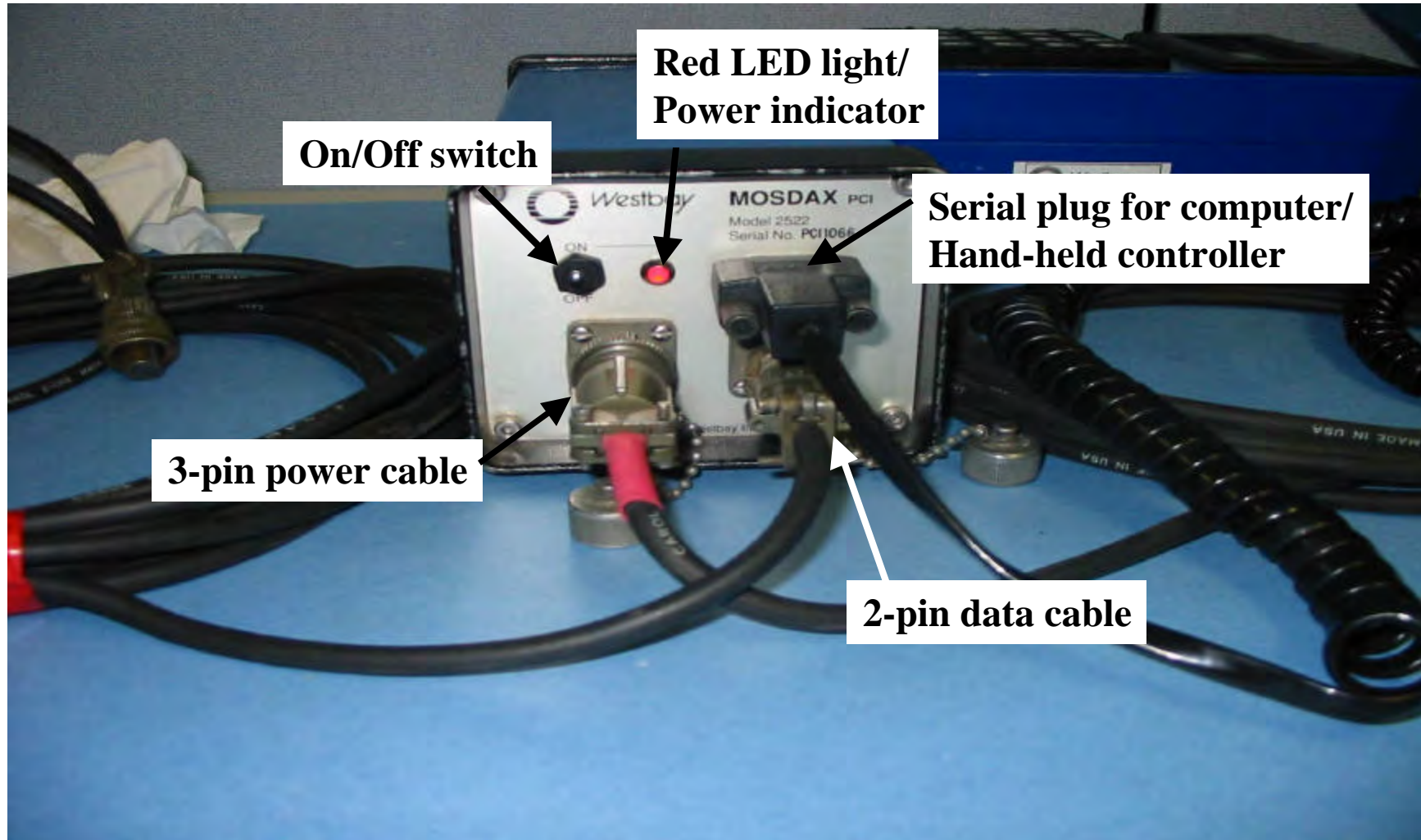
Operators: _____

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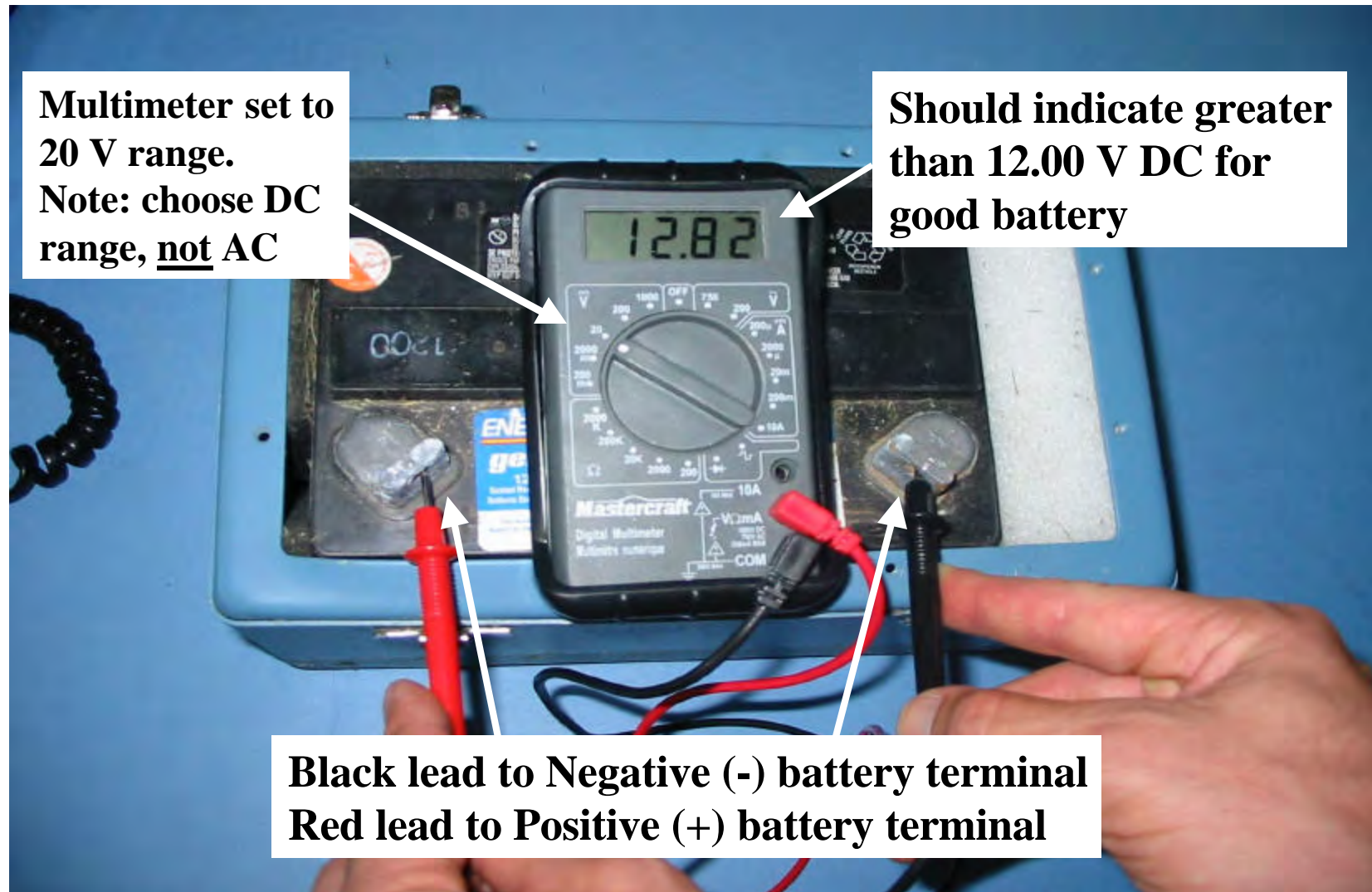
Additional Comments: (pH, turbidity, S.C., etc.)



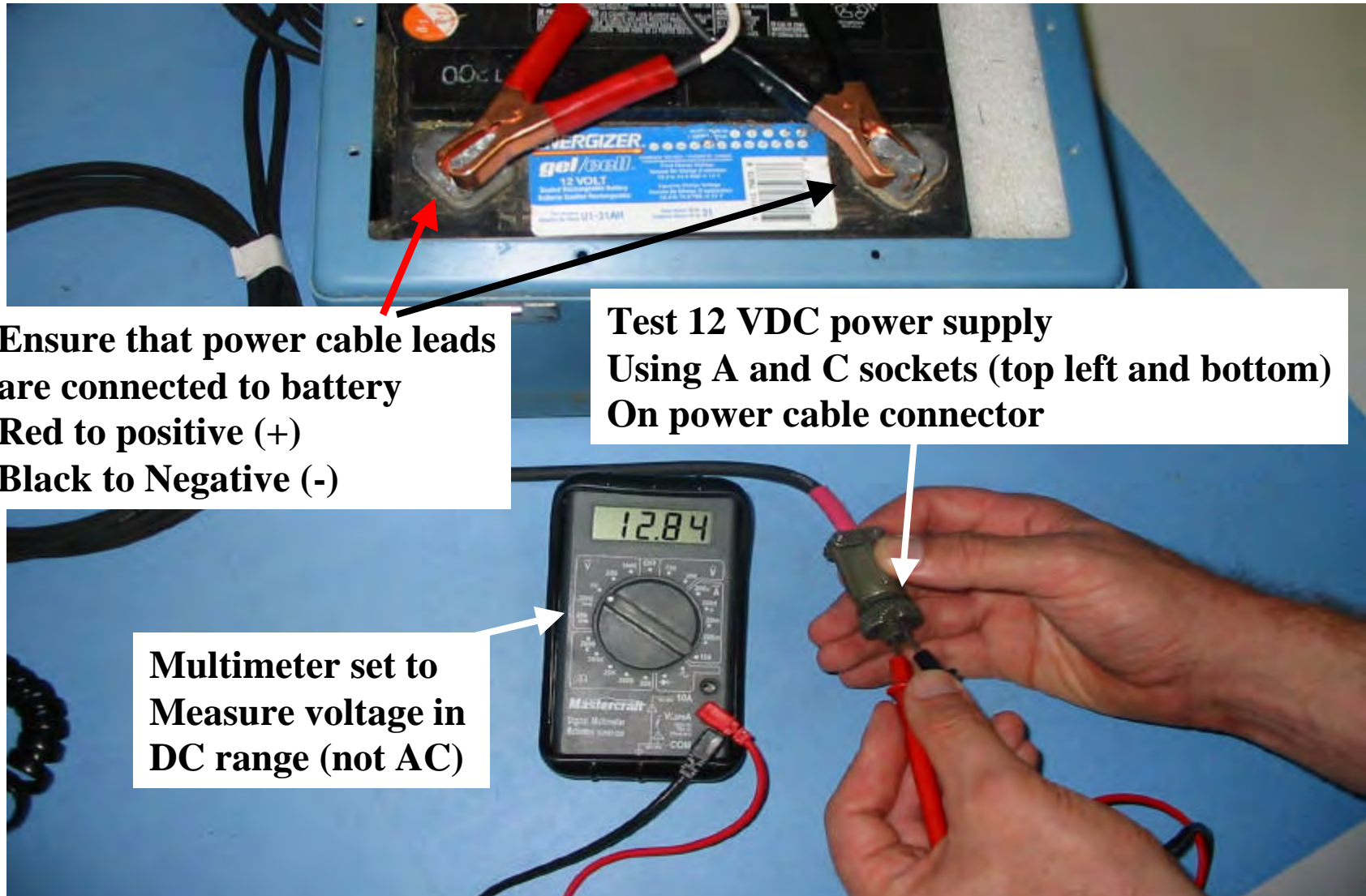
**Pic.1 Computer Interface Units, old and new:
MPCl model 2522 (left) and MAGI model 2536 (right)**



Pic.2 MPCl unit showing typical set-up configuration



Pic.3 Testing 12 VDC Power Supply using Multimeter

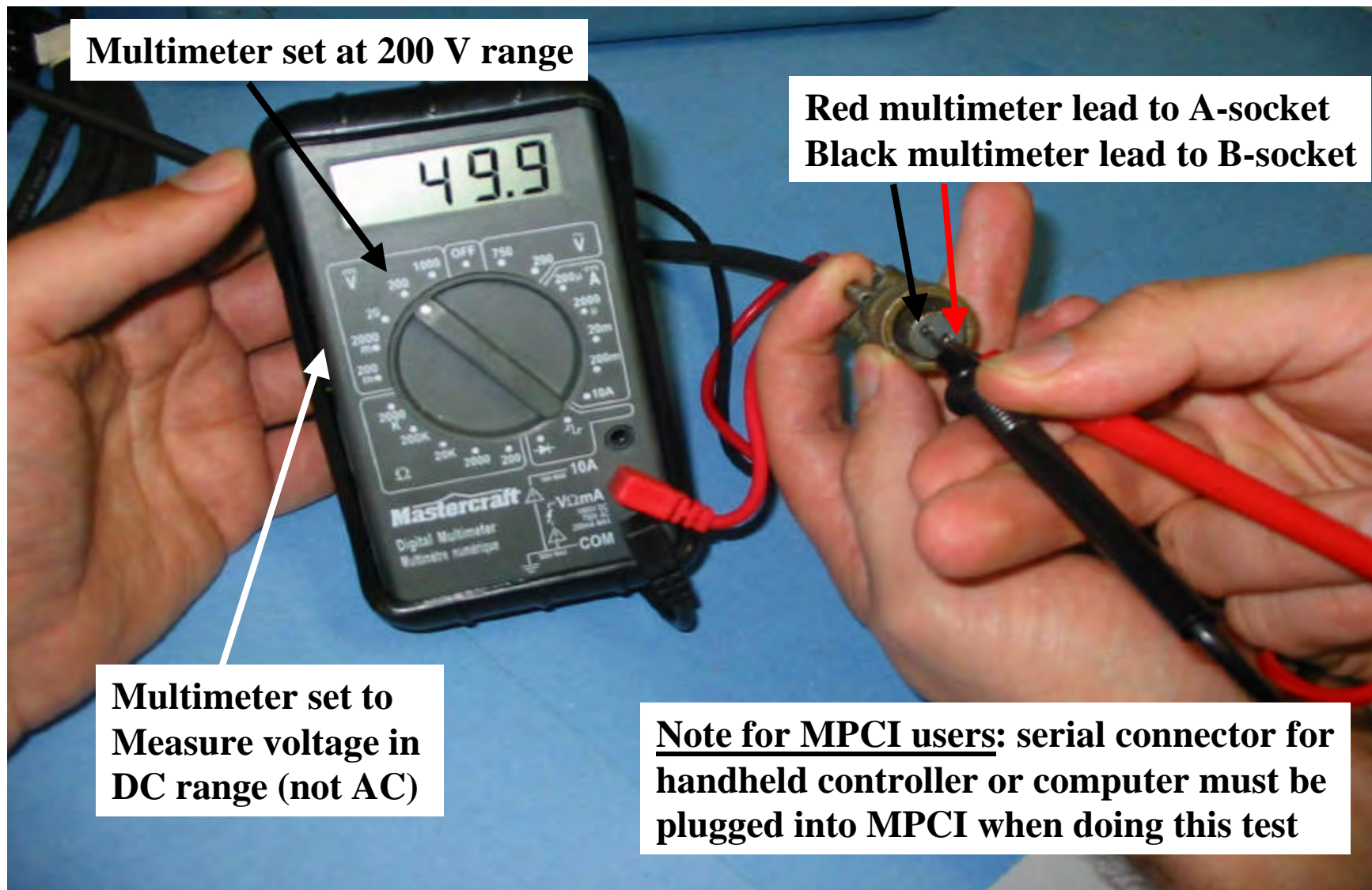


**Ensure that power cable leads
are connected to battery
Red to positive (+)
Black to Negative (-)**

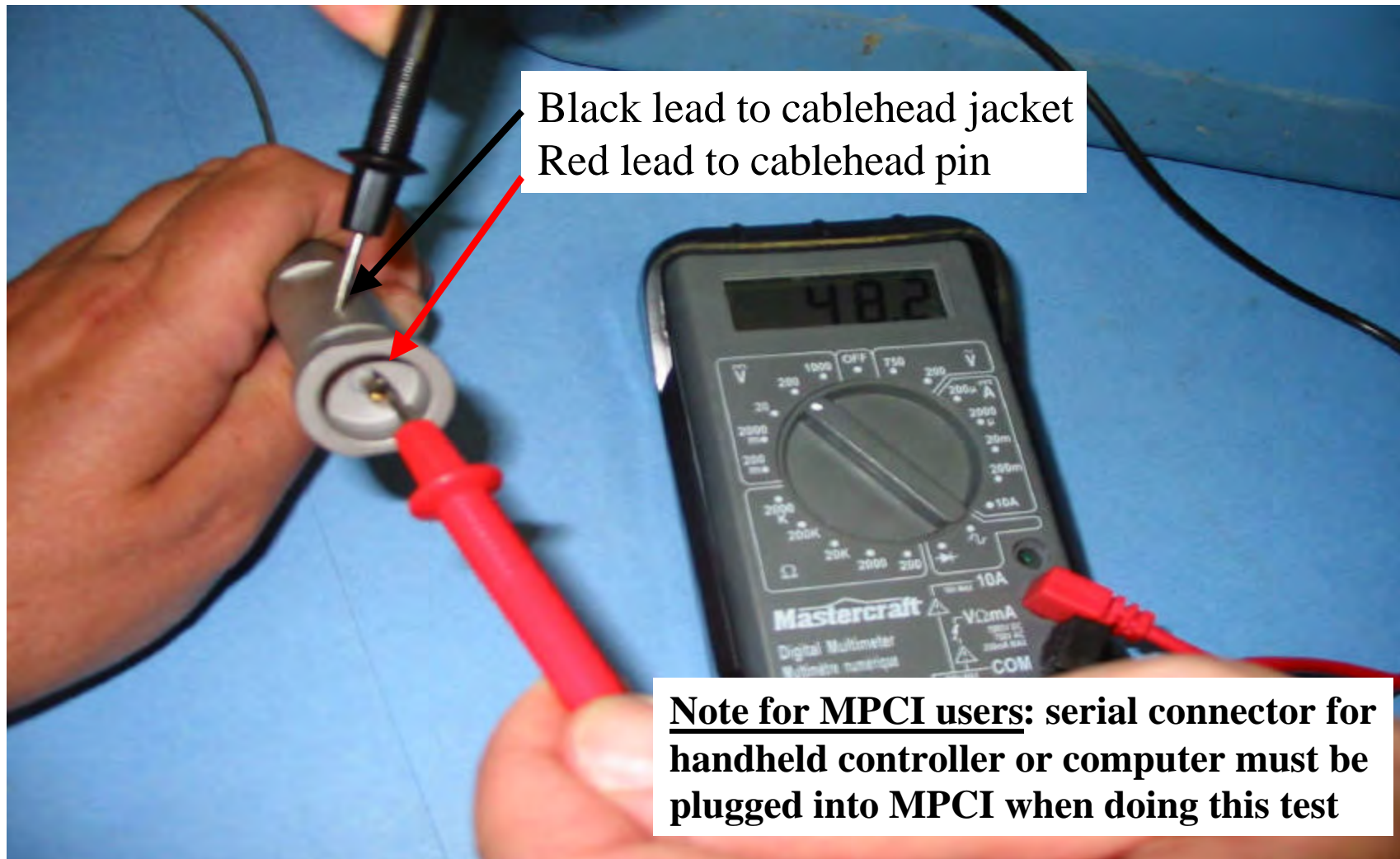
**Test 12 VDC power supply
Using A and C sockets (top left and bottom)
On power cable connector**

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

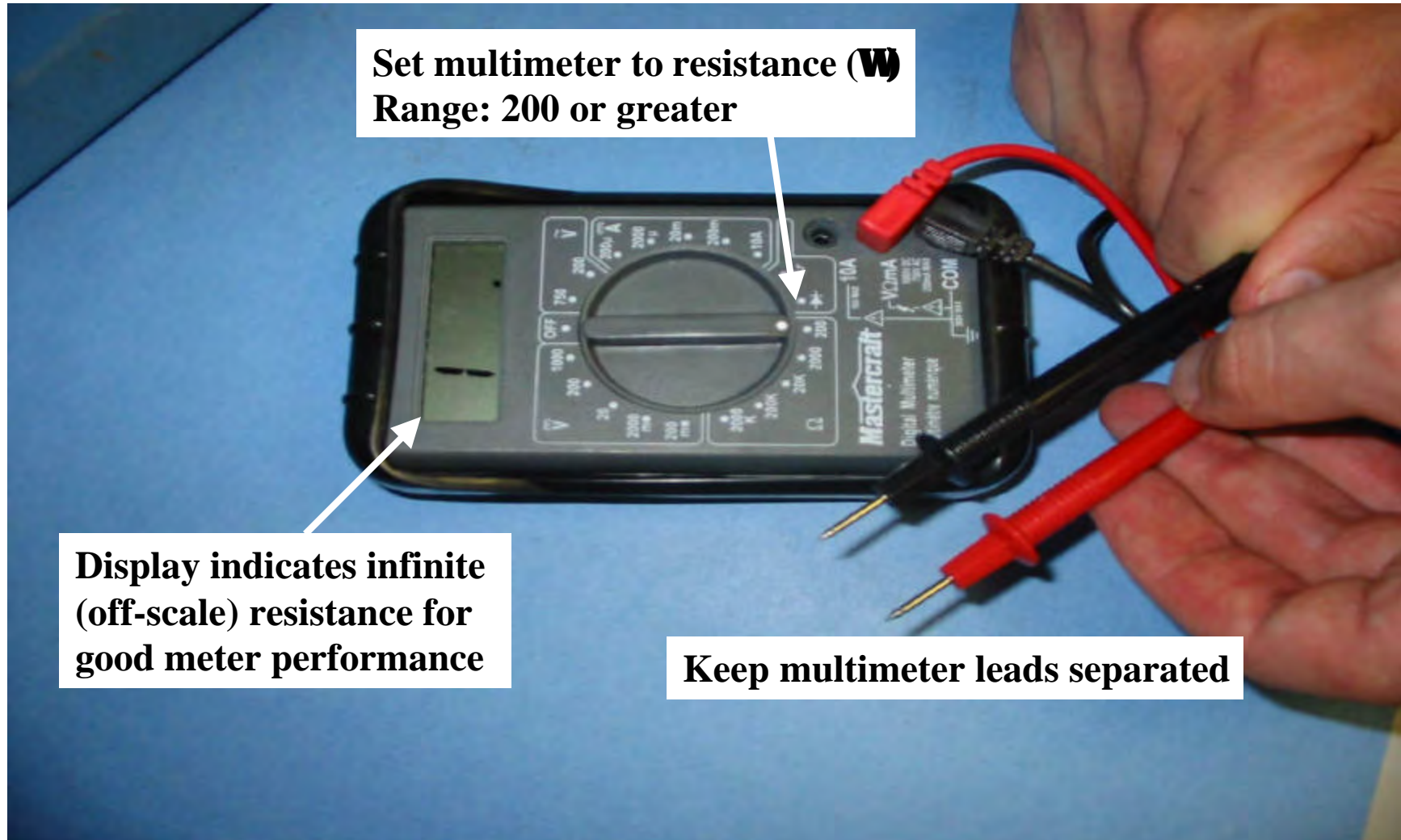
**Pic.4 Testing Power Cable Voltage
(should indicate greater than 12.00 V DC for good battery and cable)**



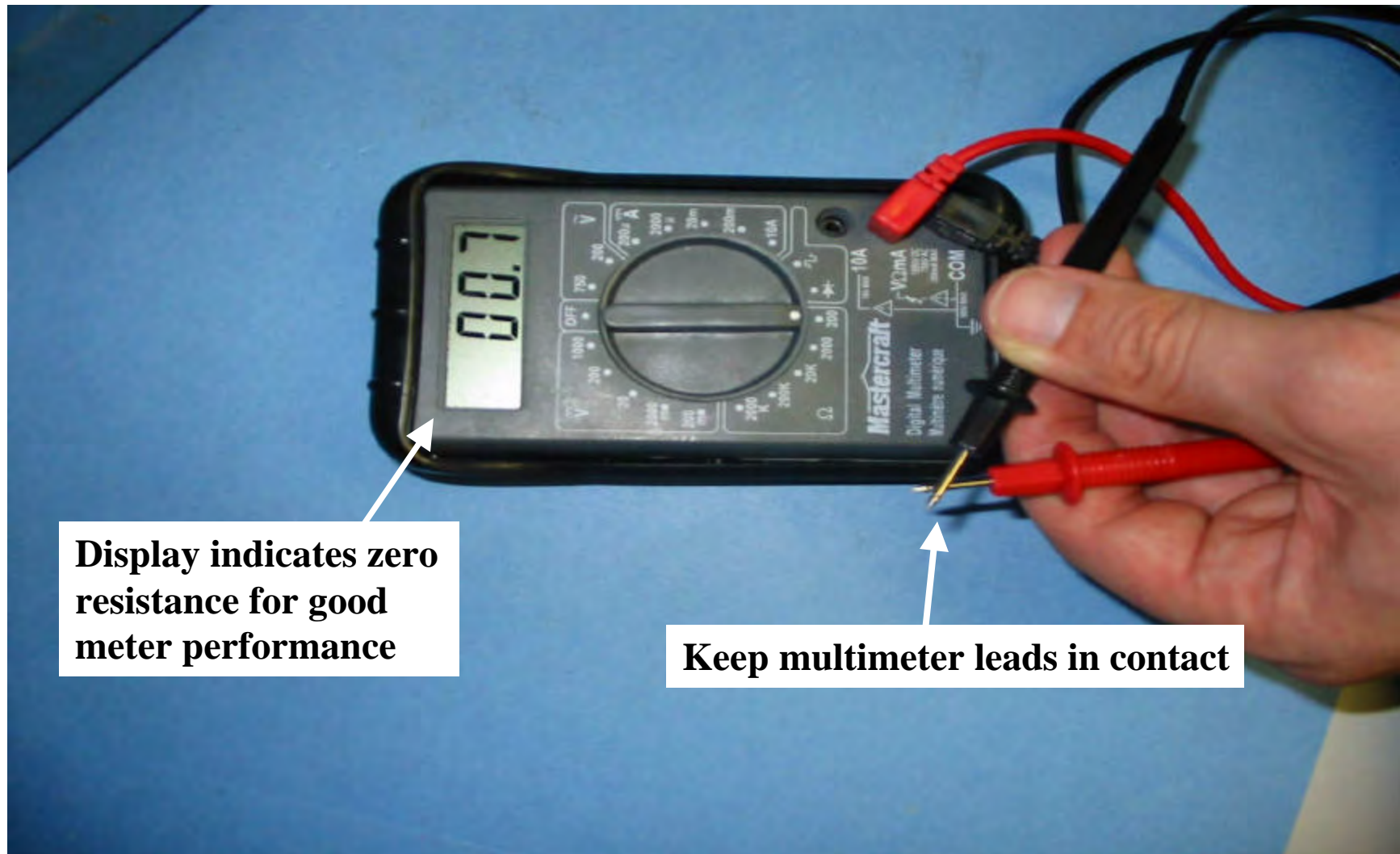
Pic.5 **Testing Power output from MPCII or MAGI using data cable**
(should be greater than 48 V) *Note: MPCII/MAGI must have*
power 'on' and be connected to power supply.



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



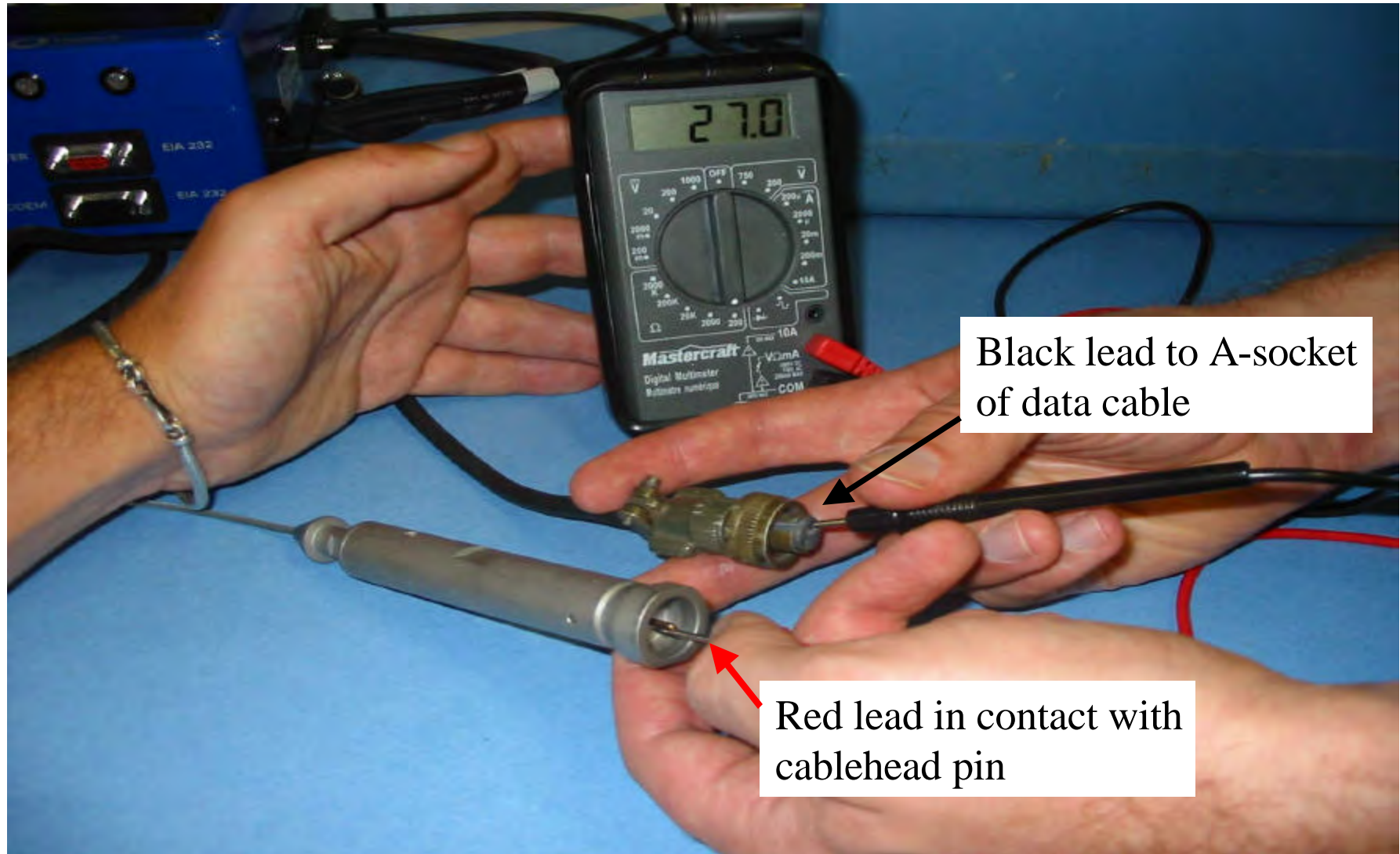
Pic.7 Test multimeter “open” resistance



Display indicates zero resistance for good meter performance

Keep multimeter leads in contact

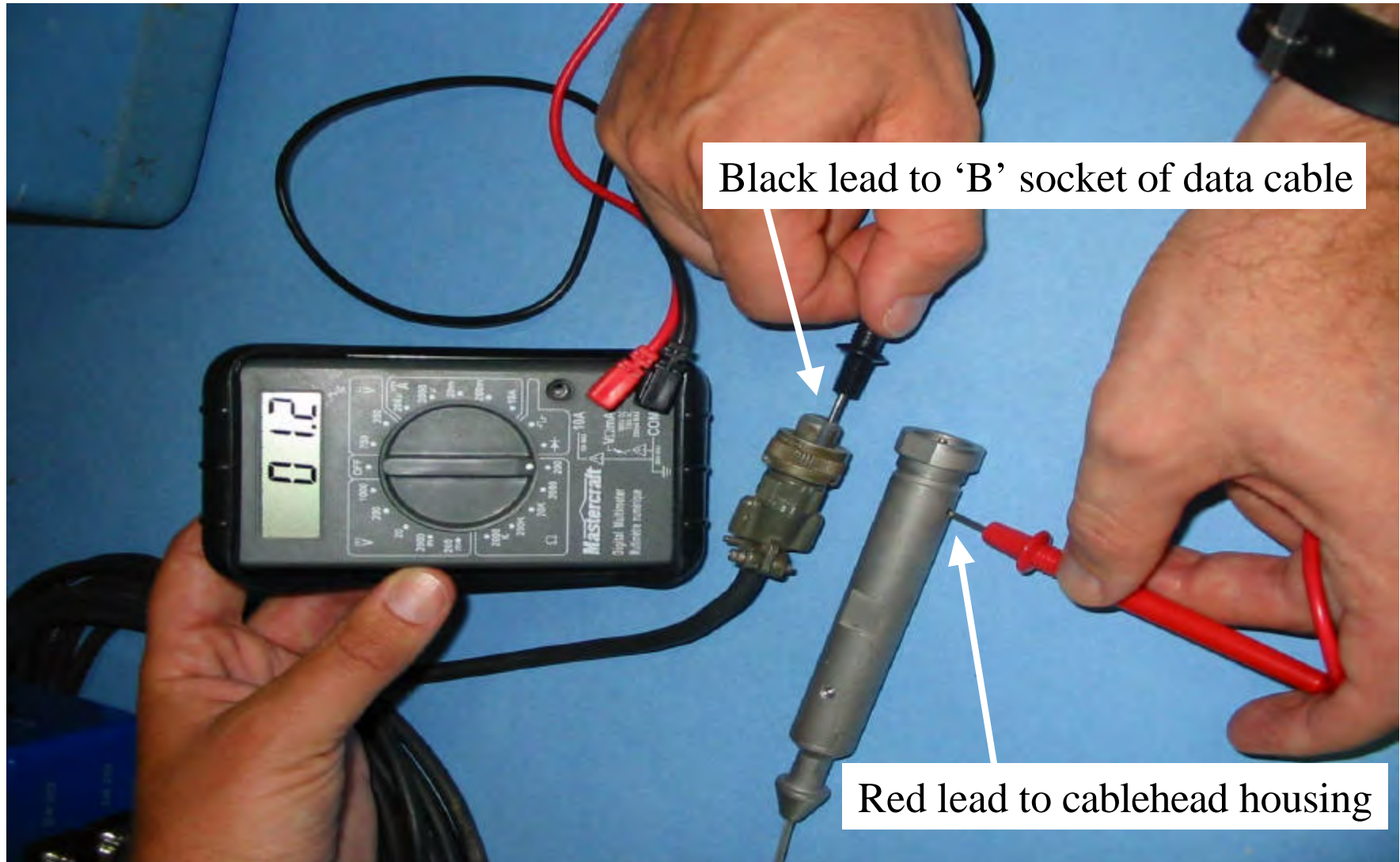
Pic.8 Test multimeter “closed” resistance



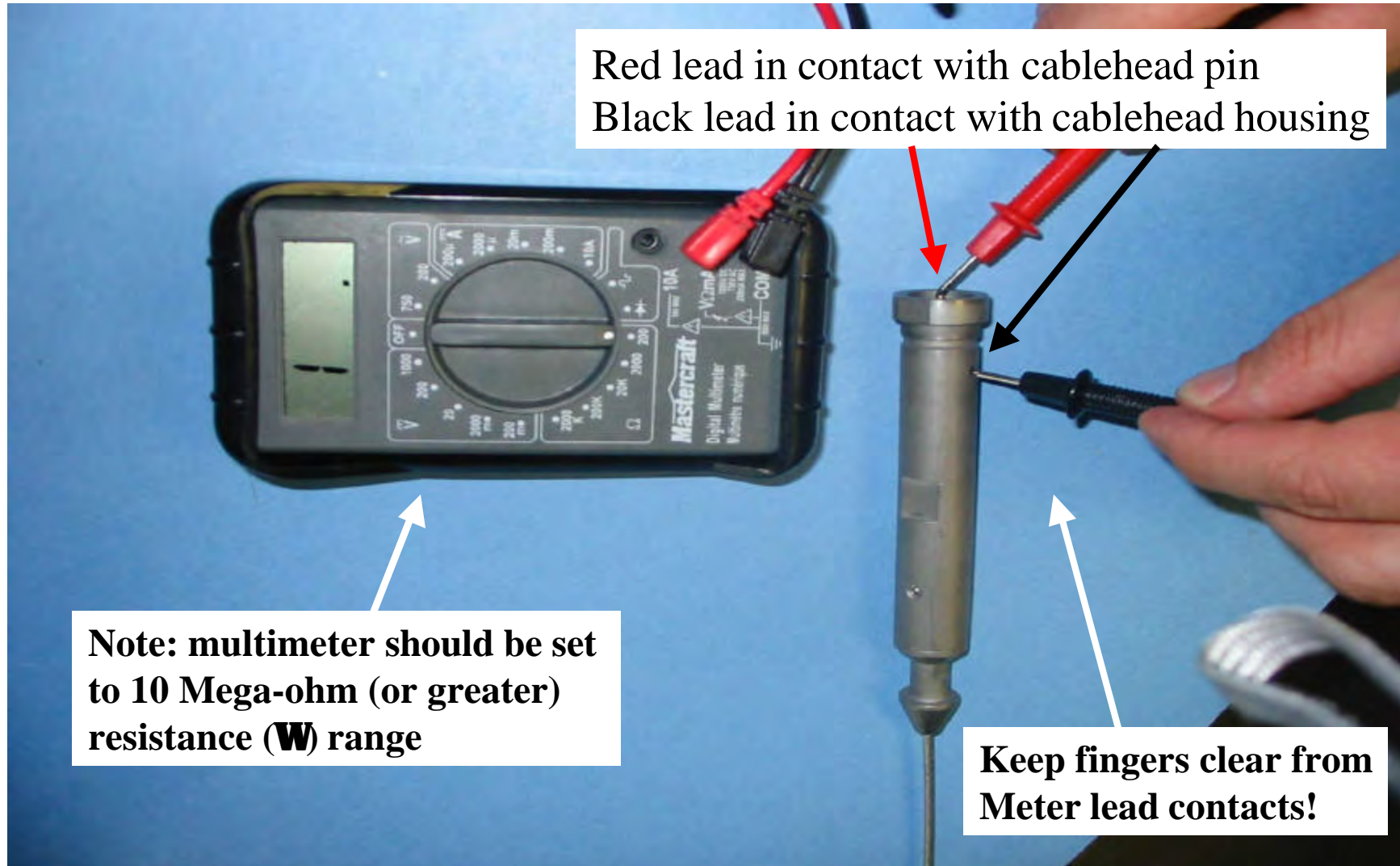
Black lead to A-socket
of data cable

Red lead in contact with
cablehead pin

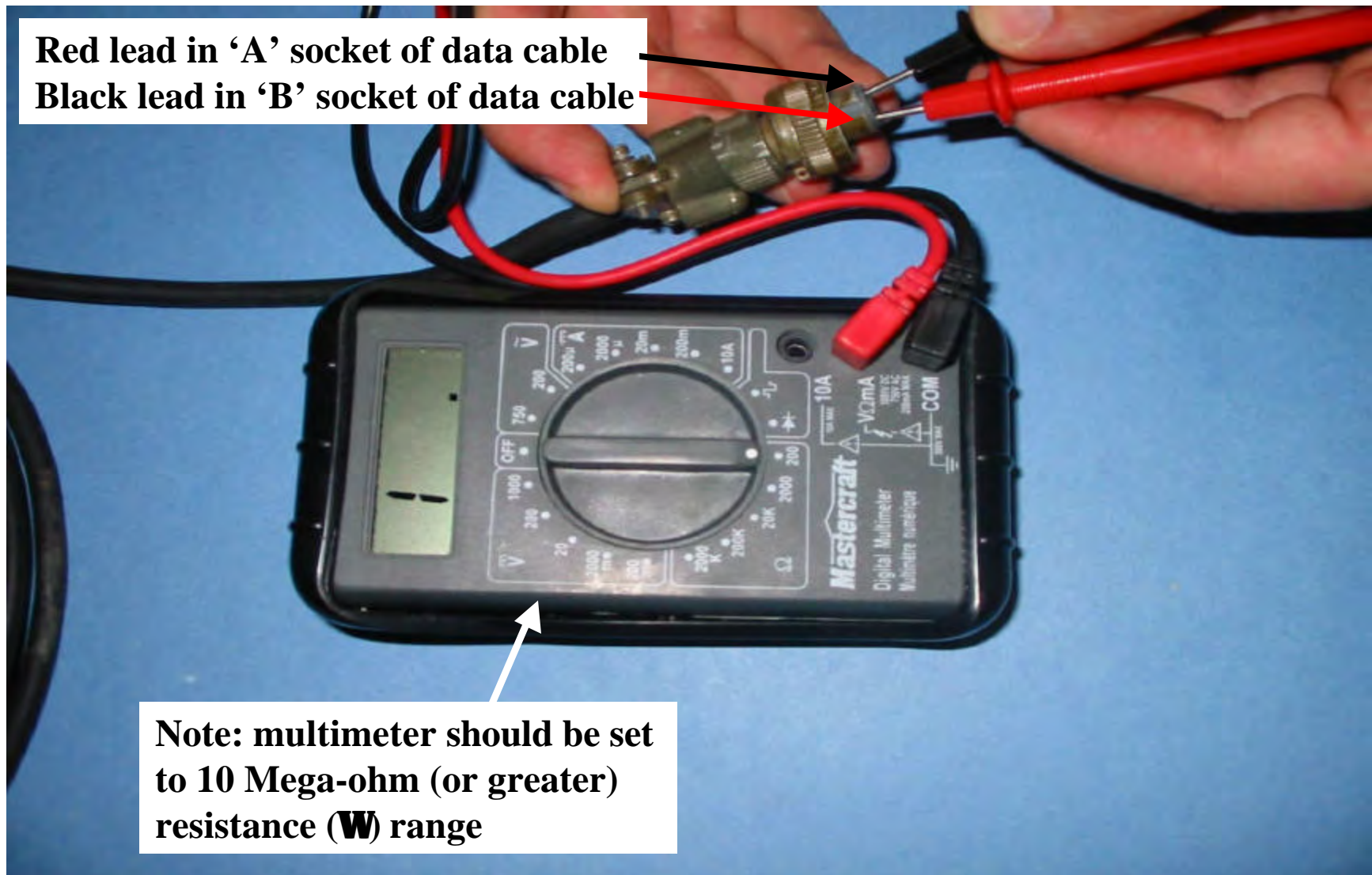
Pic.9 Test wireline 'A-A' resistance (approx. 27 Ω /1000 ft)



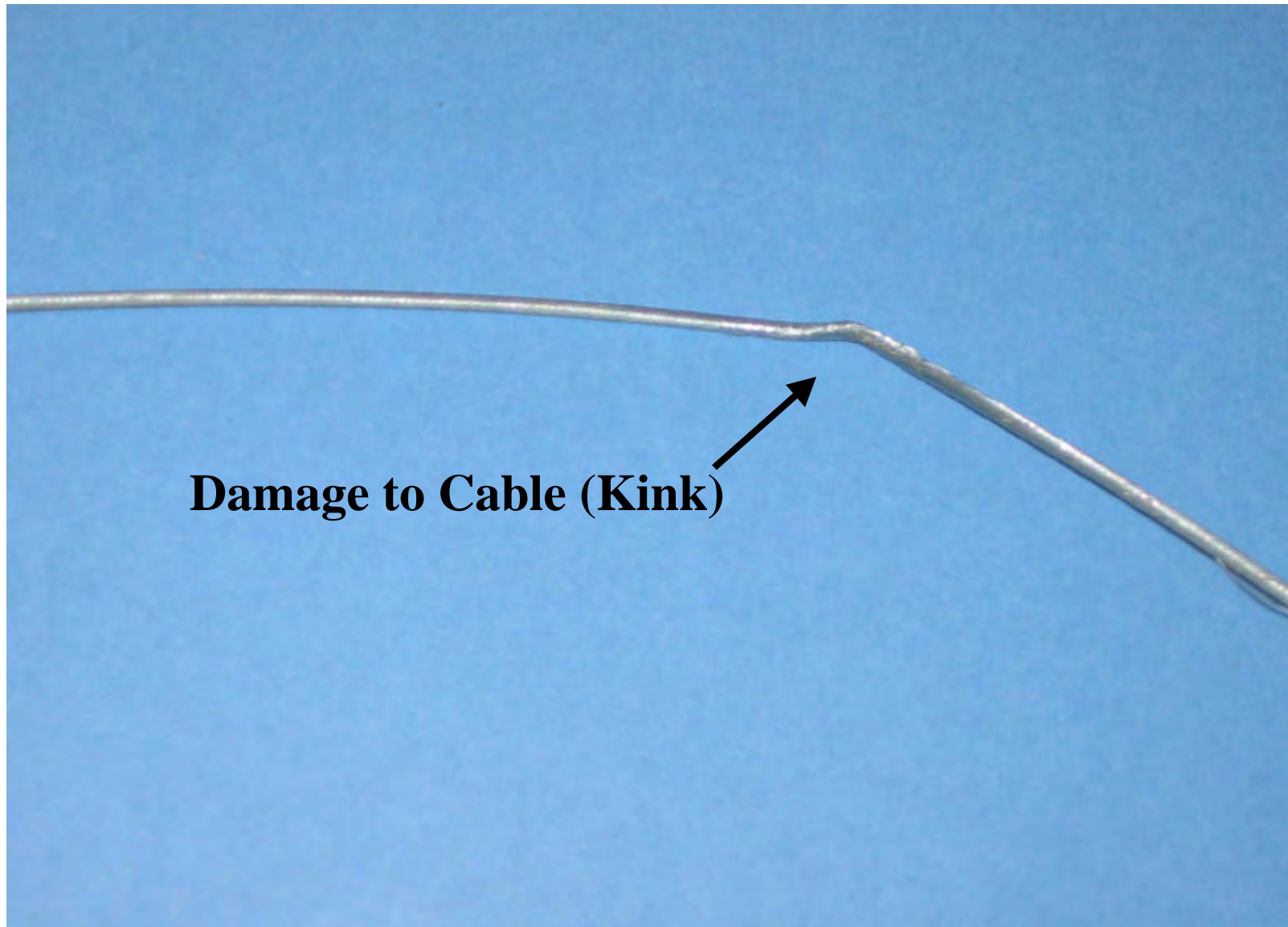
Pic.10 Test wireline 'B-B' resistance (should be less than 'A-A')



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



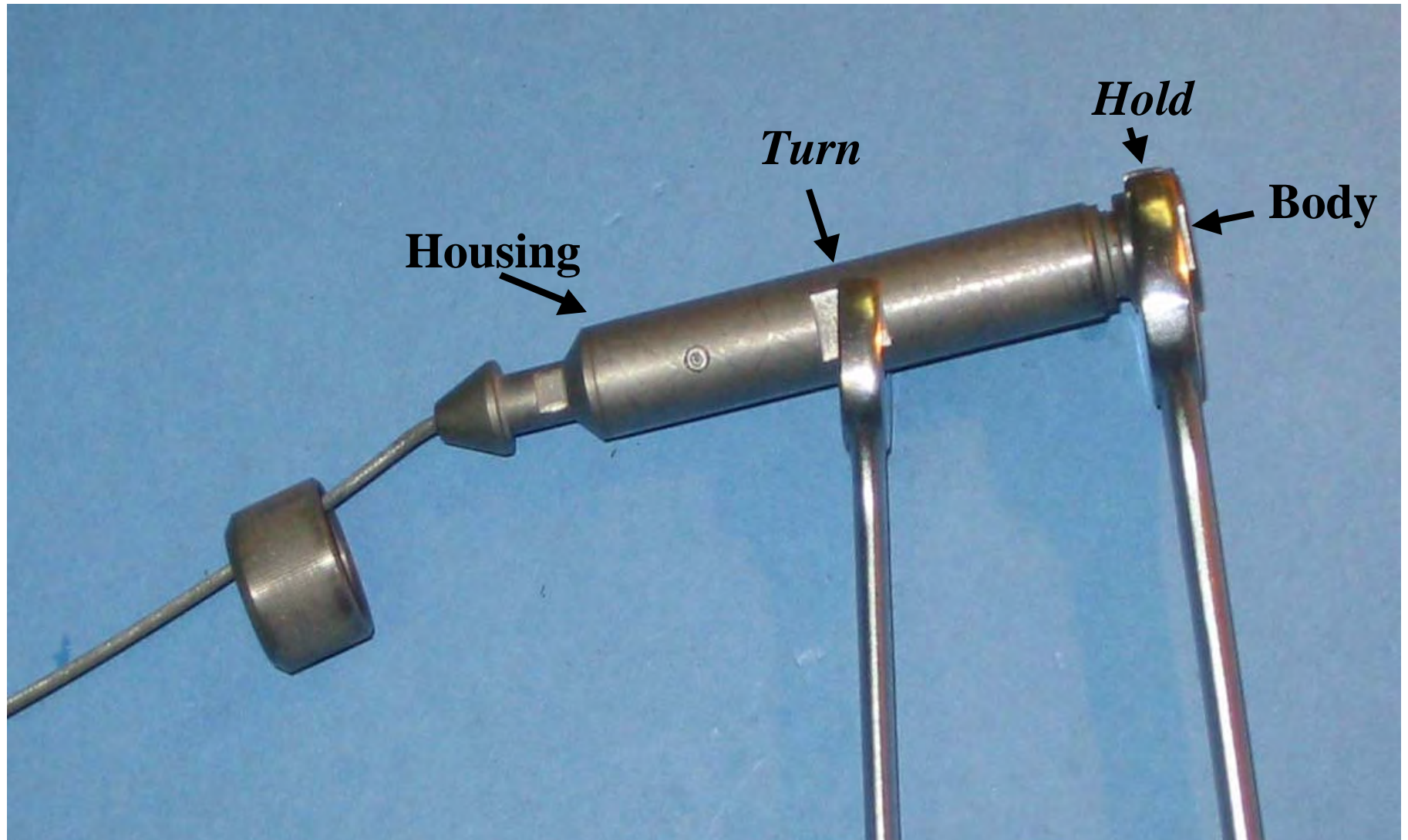
**Pic.11 Test wireline 'A-B' resistance at data cable
(should be off-scale)**



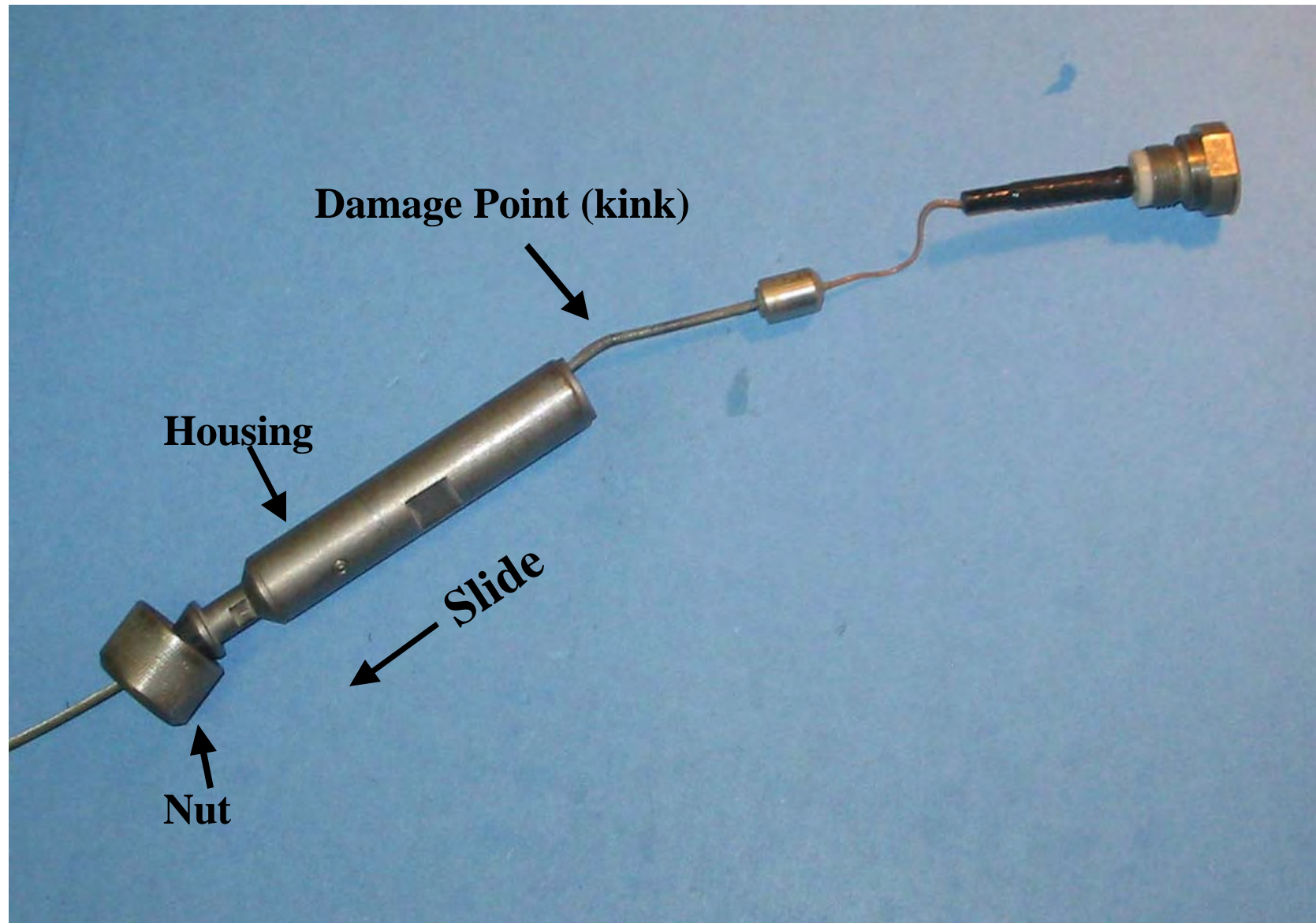
Pic.1 Identification of Cable Damage



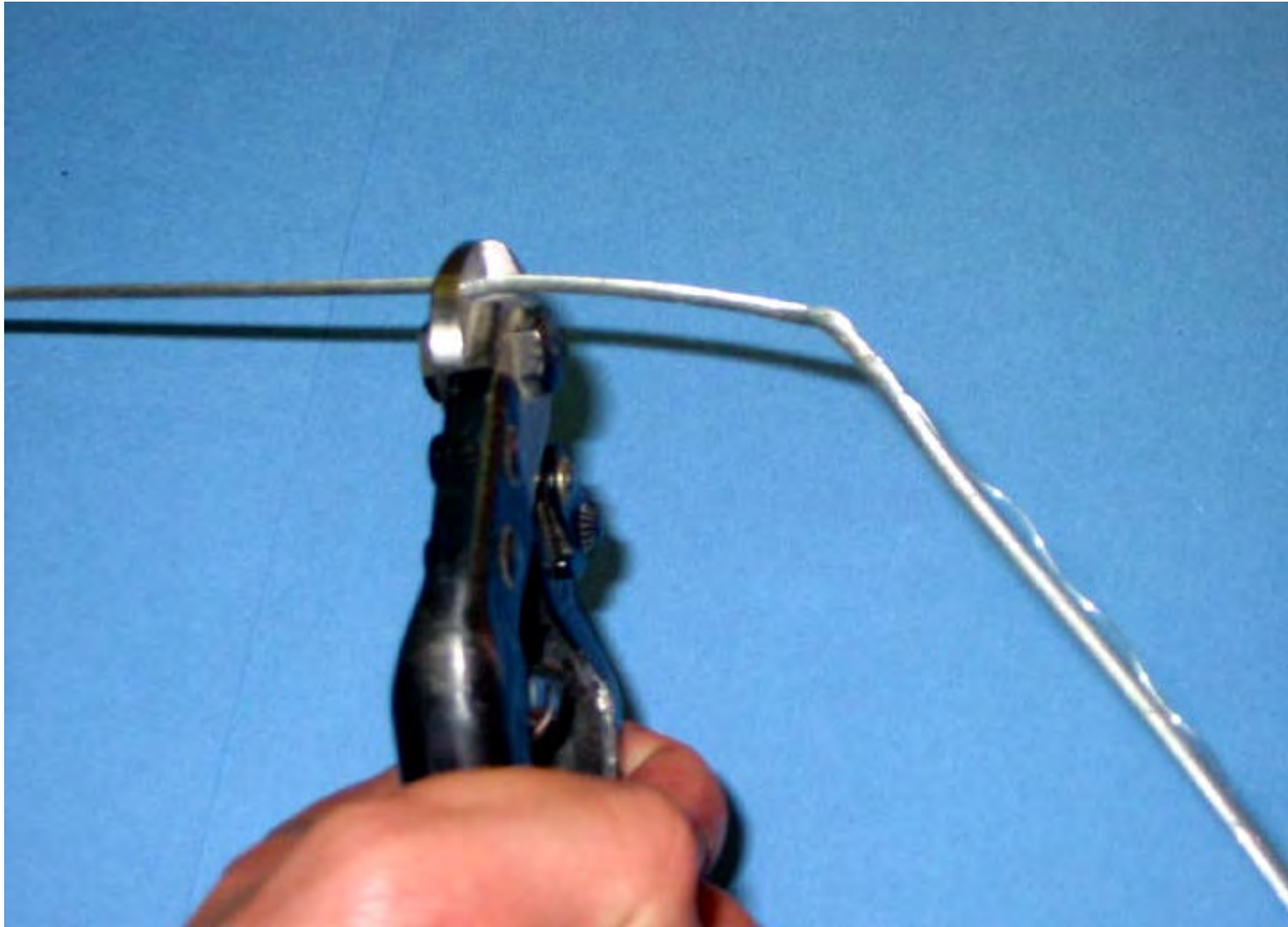
Pic.2 Cablehead Disassembly (1): Loosen set Screws



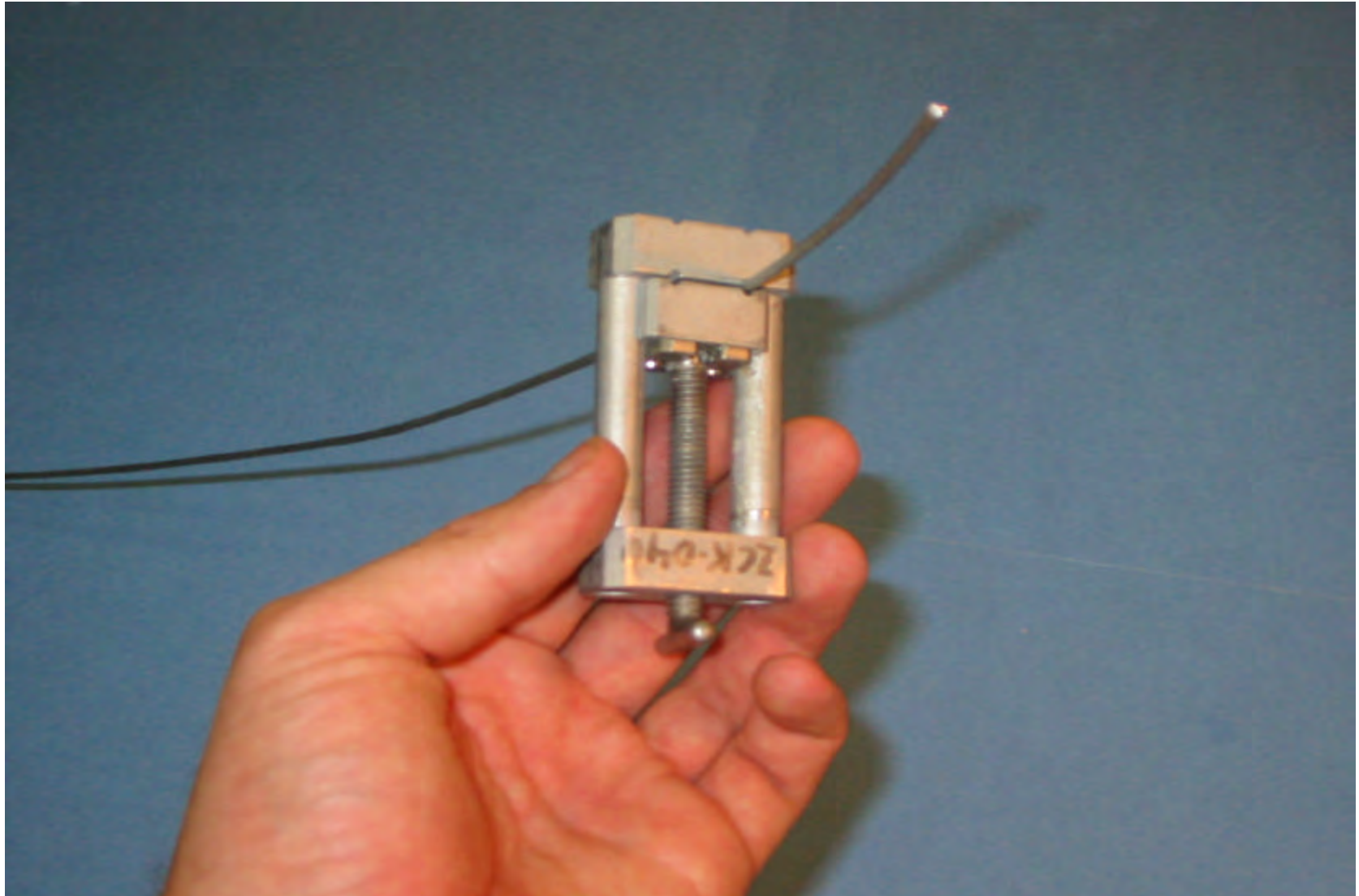
Pic.3 Cablehead Disassembly(2): Unscrew Housing From Body



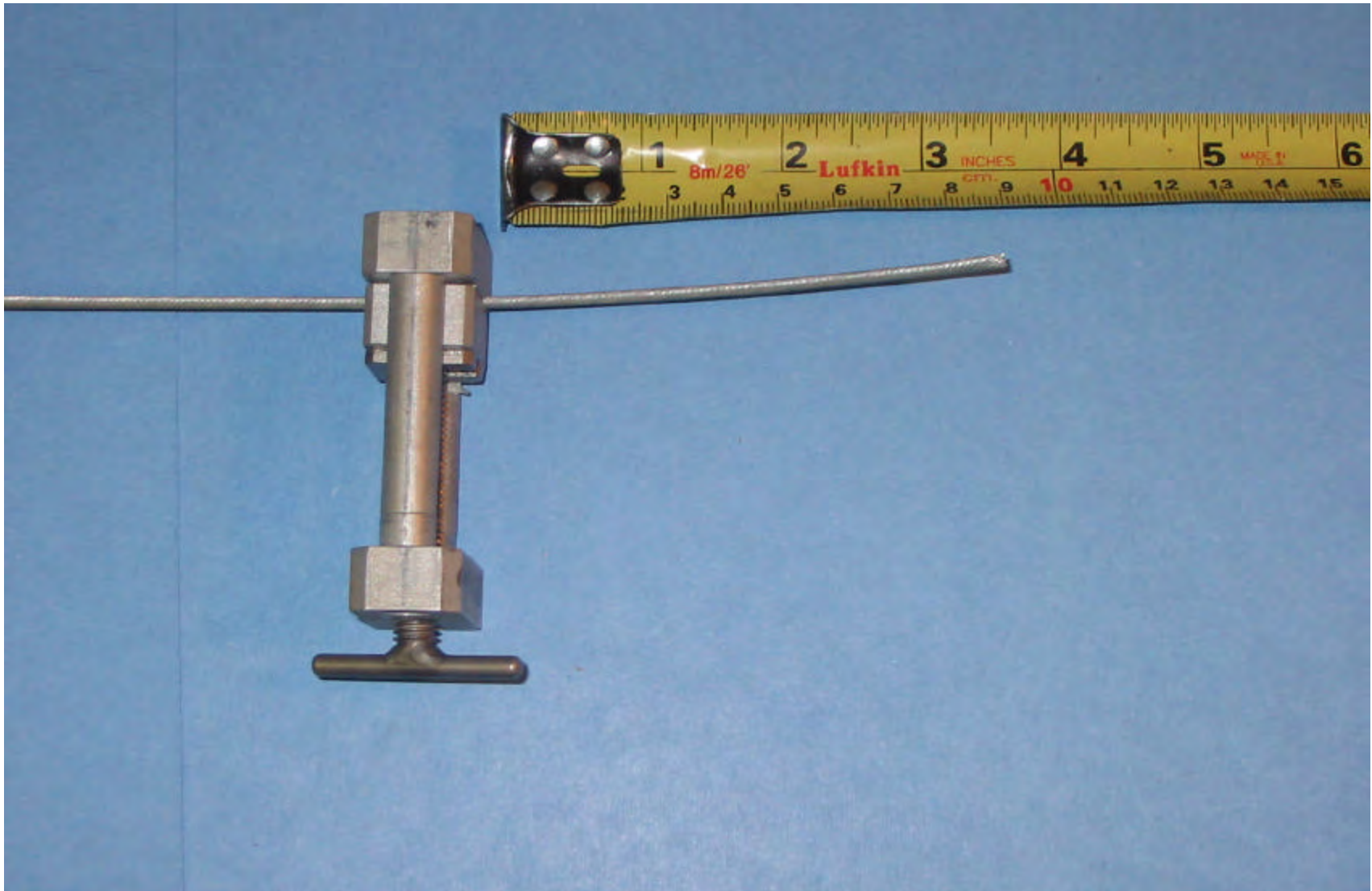
**Pic.4 Cablehead Disassembly(3):
Slide Housing and Cablehead Nut Past Damage Point**



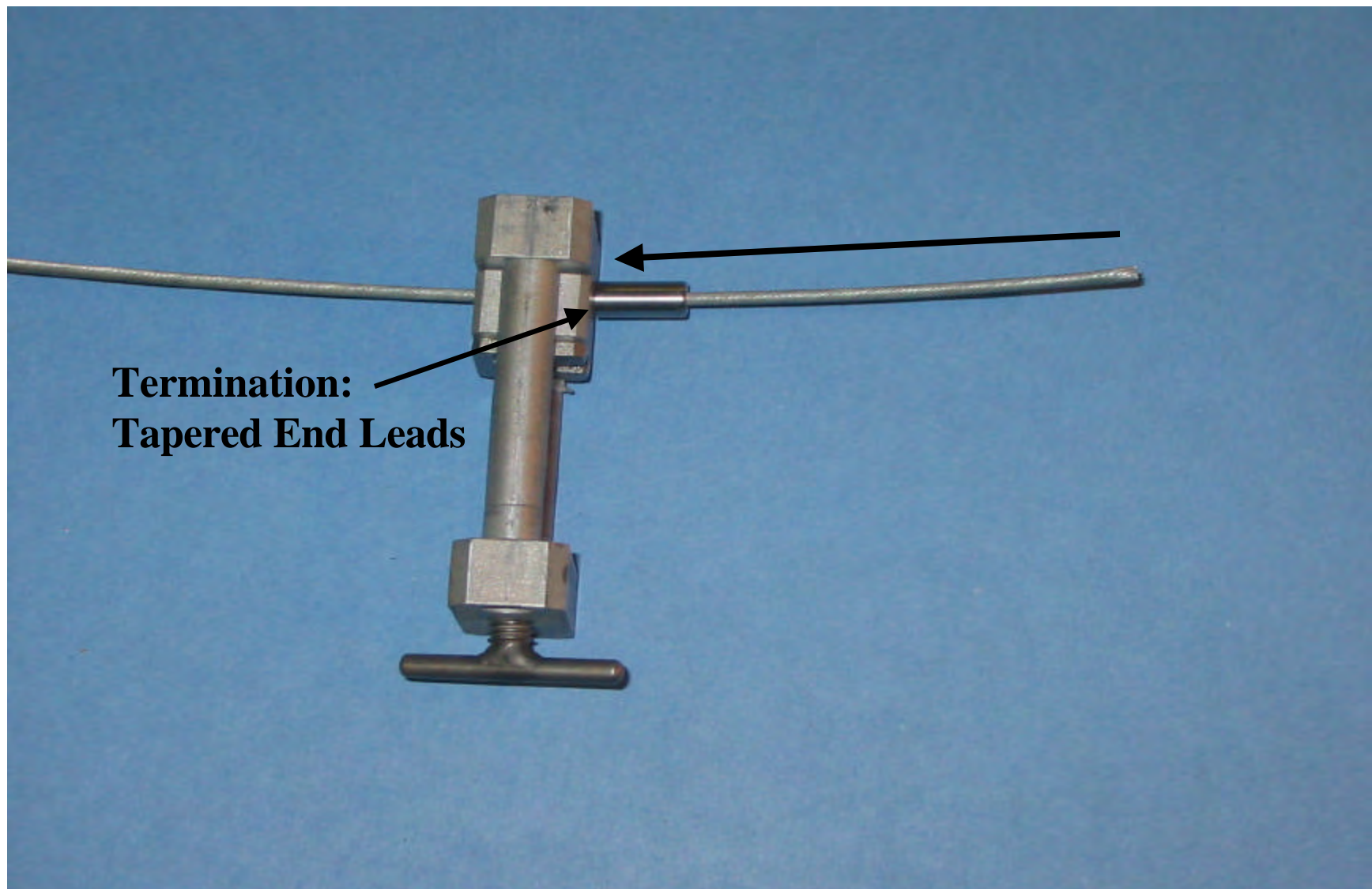
Pic.5 Cut Cable above Damage Point



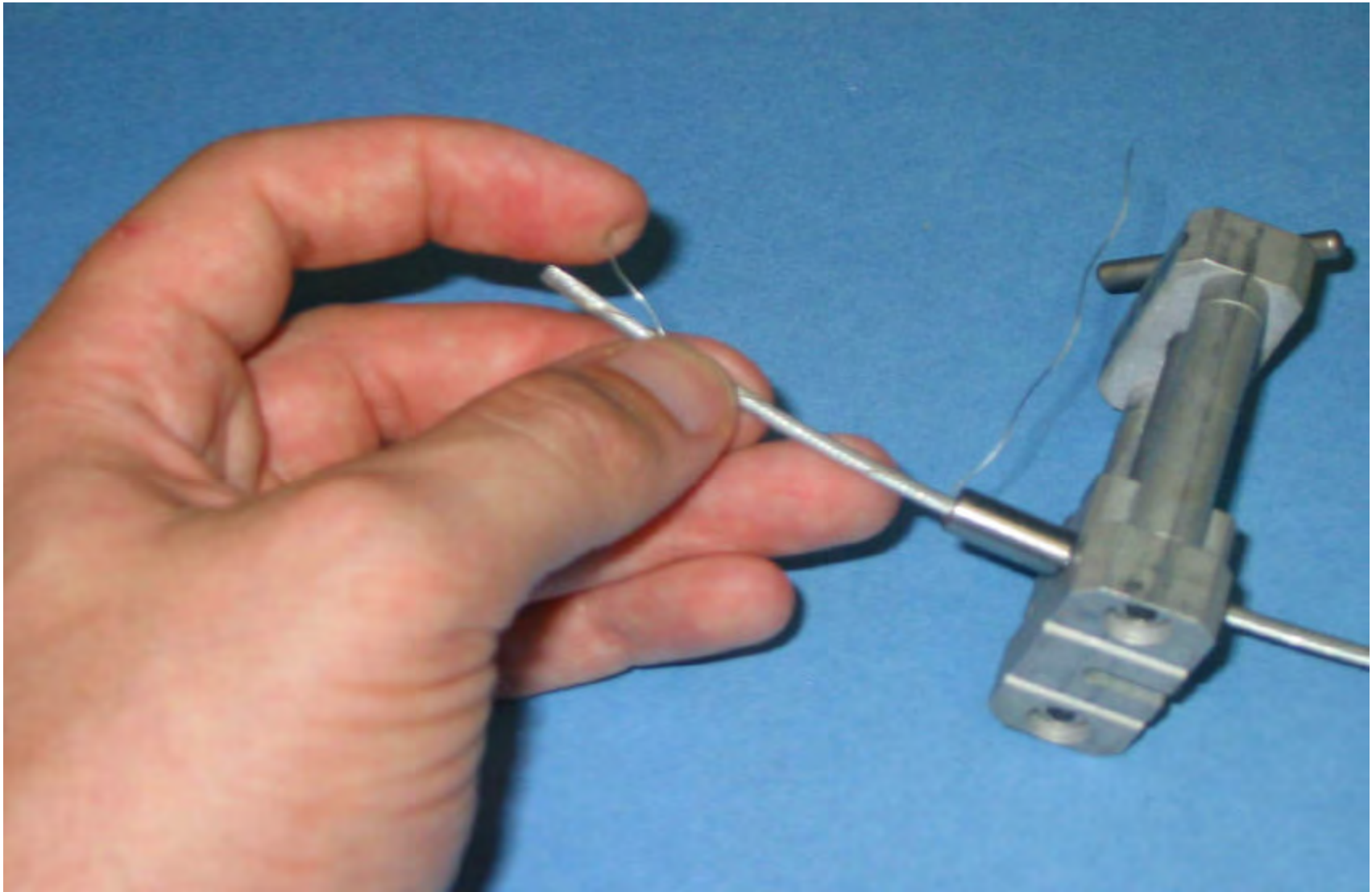
Pic.6a Clamp Cable in Termination Jig



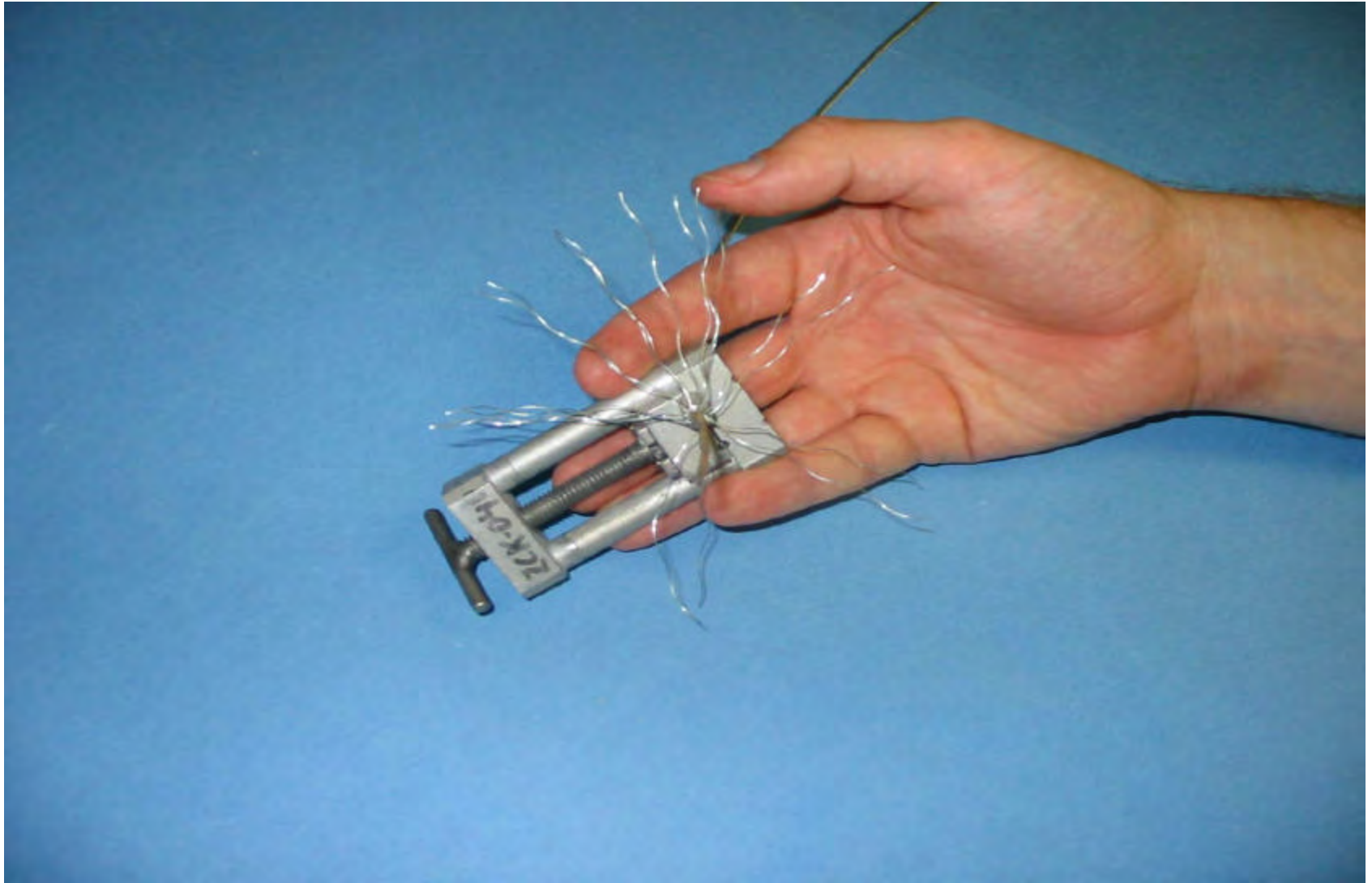
Pic.6b Leave 3.5 inches Cable Exposed



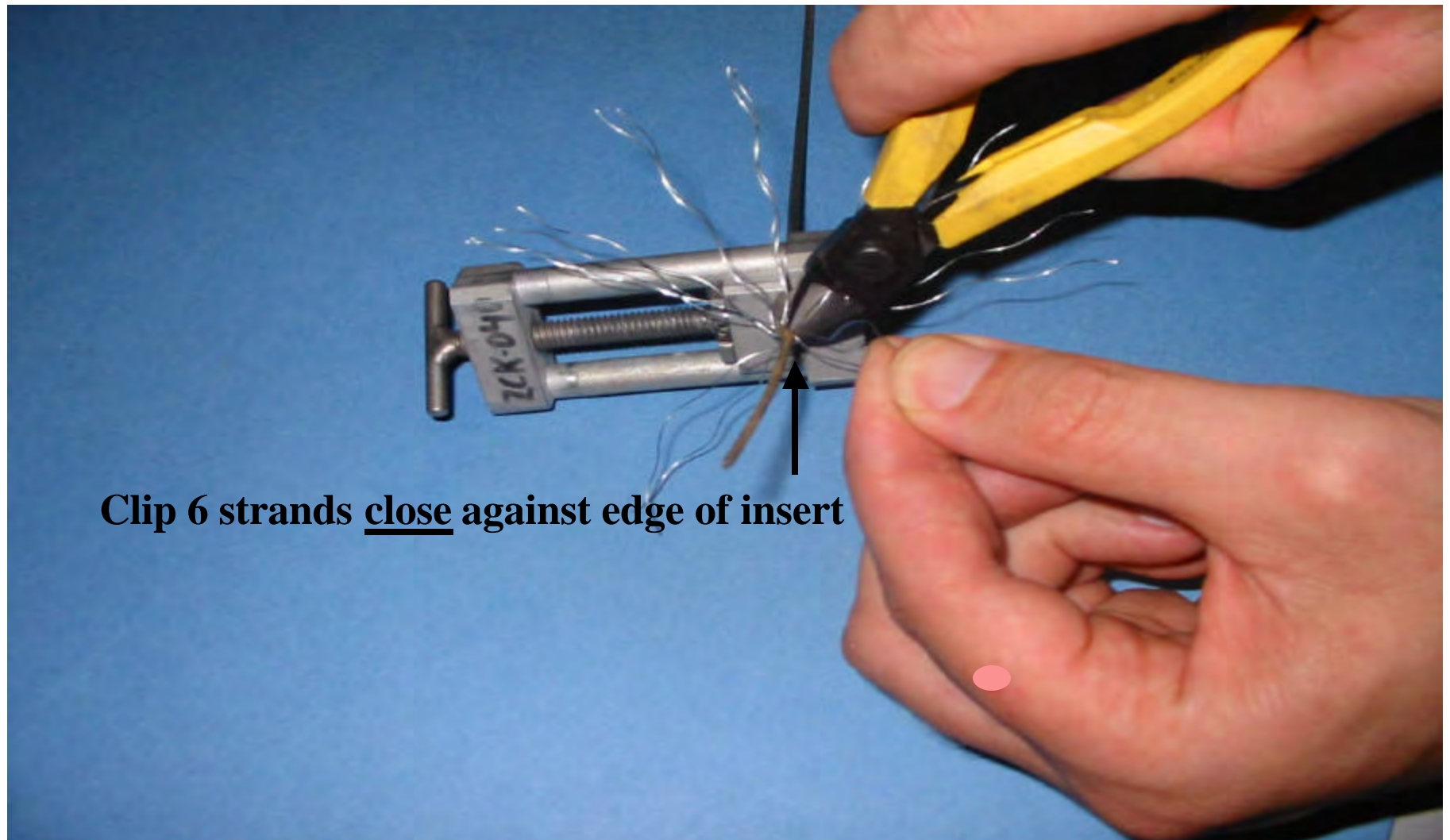
Pic.6c Slide Termination Insert Over Cable



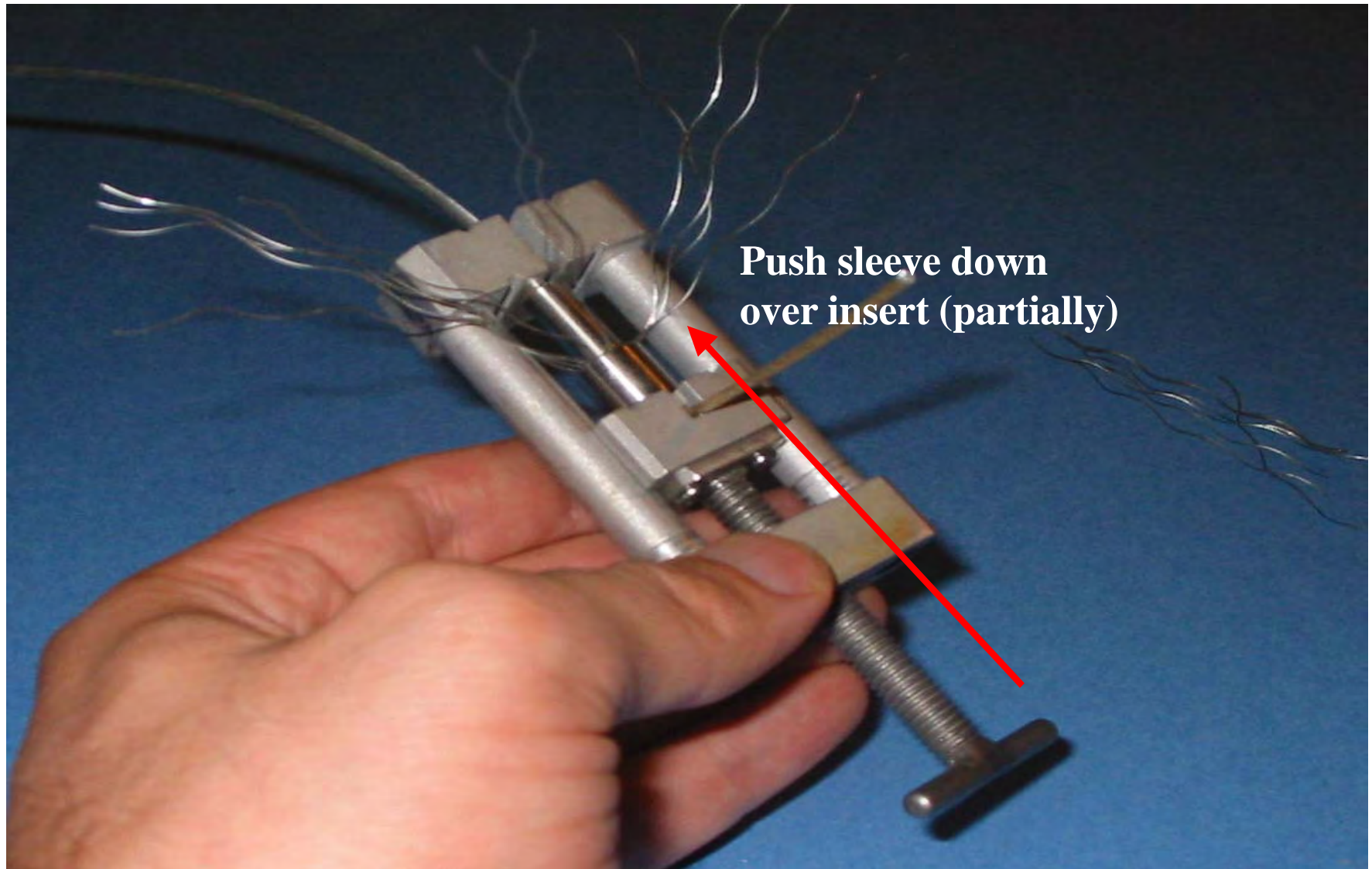
Pic.7a Unwind Outer-layer Strands (start)



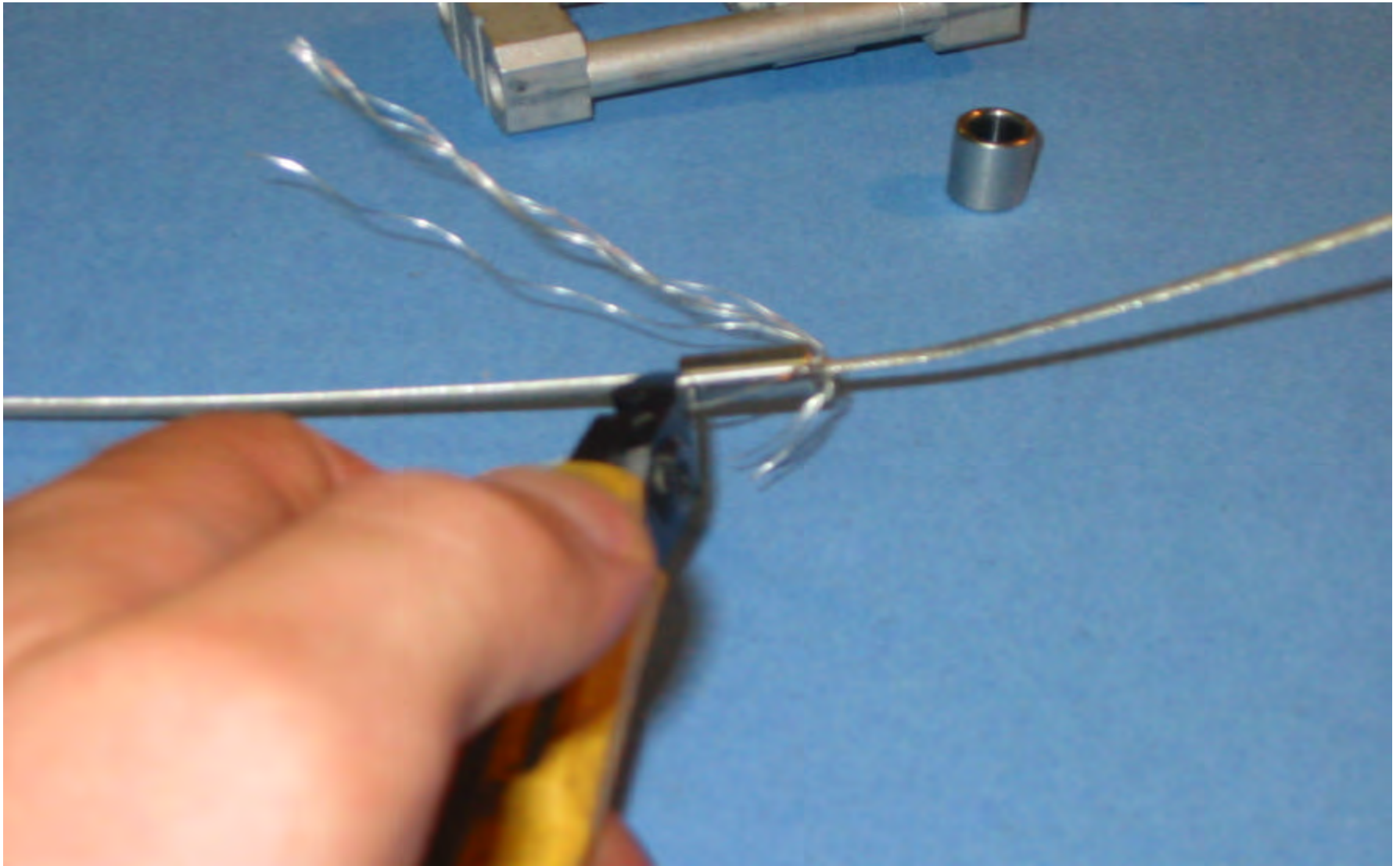
Pic.7b Unwind Outer Layer Strands (finish)



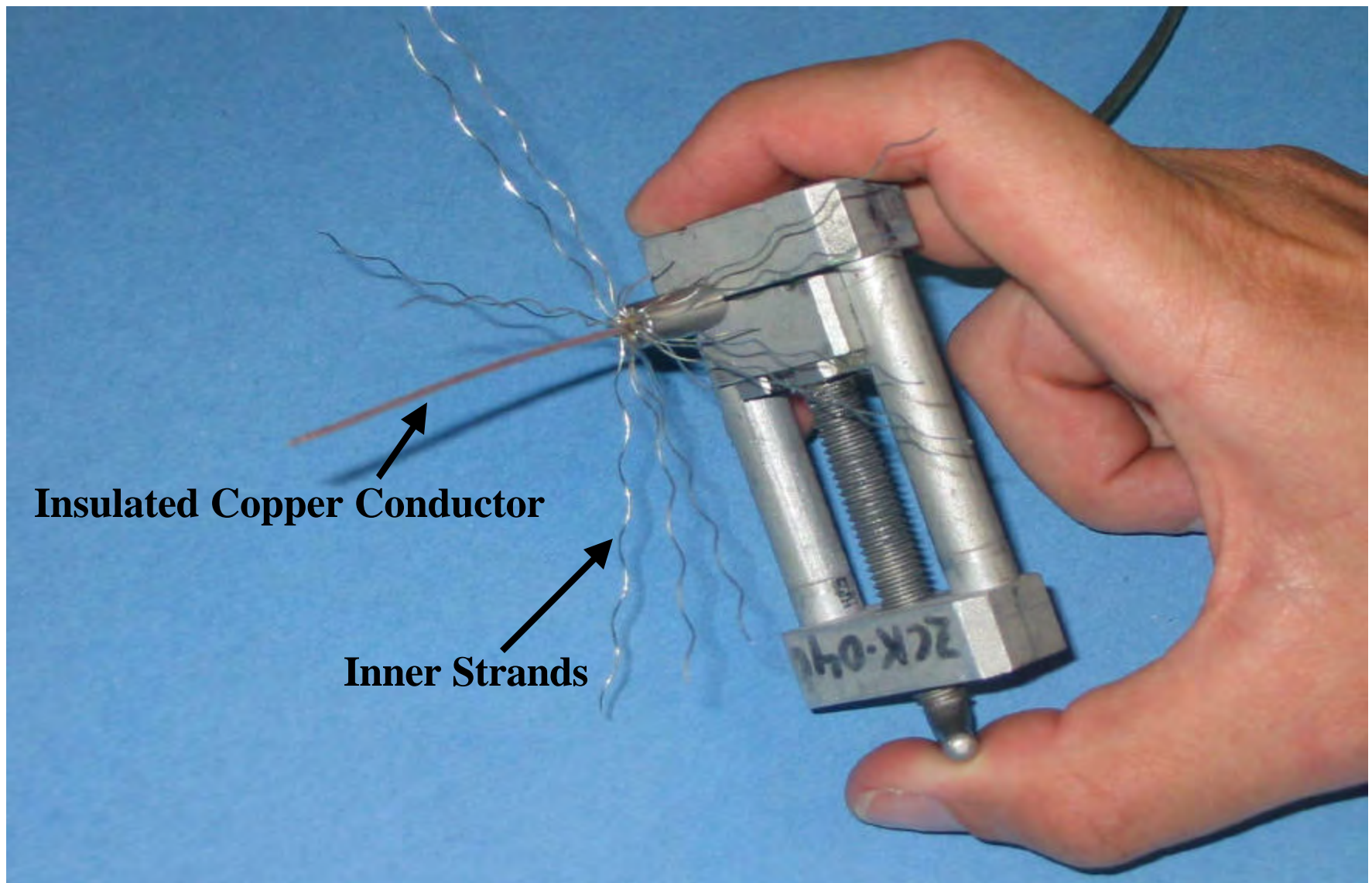
Pic.8 Clipping Outer Wire Strands (6 strands out of 18)



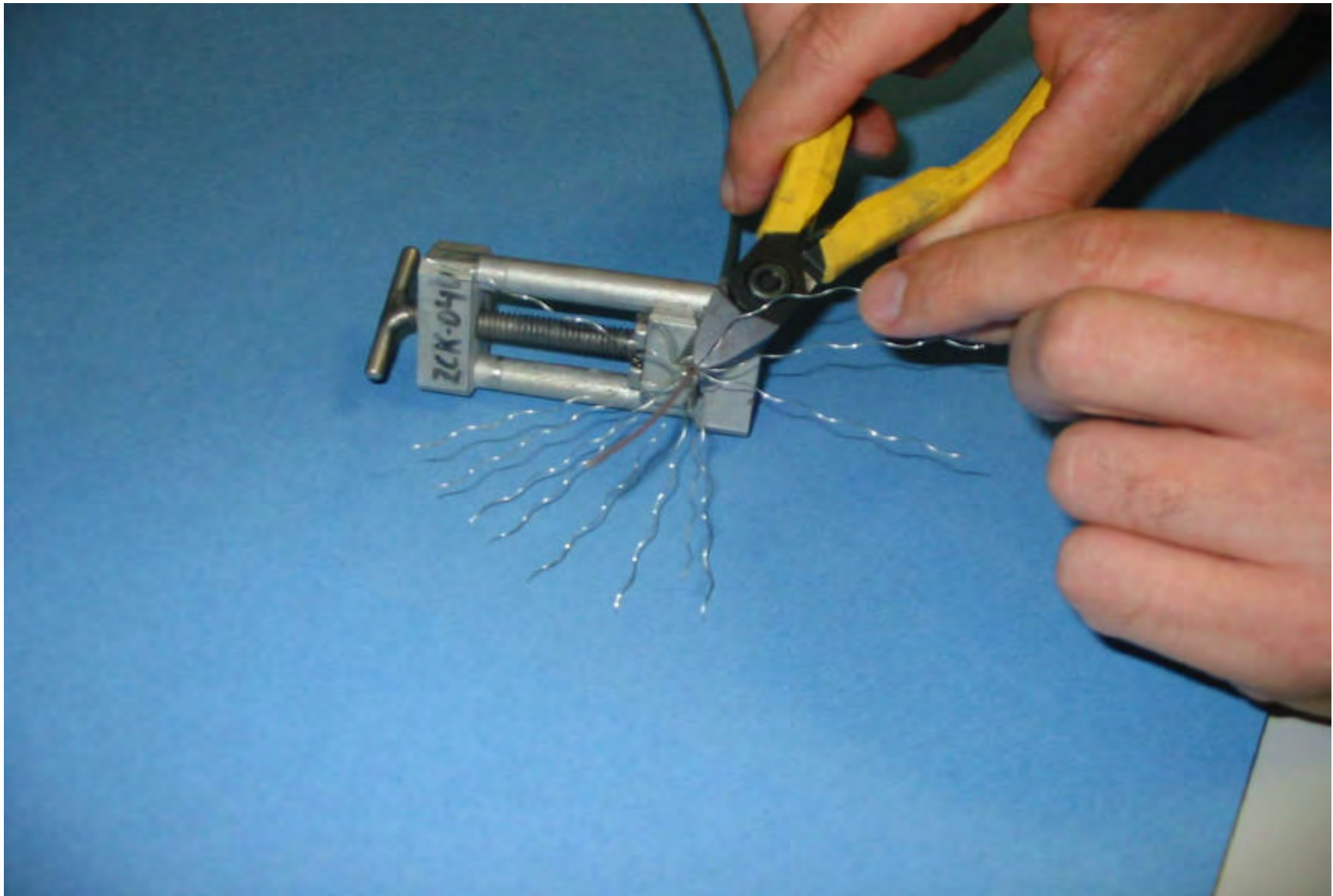
**Pic.9 Partially Push Sleeve Down on Insert Using Jig
(enough to bend strands down along insert)**



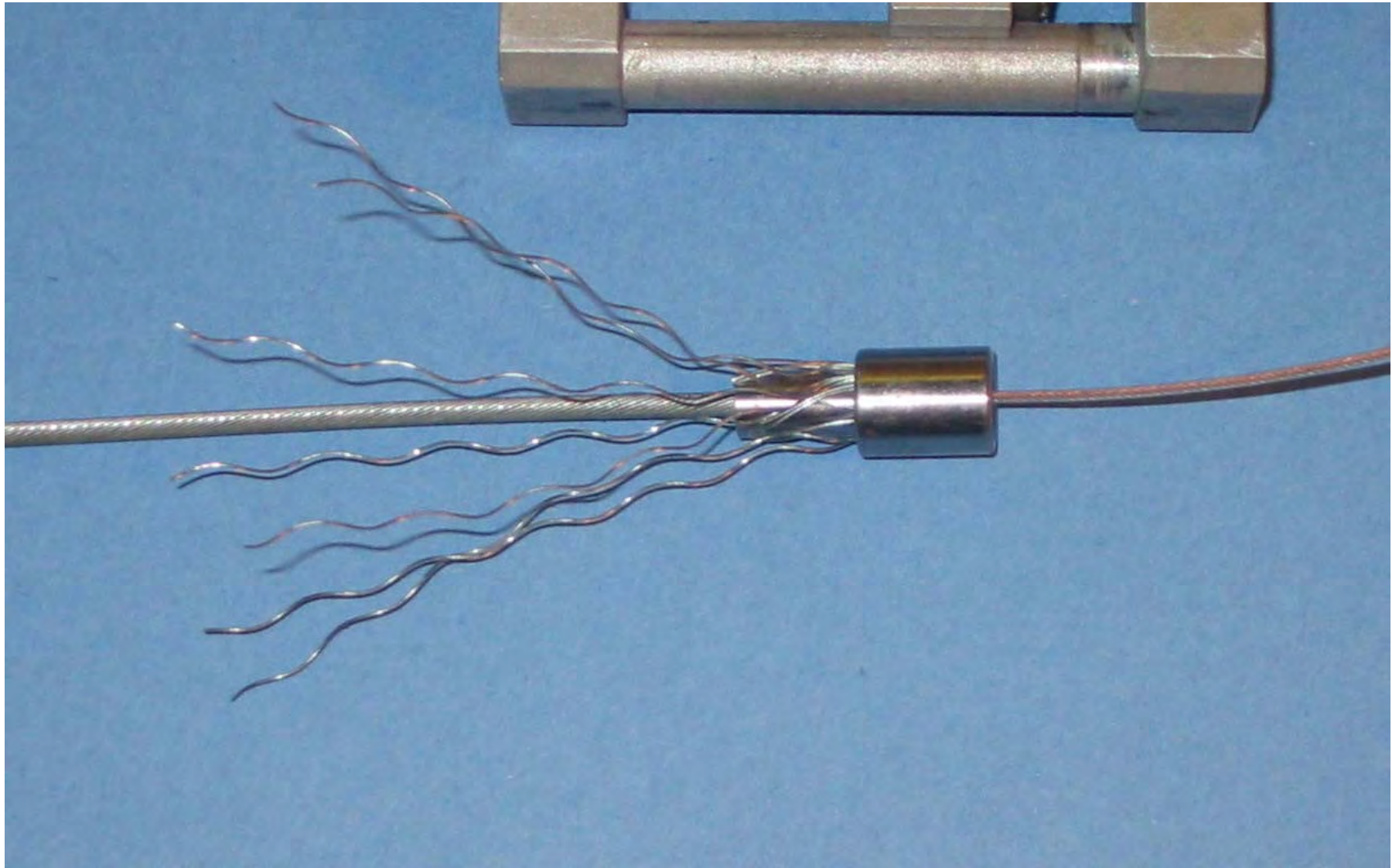
Pic.10 Trim Outer Wire Strands to Base of Insert.



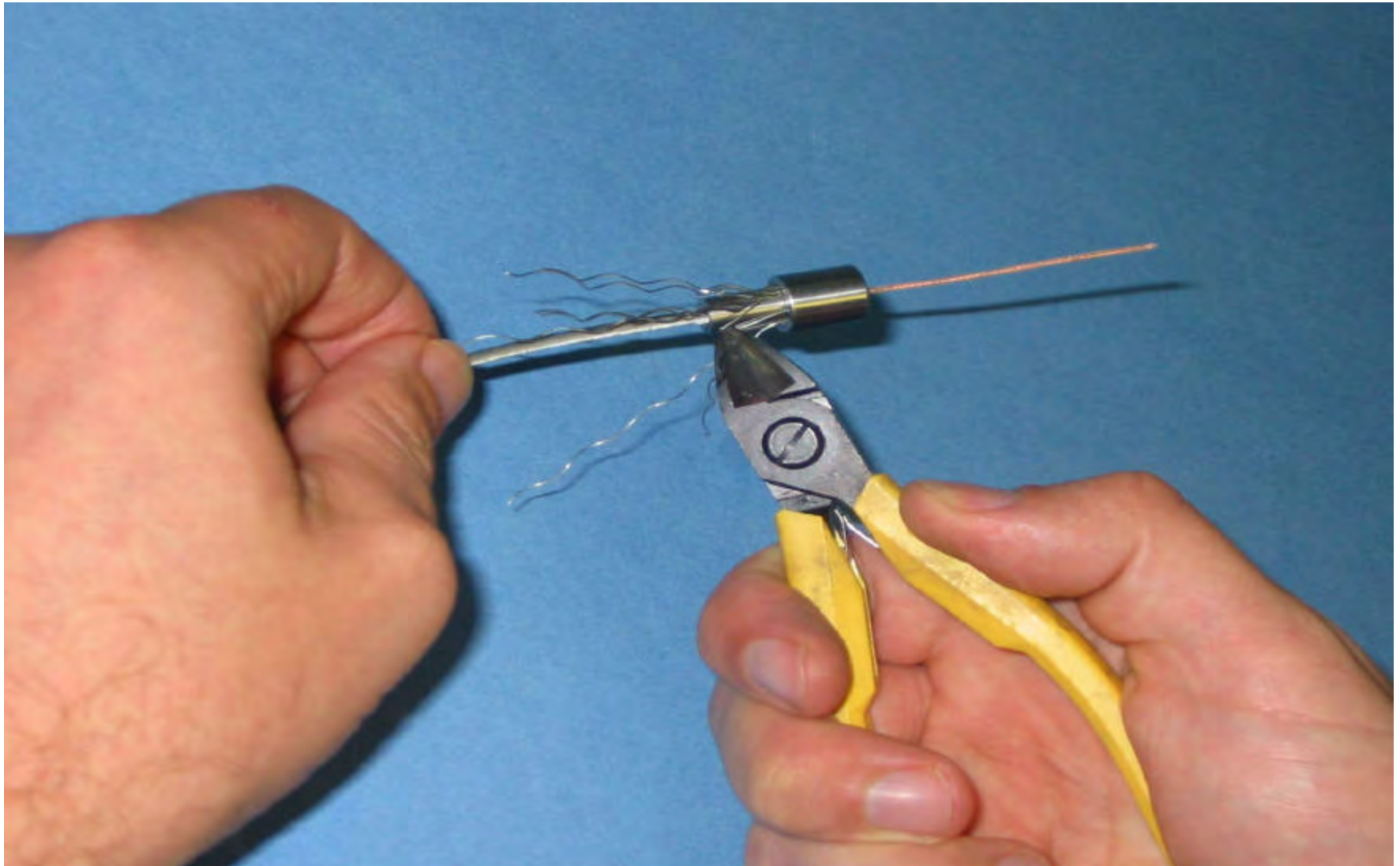
**Pic.11 Unwind inner-layer strands of armor
(exposing the insulated conductor wire)**



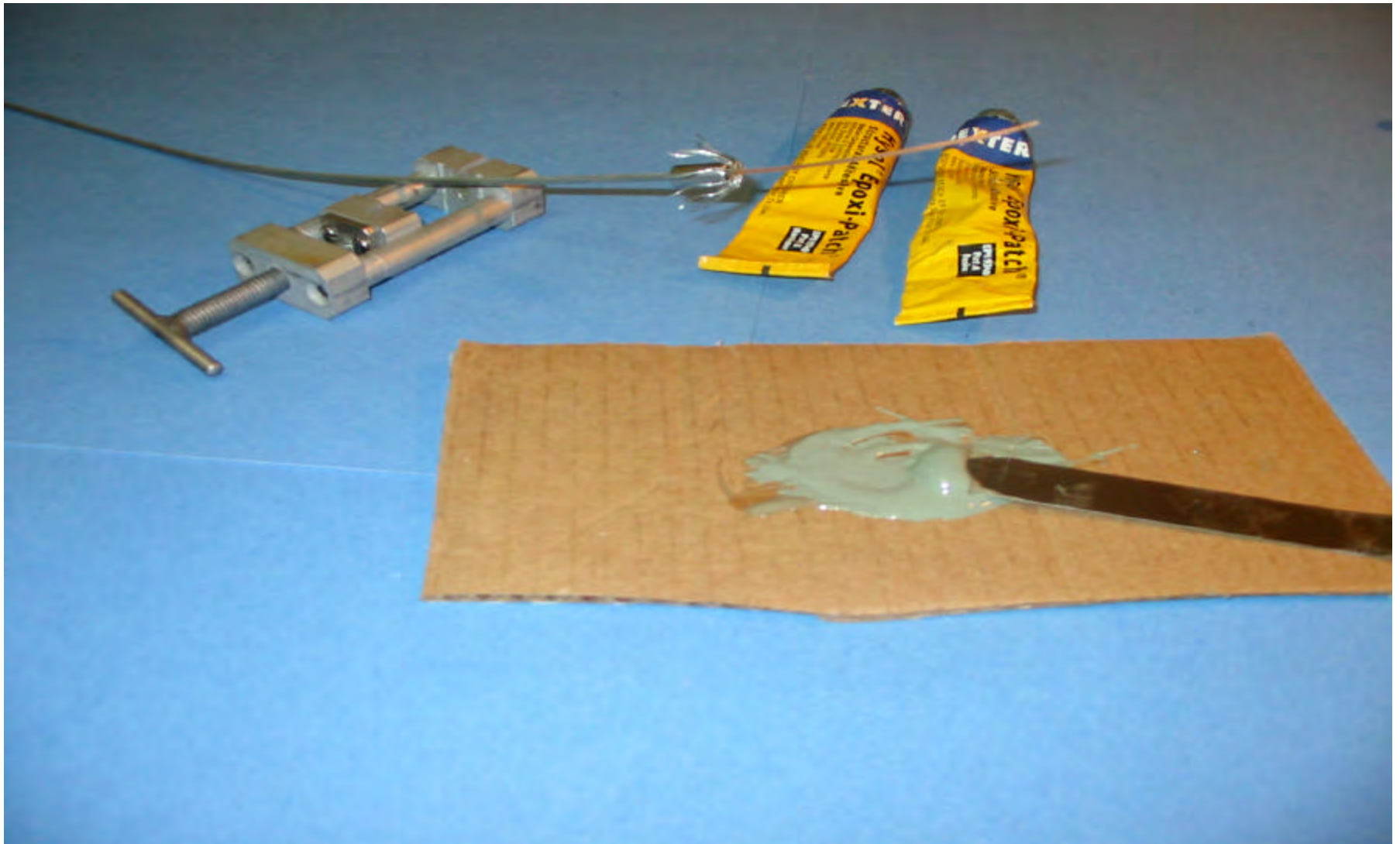
Pic.12 Clip 5 of the 12 inner armor strands close to the top of the insert



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



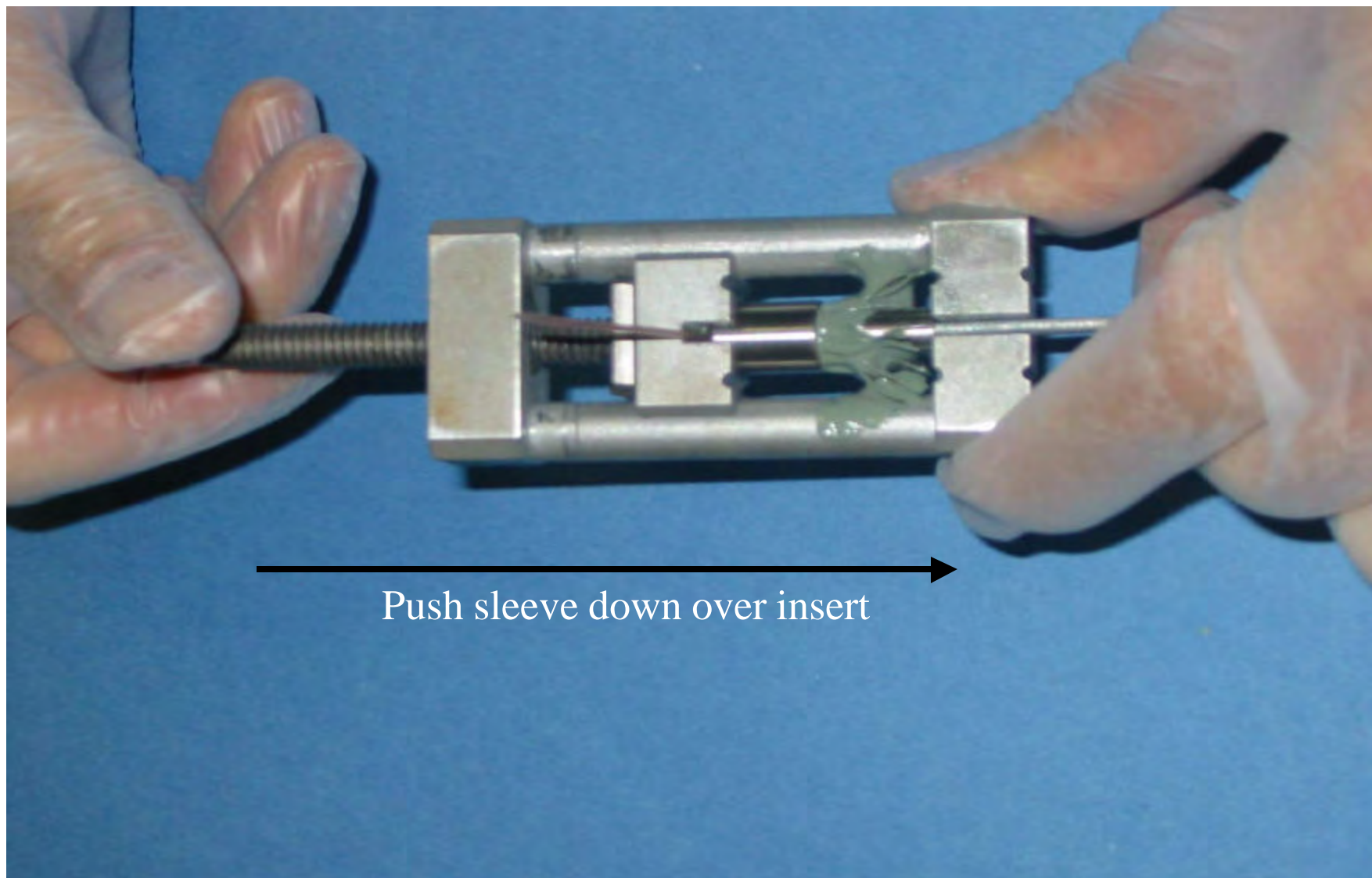
Pic.13 Trim Inner Wire Strands to Base of Insert



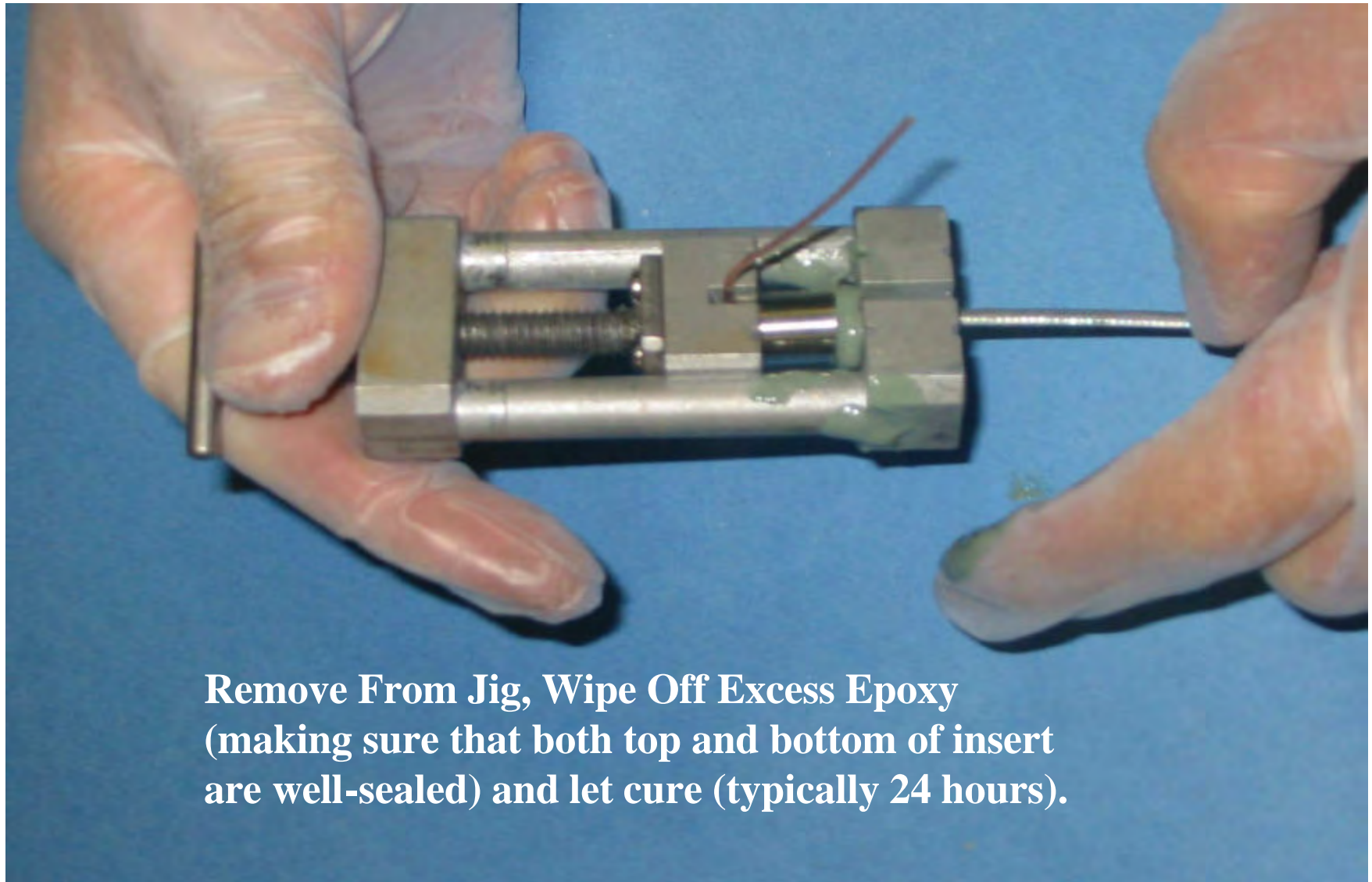
Pic.14 Mix epoxy



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



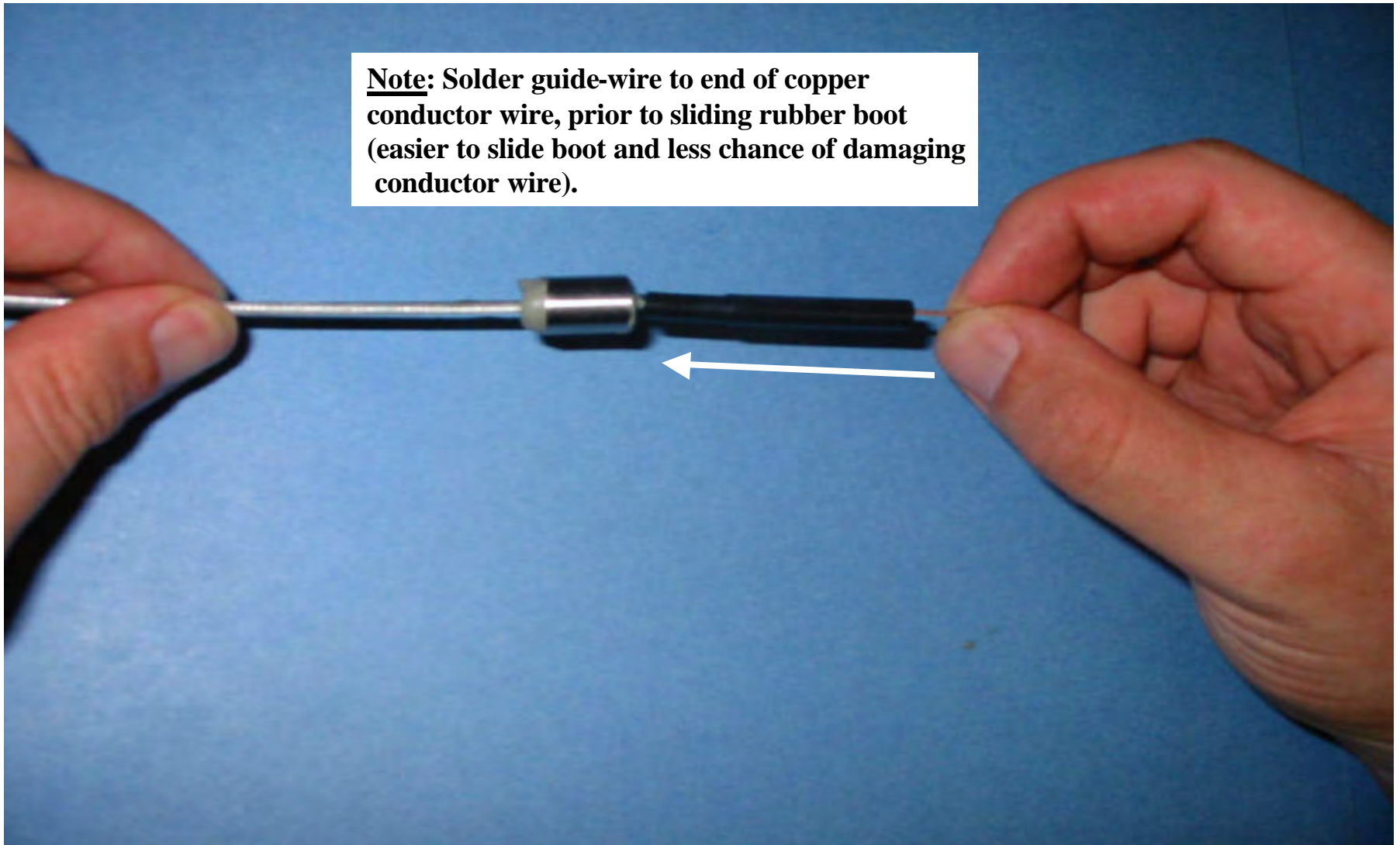
**Remove From Jig, Wipe Off Excess Epoxy
(making sure that both top and bottom of insert
are well-sealed) and let cure (typically 24 hours).**

Pic.17 Termination Sleeve completely pushed down over insert

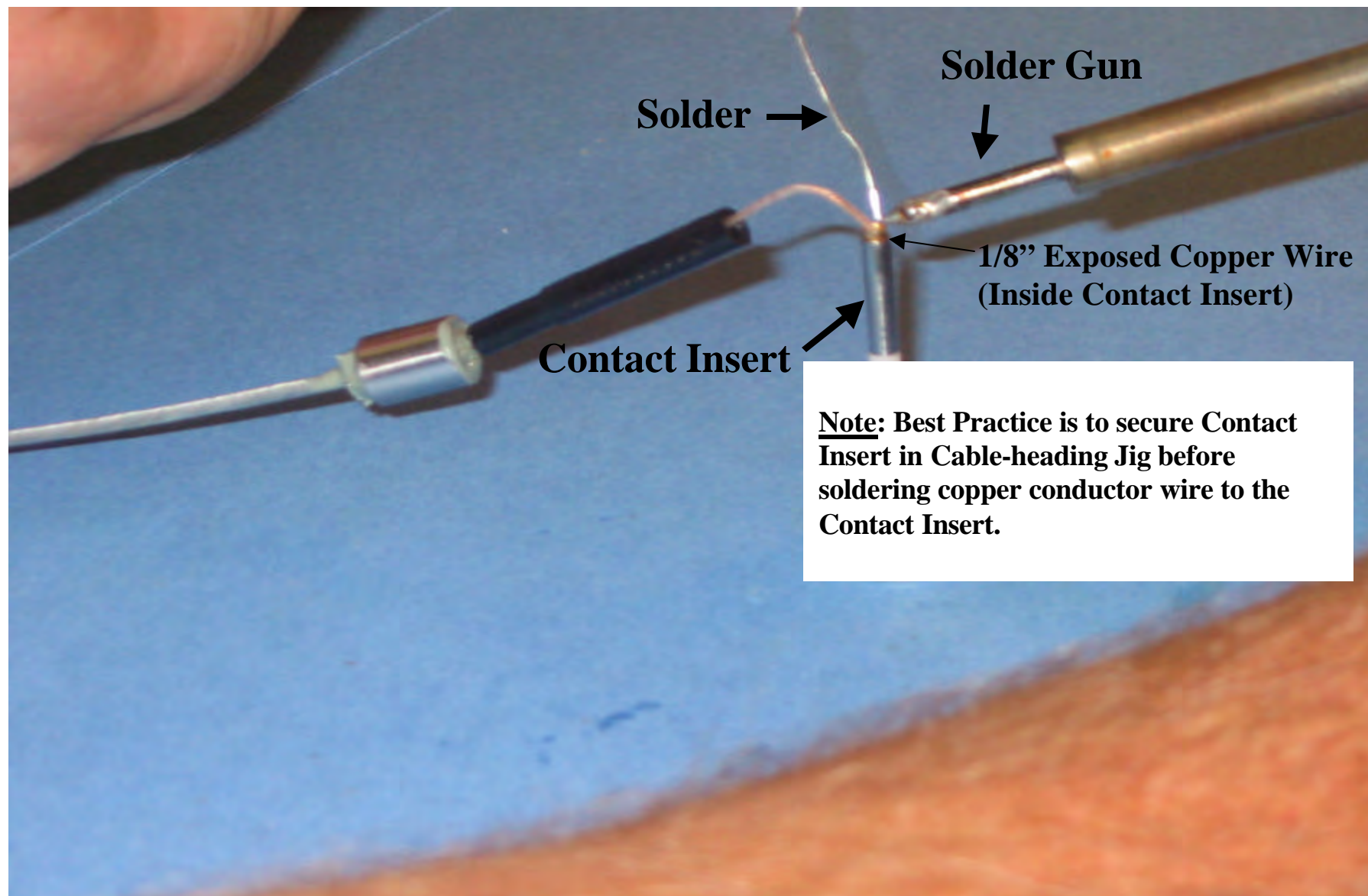


Pic.18 Apply silicon lubricant to the insulated conductor wire

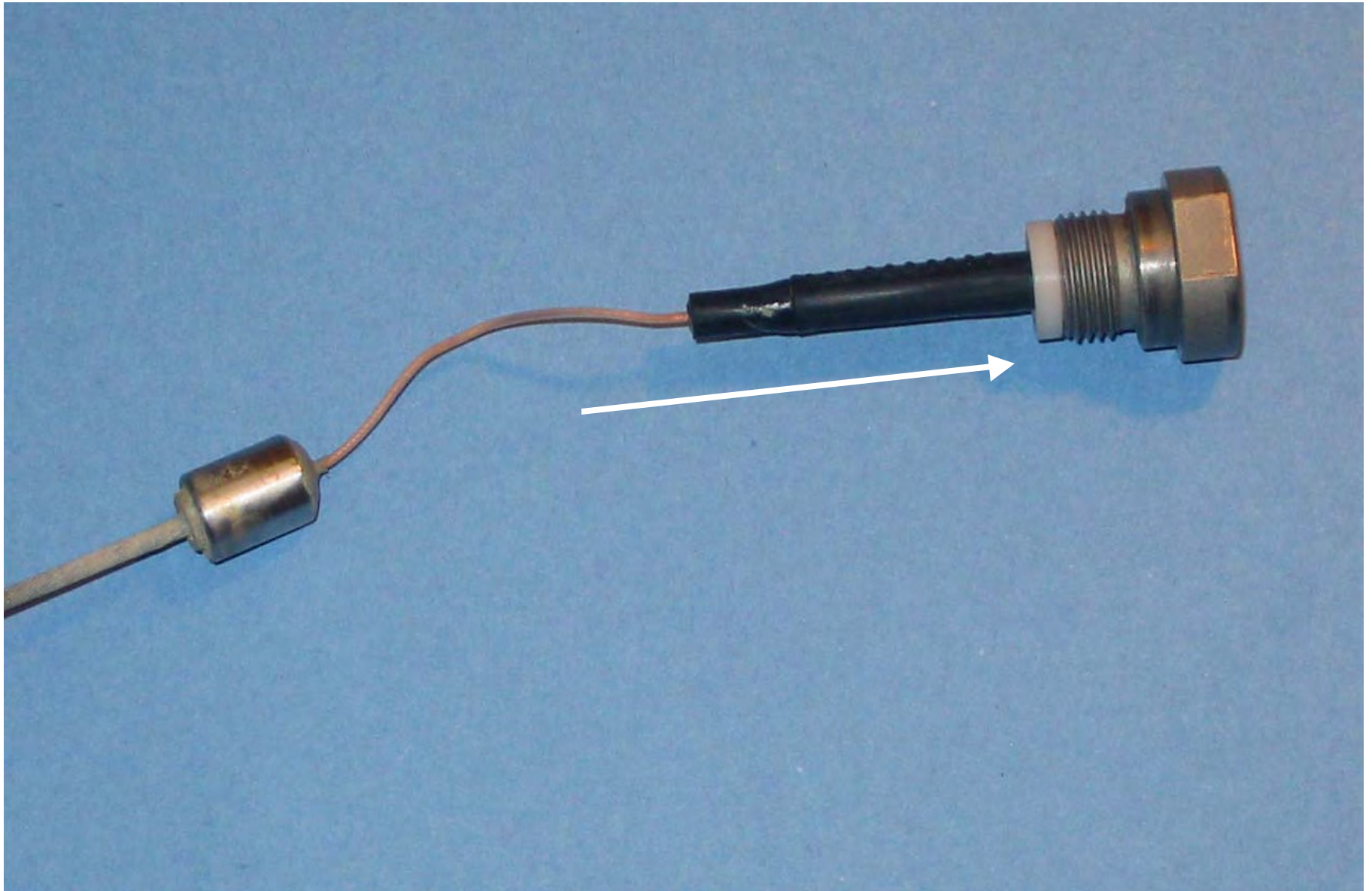
Note: Solder guide-wire to end of copper conductor wire, prior to sliding rubber boot (easier to slide boot and less chance of damaging conductor wire).



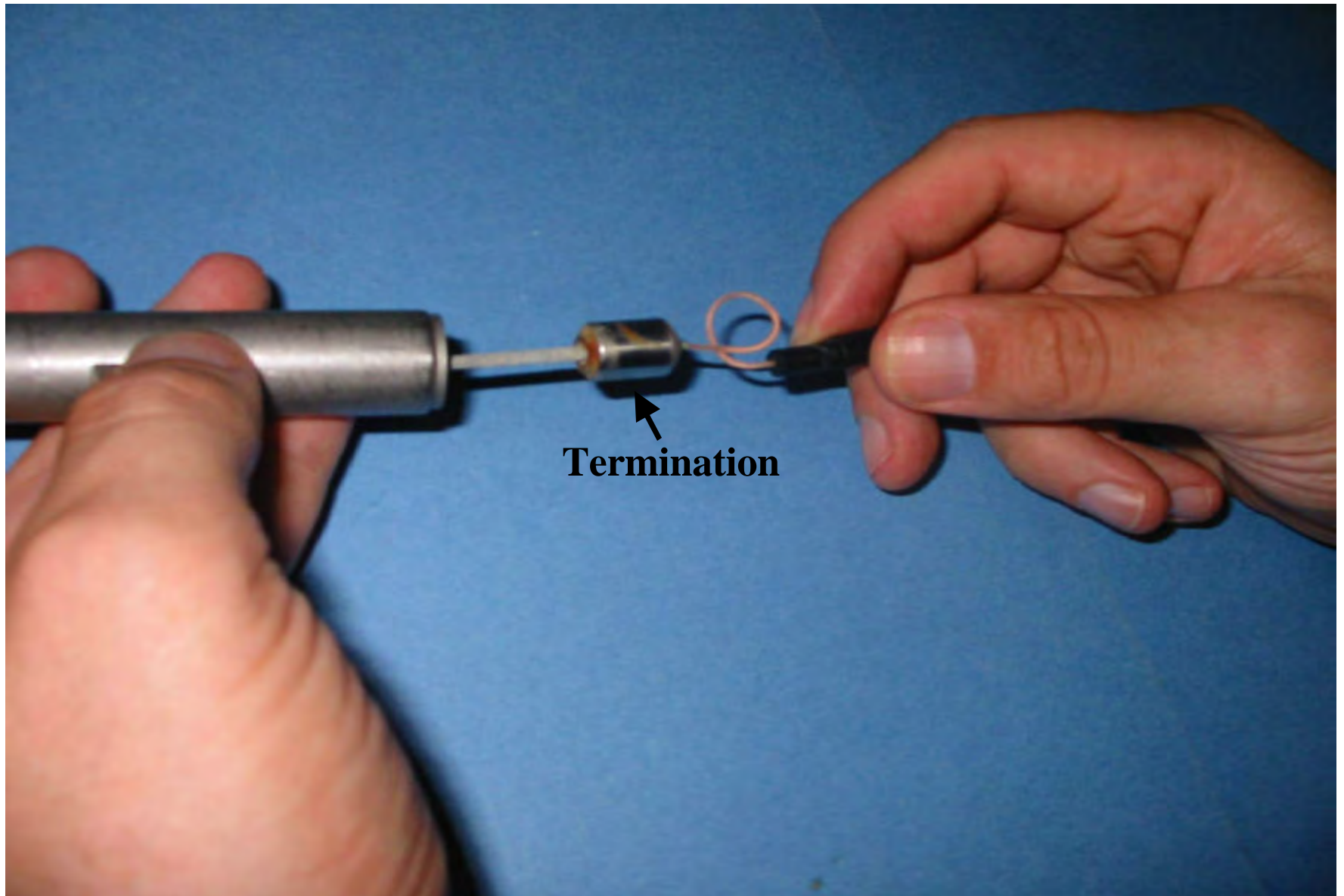
Pic.20 Slide the rubber boot towards the cablehead termination (final position)



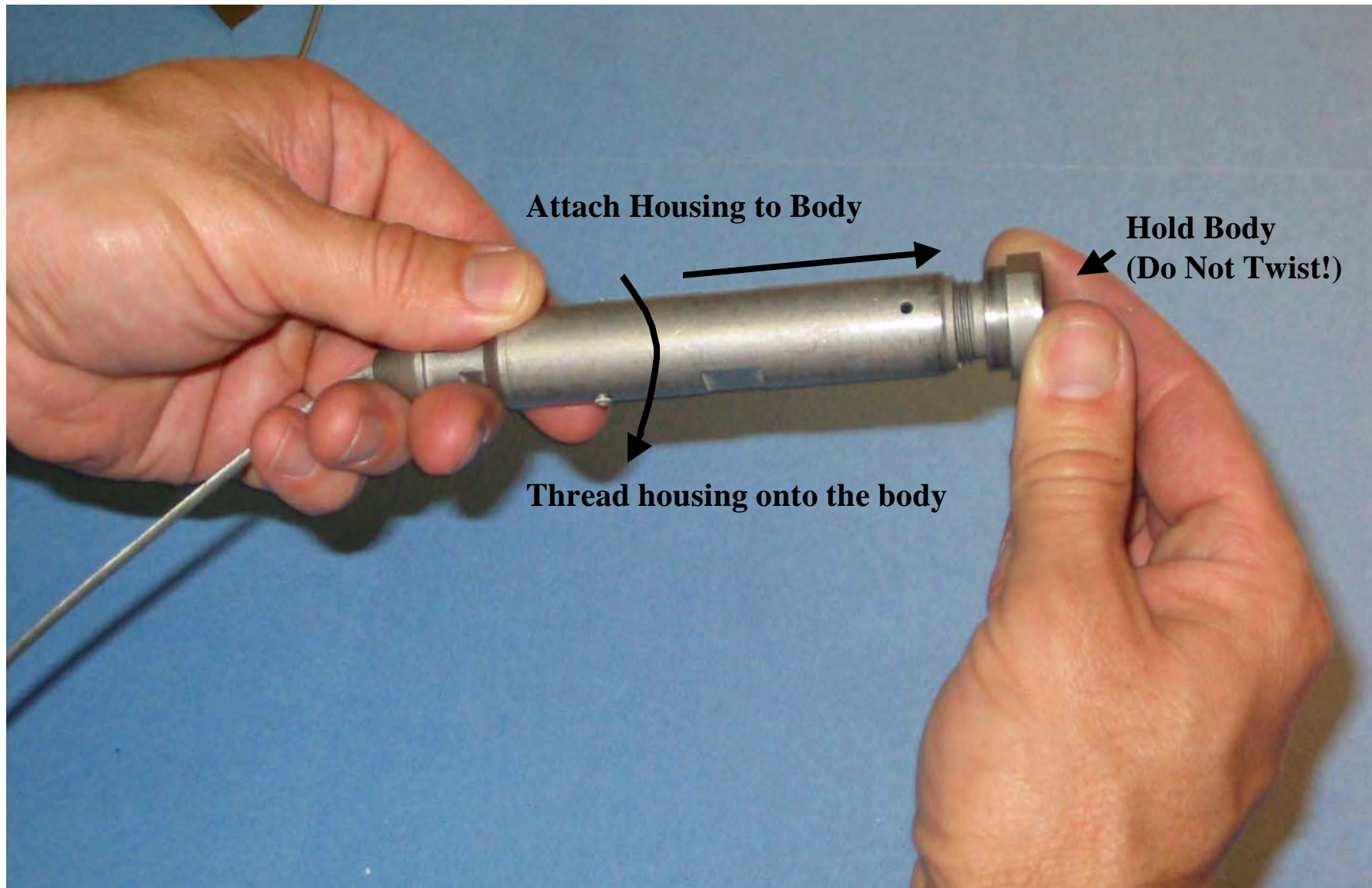
**Pic.21 Solder 1/8 inch exposed copper wire (use wire strippers)
into contact insert**



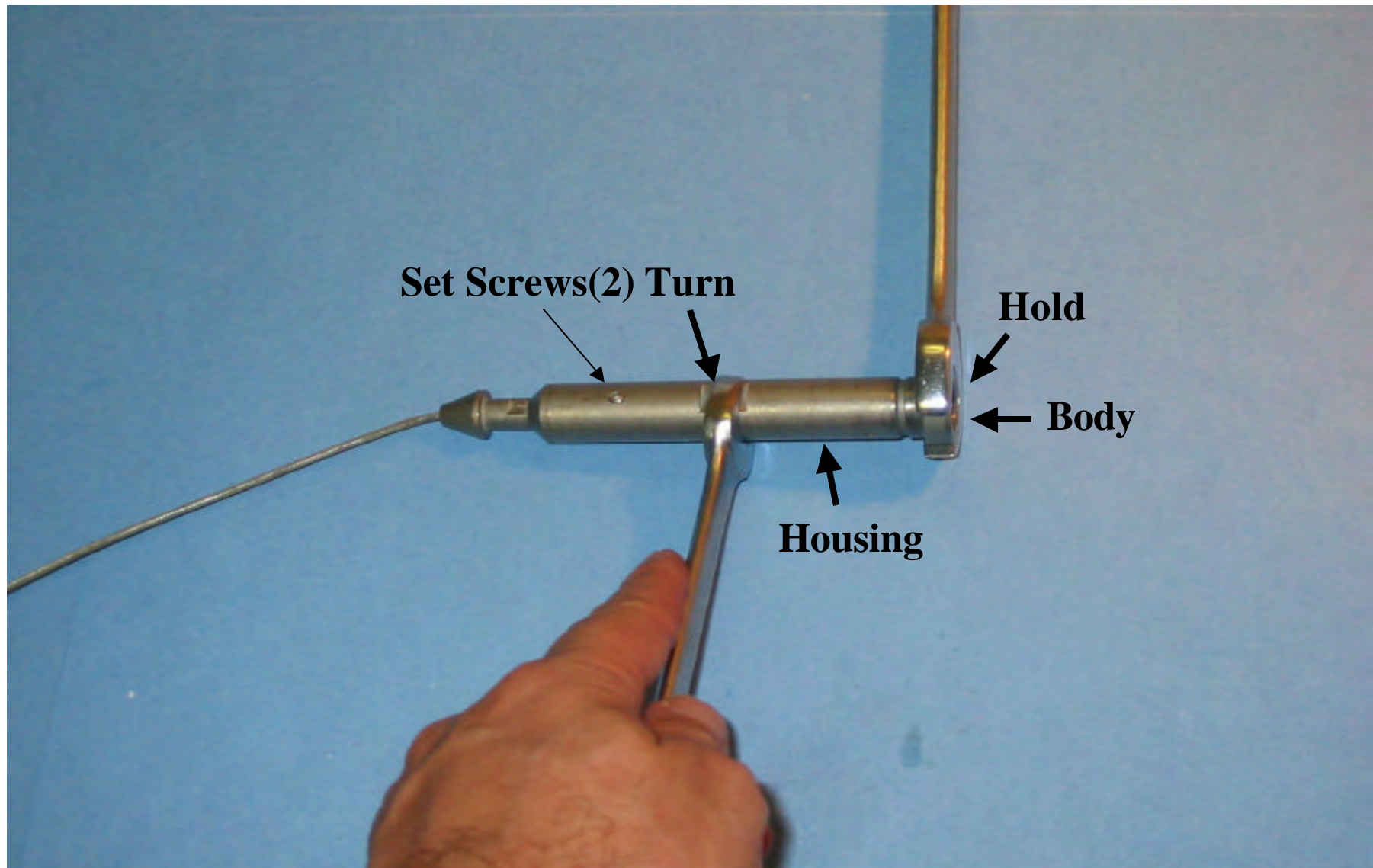
**Pic.22 Slide the rubber boot down over the contact insert
(when the solder has cooled)**



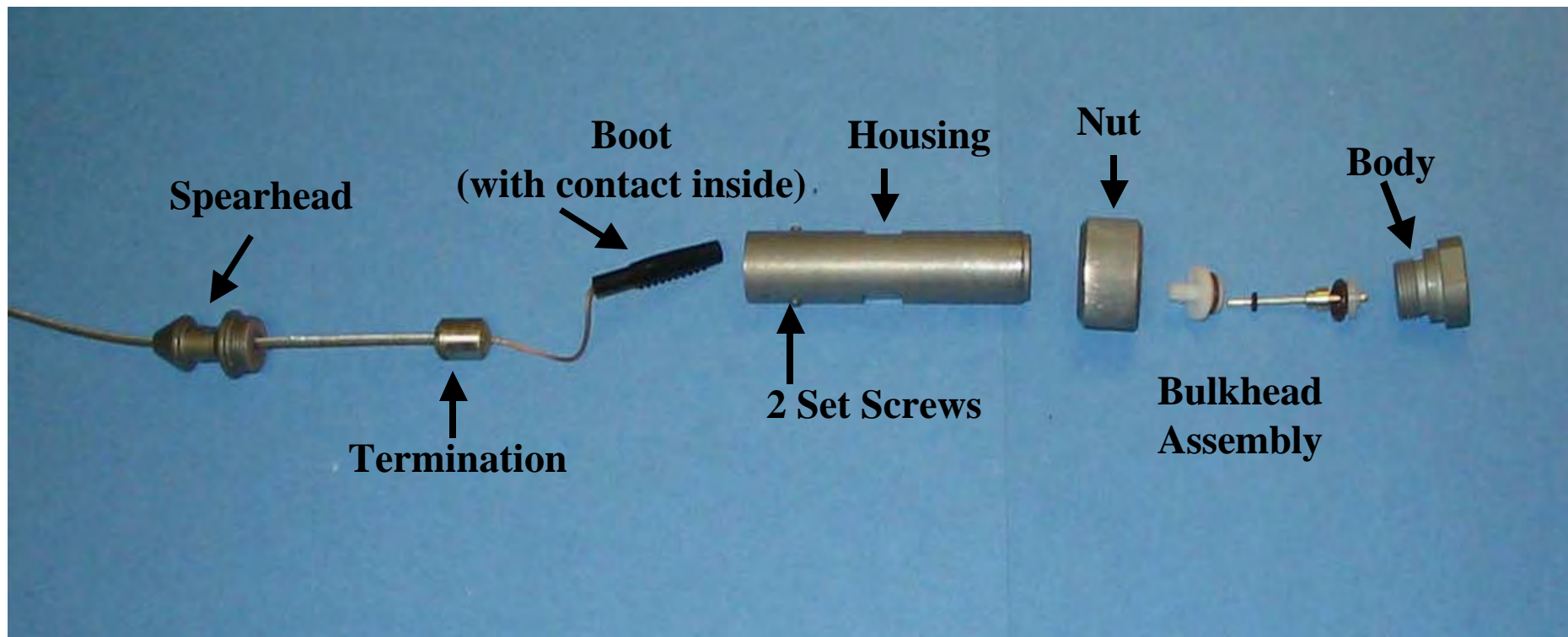
Pic.23 Create a loop in the conductor wire before sliding the cablehead housing down over the termination



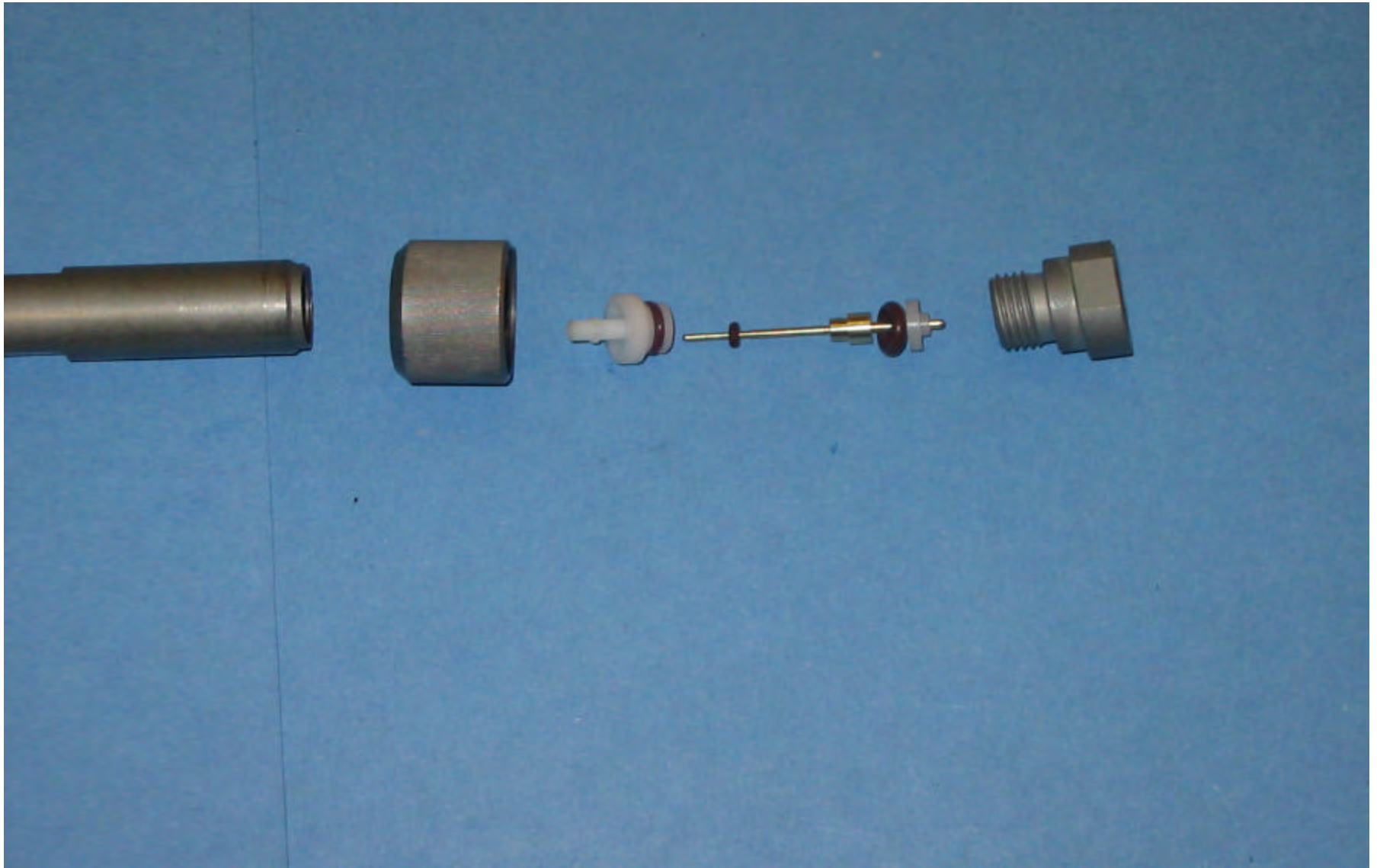
**Pic.24 Thread the cablehead housing onto the body
(Do not twist the body! –this can damage the conductor wire)**



**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

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INTERSTATE TECHNOLOGY AND REGULATORY COOPERATION WORK GROUP

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Funding for this Guide was provided by the U.S. AIR FORCE and NAVFAC (Southern and Southwest Divisions). Additionally, the following persons are recognized for their leadership and support to this project: Marty Faile, Joe Dunkle, Kay Wishkaemper, Vince Malott, and the Passive Diffusion Bag Sampler (PDBS) Work Group.

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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Columbia, South Carolina
2001

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Conversion Factors, Vertical Datum, Acronyms, and Abbreviations

Multiply	By	To obtain
<i>Length</i>		
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
<i>Area</i>		
square mile (mi ²)	2.590	square kilometer
<i>Flow</i>		
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
<i>Volume</i>		
gallon (gal)	3.785	liter

Temperature is given in degrees Celsius (°C), which can be 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
cDCE	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- <i>tert</i> -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,

tetrachloroethene, 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 equilibration 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	<i>cis</i> -1,2-Dichloroethene	1,1,1-Trichloroethane
Bromodichloromethane	Dibromochloromethane	<i>trans</i> -1,2-Dichloroethene	1,1,2-Trichloroethane
Bromoform	Dibromomethane	1,2-Dichloropropane	Trichloroethene
Chlorobenzene	1,2-Dichlorobenzene	<i>cis</i> -Dichloropropene	Trichlorofluoromethane
Carbon tetrachloride	1,3-Dichlorobenzene	1,2-Dibromoethane	1,2,3-Trichloropropane
Chloroethane	1,4-Dichlorobenzene	<i>trans</i> -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- <i>tert</i> -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 semi-volatile 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; Kearn 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 ($2 \text{ ft} - 0.75 \text{ ft}$) and 2.75 ft ($2 \text{ ft} + 0.75 \text{ ft}$) 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 (O'Brien & 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 under-

estimate 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 pres-

ence of contaminant stratification, and borehole flow-meters 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 ($\mu\text{g/L}$) 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 Gibbs, 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; Gibbs and others, 1993; Reilly and Gibbs, 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 Gibbs, 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 Gibbs, 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, tetrachloroethene, 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 equilibration 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

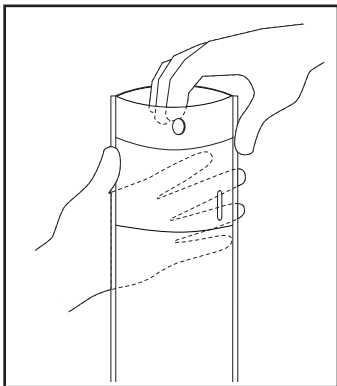
Field Manual

Introduction

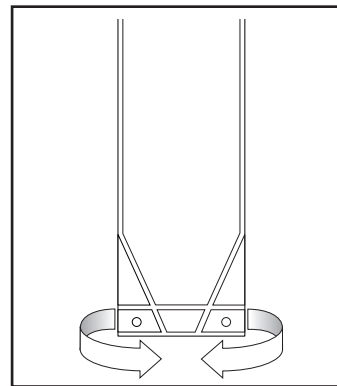
The HydraSleeve groundwater sampler can be used to collect a representative sample for most physical and chemical parameters without purging the well. It collects a whole water sample from a user-defined interval (typically within the well screen), without mixing fluid from other intervals. One or more 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

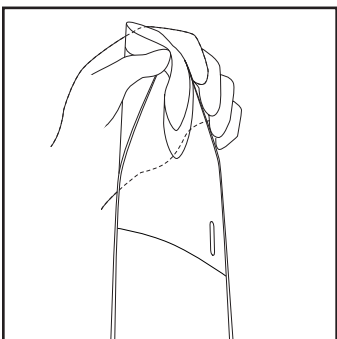
Assembling the HydraSleeve is simple, and can be done by one person in the field, taking only a minute or two.



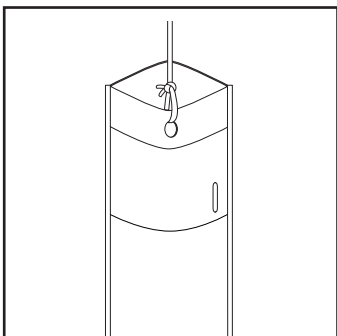
1 Remove HydraSleeve from package and grasp top to "pop" open.



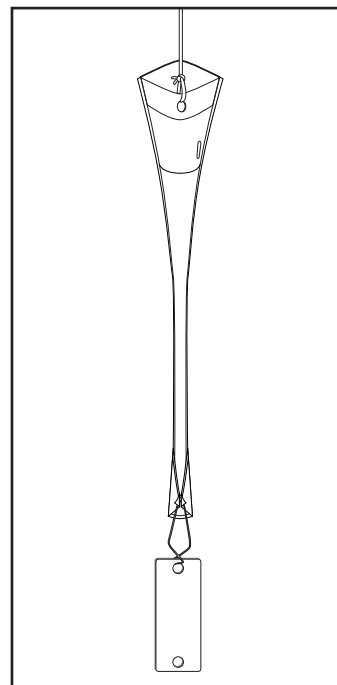
4 Fold the two holes at bottom of HydraSleeve together and attach weight



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



3 Attach line to hole at top of HydraSleeve.



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.

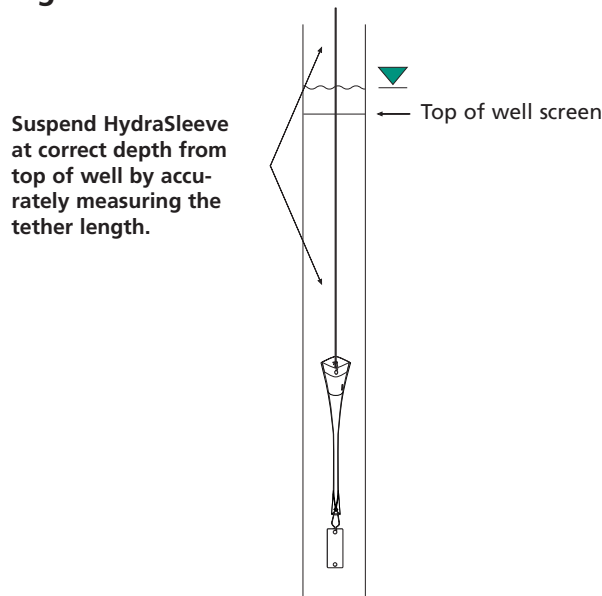
There are three basic methods for holding a HydraSleeve in position as the well equilibrates.

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

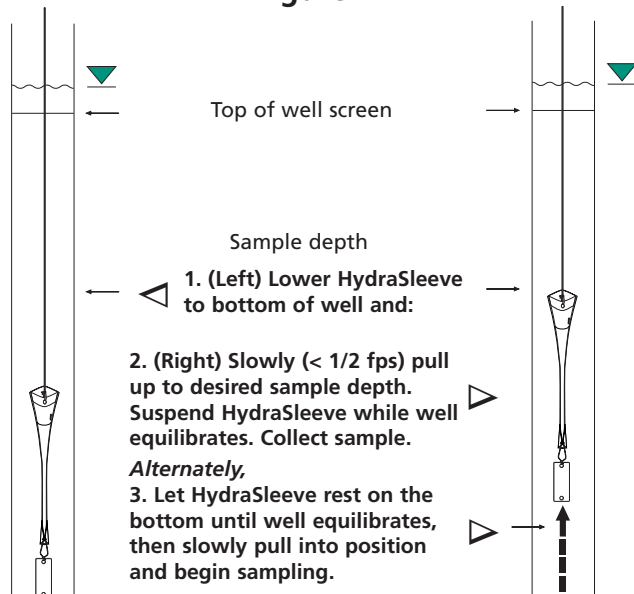


BOTTOM DEPLOYMENT (Figure 2)

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.

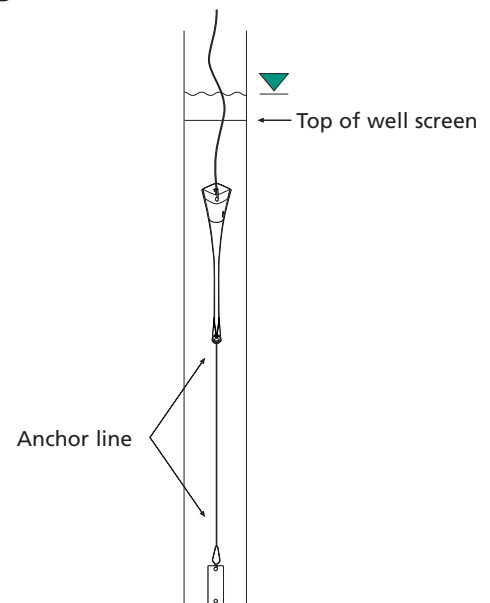
Figure 2



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

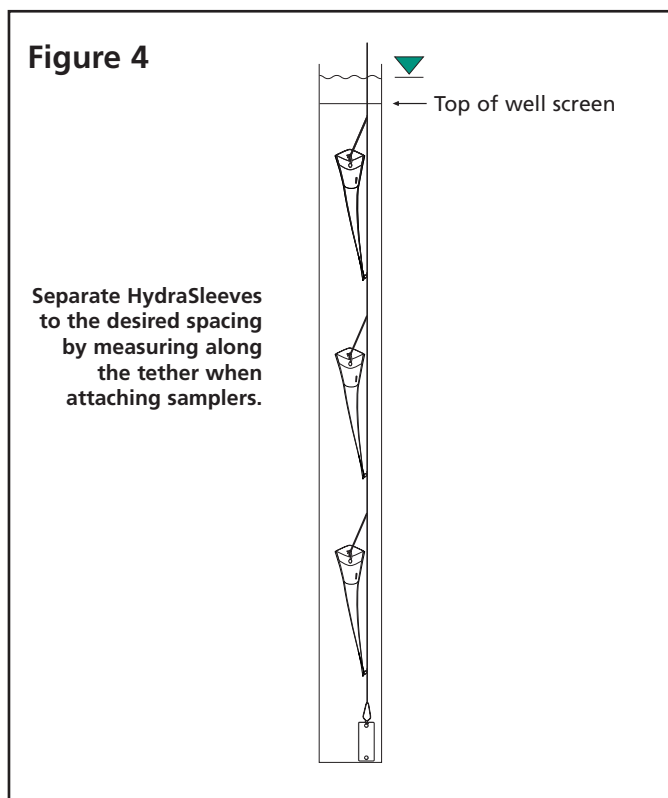


Multiple Interval Deployment

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

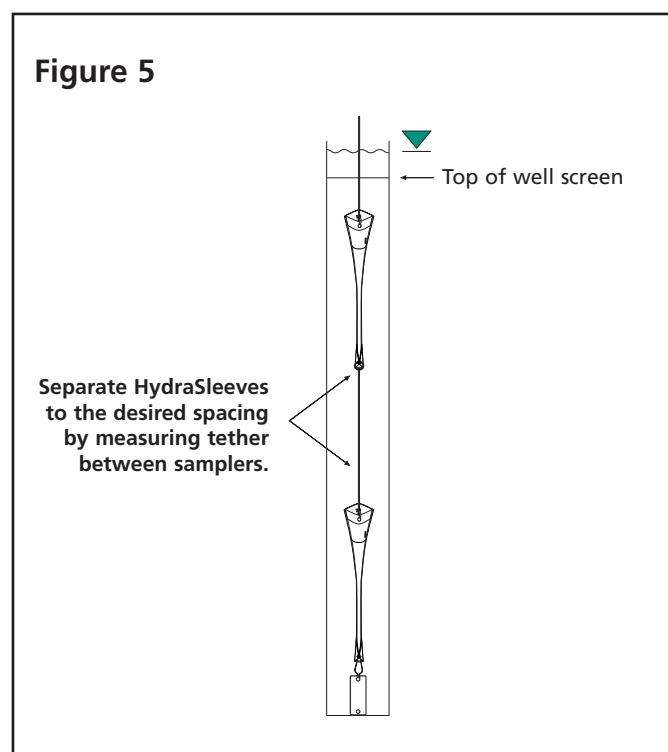
ATTACHED TO A SINGLE TETHER (Figure 4)

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.



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.



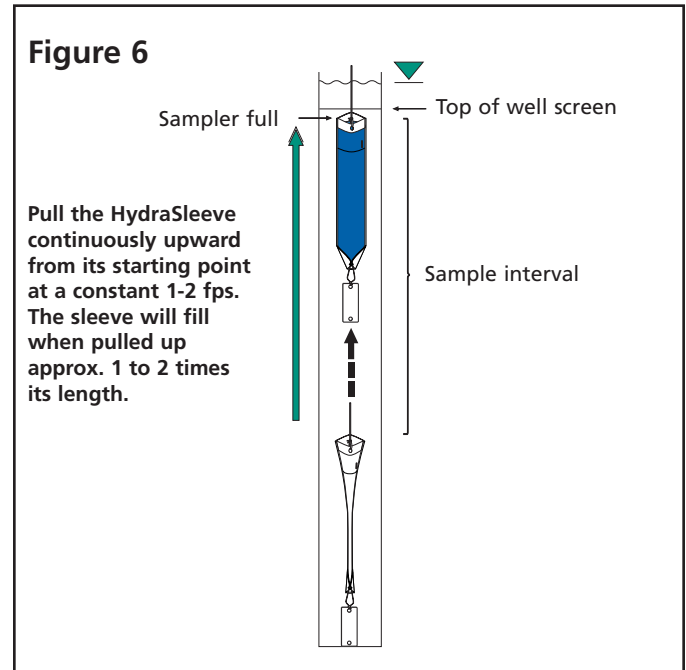
Sample Collection

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.

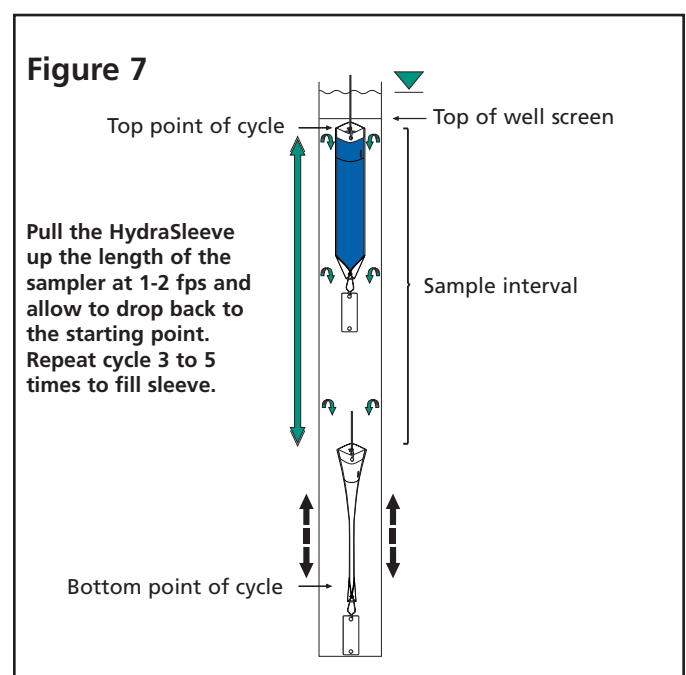
Note: When using this method, the screen interval should be long enough so the sampler fills before exiting the top of the screen.



SHORT STROKES (Figure 7)

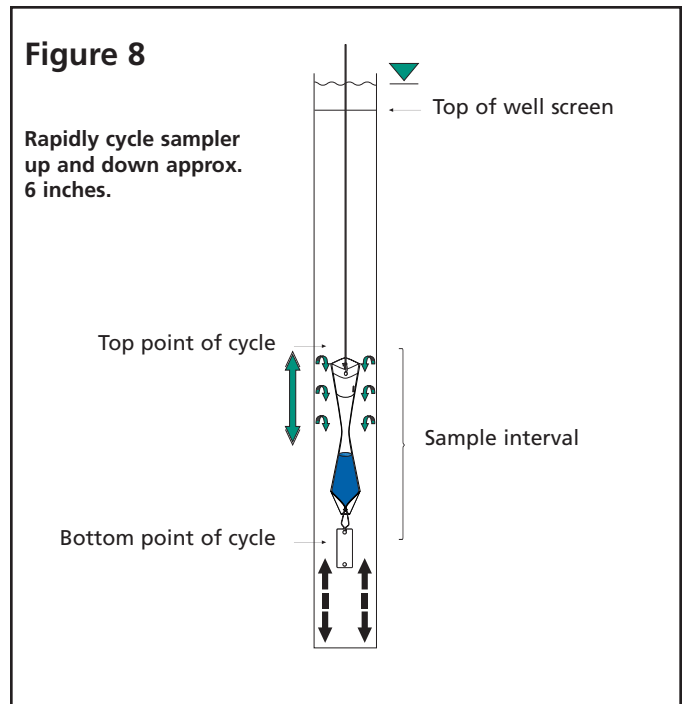
Pull the sampler upward at about 1 to 2 feet per second for the length of the sampler and let it drop back to the starting point. Repeat the cycle 3 to 5 times.

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.



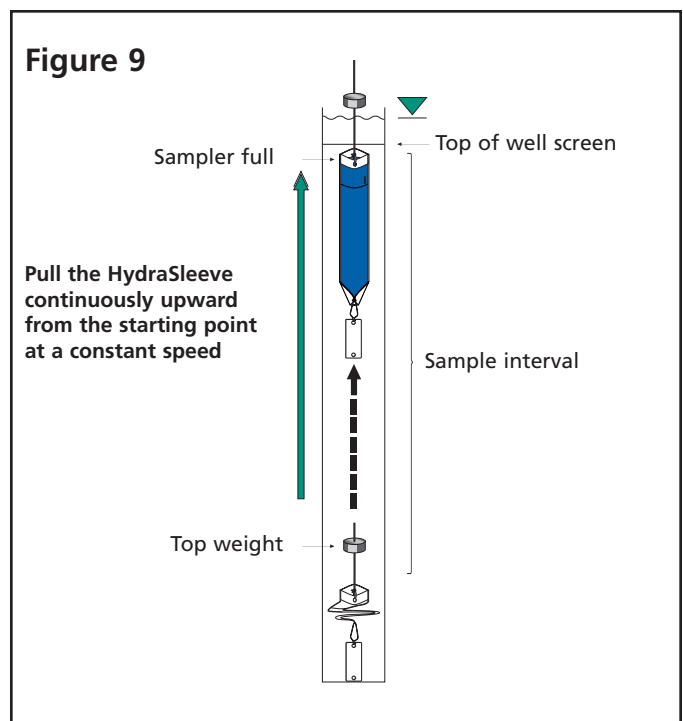
RAPID, SHORT CYCLES (Figure 8)

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.



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.



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).



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.



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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 basis². 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 field 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 40mL 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 GWTs and OUCTP EISB Extraction Well

Sample Handling and Custody Requirements

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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 $4^{\circ}\text{C} \pm 2^{\circ}\text{C}$.
- 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 1/2" 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: $\pm 3\%$ mS/cm

- ORP: ± 10 mV
- Dissolved oxygen: ± 10 percent mg/L
- Temperature: ± 1.0 °C
- Turbidity: $\pm 10\%$ 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.

Multi Water Quality Checker U-50 Series

Instruction Manual

CODE:GZ0000144342

Preface

This manual describes the operation of the Multi Water Quality Checker, U-50 Series. Be sure to read this manual before using the product to ensure proper and safe operation of the instrument. Also safely store the manual so it is readily available whenever necessary.

Product specifications and appearance, as well as the contents of this manual are subject to change without notice.

■ Warranty and Responsibility

HORIBA warrants that the Product shall be free from defects in material and workmanship and agrees to repair or replace free of charge, at HORIBA's option, any malfunctioned or damaged Product attributable to HORIBA's responsibility for a period of one (1) year from the delivery unless otherwise agreed with a written agreement. In any one of the following cases, none of the warranties set forth herein shall be extended;

- Any malfunction or damage attributable to improper operation
- Any malfunction attributable to repair or modification by any person not authorized by HORIBA
- Any malfunction or damage attributable to the use in an environment not specified in this manual
- Any malfunction or damage attributable to violation of the instructions in this manual or operations in the manner not specified in this manual
- Any malfunction or damage attributable to any cause or causes beyond the reasonable control of HORIBA such as natural disasters
- Any deterioration in appearance attributable to corrosion, rust, and so on
- Replacement of consumables

HORIBA SHALL NOT BE LIABLE FOR ANY DAMAGES RESULTING FROM ANY MALFUNCTIONS OF THE PRODUCT, ANY ERASURE OF DATA, OR ANY OTHER USES OF THE PRODUCT.

■ Trademarks

Generally, company names and brand names are either registered trademarks or trademarks of the respective companies.

For your safety

Warning messages are described in the following manner. Read the messages and follow the instructions carefully.

● Meaning of warning messages



This indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.



This indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.



This indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

Without safety alert indication of hazardous situation which, if not avoided, could result in property damage.

● Symbols





Description of what should be done, or what should be followed







Description of what should never be done, or what is prohibited

■ Safety Precautions

This section provides precautions to enable you to use the product safely and correctly and to prevent injury and damage. The terms of DANGER, WARNING, and CAUTION indicate the degree of imminency and hazardous situation. Read the precautions carefully as it contains important safety messages.

 WARNING	
	Do not disassemble or modify the meter. May cause overheating or fire, resulting in accidents.

 CAUTION	
	The pH and ORP sensors are made of glass. Handle them carefully to avoid breakage.
	Never ingest the DO, pH or ORP standard solutions. If it comes into contact with the eyes, rinse thoroughly with water. If swallowed, consult a physician.
	Keep away from water when using USB communication. Improper use may result in fire or damage.

Points of concern

Use of the equipment in a manner not specified by the manufacturer may impair the protection provided by the equipment. It may also reduce equipment performance.

ItemDescription

● Sensor probe

- Do not use in seawater.
- Do not immerse the sensor probe into alcohol, organic solvent, strong acid, strong alkaline, and other similar solutions.
- Do not subject to strong shocks.
- Do not perform measurement in environments of magnetic fields. Measurement errors may result.
- The sensor probe is no longer waterproof when the sensor is not mounted.
- Does not support measurement of samples containing fluorine.
- To disconnect the sensor cable or interface cable, pull them out with holding the connector part. Do not pull the cable part; it may cause breakage.

● Control unit

- Do not subject to strong shocks.
- Perform the key operation by the fingers, not by the hard object like metal stick or rod.
- The control unit is no longer waterproof when the USB cable is connected.
- When operating the control unit only, protect the connector with the connector cap provided.
- Remove the batteries when not using the control unit for an extended period of time. Battery fluid leakage may cause equipment failure.
- Do not wipe the control unit with organic solvents or powder polish. The surface may deteriorate or its printing may disappear. If the display becomes dirty, wipe the dirt off with a soft cloth soaked in neutral detergent.
- Do not turn the power OFF or disconnect the cable during calibration or setting. Memory data may be erased.
- To perform measurement, connect the sensor probe cable before turning the power ON.
- Do not remove the battery gasket or twist it.
- When opening the battery case, make sure that no foreign matter is attached to the battery gasket.
- Do not use any unspecified batteries ; it may cause breakage.

● Measurement

- Do not pull the cable when lowering the sensor probe into the sample during measurement. Lower the sensor probe into the sample on a chain or string.
- Before lowering the sensor probe into the sample, do not connect the hook on the unit to a human body.
- The correct values are not displayed if the sensor is not mounted when the measurement display is activated.
- Perform DO measurement with no air bubbles in the internal solution.
- Do not reuse a membrane cap of DO sensor.
- Use the spanner for DO sensor provided to attach or remove the DO sensor.
- Avoid both U-53 and U-53G turbidity measurement in air, since the rubber wiper will quickly become damaged.
- Avoid turbidity measurement in direct sunlight, since the readout may be affected.

● Calibration

During atmosphere calibration for the DO electrode with DO salinity compensation set to automatic, values are compensated based on electrical conductivity, but calibration is performed normally.

Location of use and storage

- Storage temperature: -10 °C to 60 °C
- Relative humidity: Under 80% and free from condensation

Store the meter in locations void of dust, strong vibrations, direct sunlight, corrosive gases, near air conditioners or windy areas.

Disposal of the product

When disposing of the product, follow the related laws and/or regulations of your country for disposal of the product.

Description in this manual

Note

This interprets the necessary points for correct operation and notifies the important points for handling the unit.

Reference

This indicates where to refer for information.

Tip

This indicates reference information.

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1 About this Unit

The U-50 Series Multi Water Quality Checker features an integrated control unit and sensors. It is capable of making a maximum of eleven simultaneous measurements for various parameters, and is perfect for use in the field. The U-50 Series is designed with on-site ease-of-use in mind, provides a wide variety of functions, and can be used for water quality measurements and inspections of river water, groundwater, and waste water.

2 Device Information

2.1 Measurement parameters

Parameters	Model				
	U-51	U-52	U-52G	U-53	U-53G
pH (pH)	✓	✓	✓	✓	✓
pH (mV)	✓	✓	✓	✓	✓
Oxidation reduction potential (ORP)	✓	✓	✓	✓	✓
Dissolved oxygen (DO)	✓	✓	✓	✓	✓
Electrical conductivity (COND)	✓	✓	✓	✓	✓
Salinity (SAL) [expressed as electrical conductivity]	✓	✓	✓	✓	✓
Total dissolved solids (TDS) [expressed as electrical conductivity]	✓	✓	✓	✓	✓
Seawater specific gravity (SG) [expressed as electrical conductivity]	✓	✓	✓	✓	✓
Water temperature (TEMP)	✓	✓	✓	✓	✓
Turbidity (TURB) [LED transmission/front 30° scattering method]	–	✓	✓	–	–
Turbidity (TURB) [tungsten lamp 90° transmission/scattering method] with wiper	–	–	–	✓	✓
Water depth (DEP)	–	–	✓	✓	✓
GPS	–	–	✓	–	✓

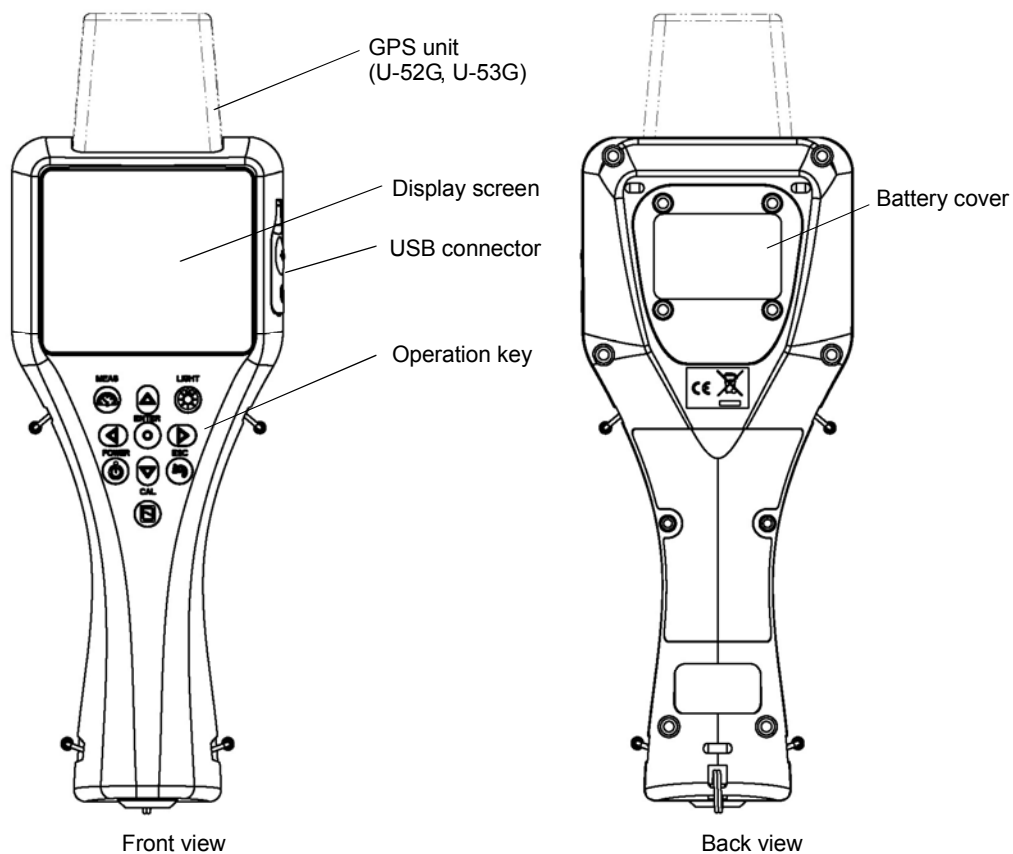
"✓" indicates a measurable parameter.

2.2 Packing list

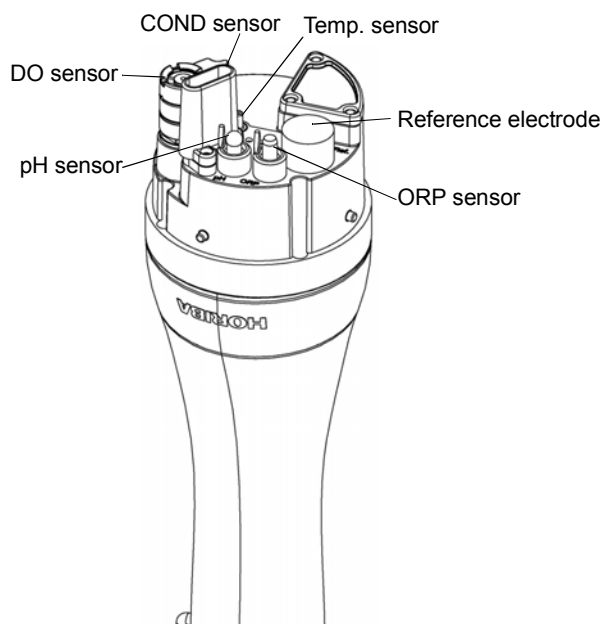
Parts Name	Quantity	Note
Control unit	1	
Sensor probe	1	
pH sensor	1	
ORP sensor	1	
Reference electrode	1	
DO sensor	1	
Turbidity sensor	1	Not included with U-51.
pH 4 standard solution	1	500 mL
pH reference internal solution	1	250 mL
DO sensor internal solution set	1	<ul style="list-style-type: none"> ● Internal solution (50 mL) ● Sandpaper (#8000, #600) ● Syringe
DO Membrane spare parts set	1	
Spanner for DO sensor	1	
Cleaning brush	1	
calibration cup	1	transparent calibration cup+black calibration cup
Bag	1	
Strap	1	
Alkaline batteries	4	LR14
Silicon grease	1	
Instruction manual	1	

2.3 Parts name and functions

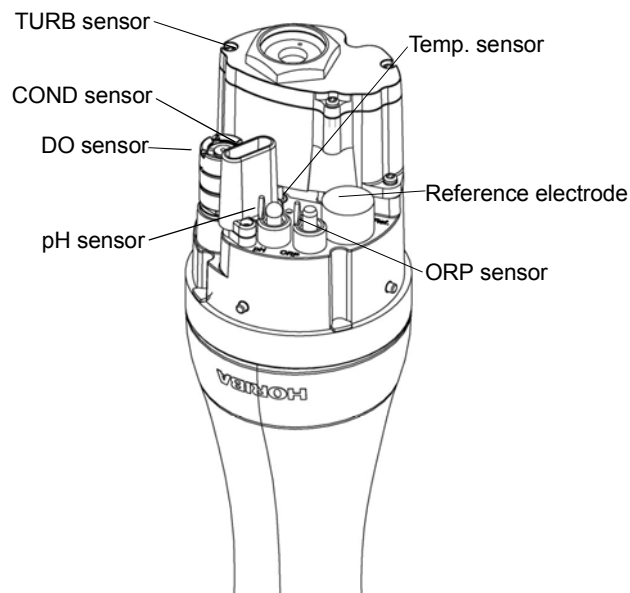
● Display



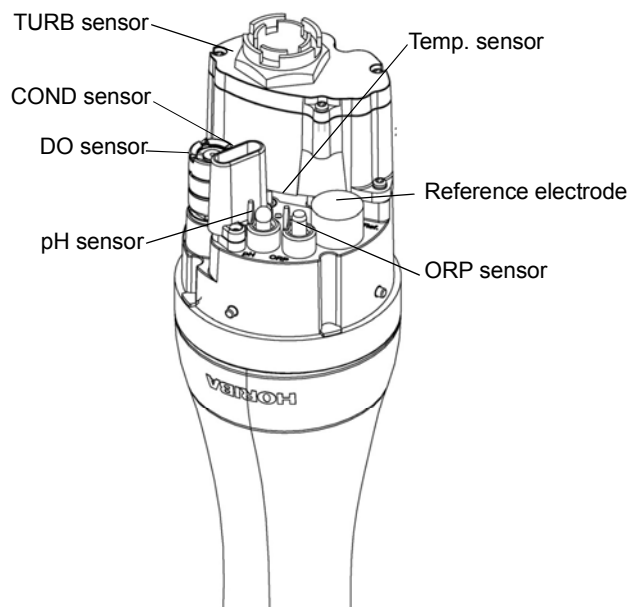
● Sensor probe (U-51)



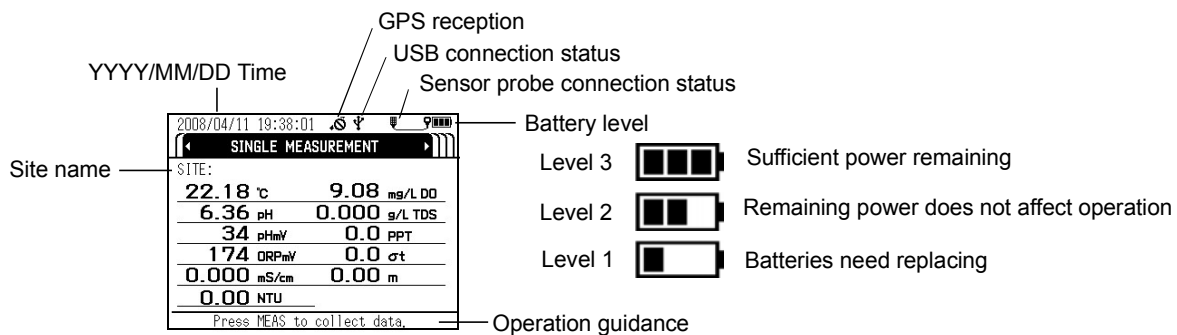
● Sensor probe (U-52)













● Sensor probe (U-53)



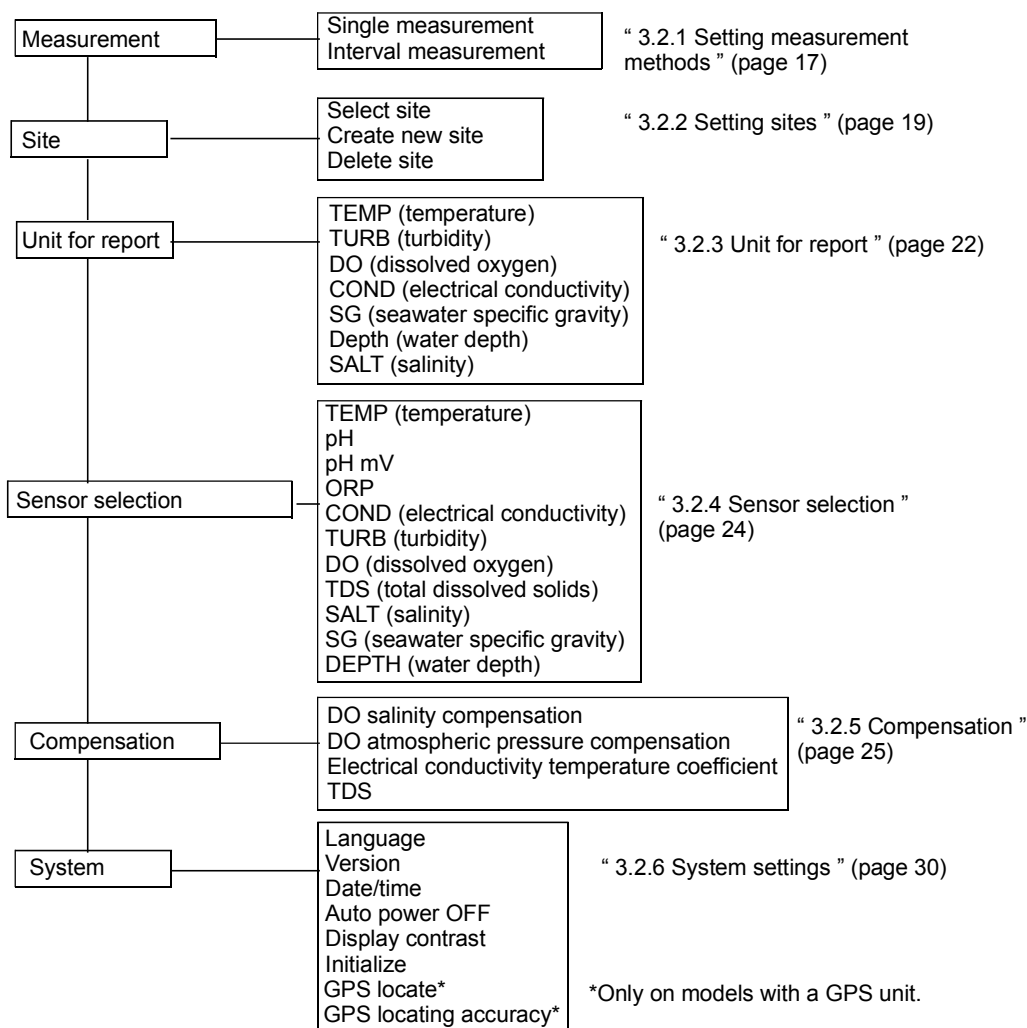
● Display screen



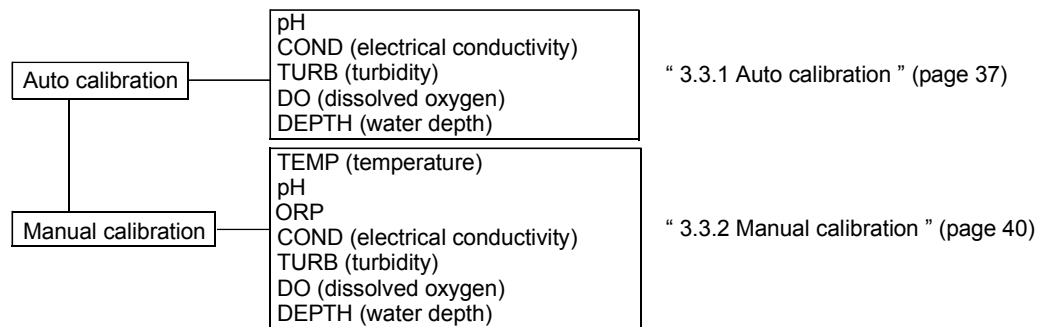
● Operation key

	Key name	description
POWER 	POWER key	Turns the system's power ON/OFF. The initial screen appears immediately after turning the power ON.
MEAS 	MEAS key	<p>When pressed in the measurement screen, used to set the measurement values of all the measurement parameters. Measurement values flash until the data stabilizes.</p> <p>When pressed in the setting, calibration or data operation screen, returns to the measurement screen.</p>
ENTER 	ENTER key	Used to execute functions, set entered values or store data in memory.
CAL 	CAL key	Switches to the calibration screen.
ESC 	ESC key	Returns to the immediately preceding operation.
LIGHT 	LIGHT key	<p>Turns the backlight ON/OFF.</p> <ul style="list-style-type: none"> ● Using the backlight shortens battery life. ● The backlight does not light for approx. 3 seconds after power ON. ● When the sensor probe is connected while the display's backlight is lit, the backlight goes out for approx. 3 seconds.
	Left key	Moves the cursor to the left.
	Right key	Moves the cursor to the right.
	Up key	Moves the cursor up.
	Down key	Moves the cursor down.

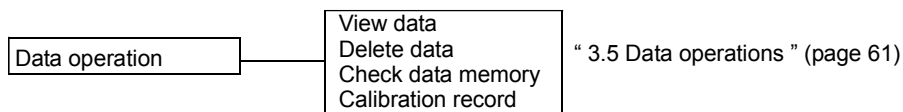
2.4 Setting menu items



2.5 Calibration menu items



2.6 Data operation menu items



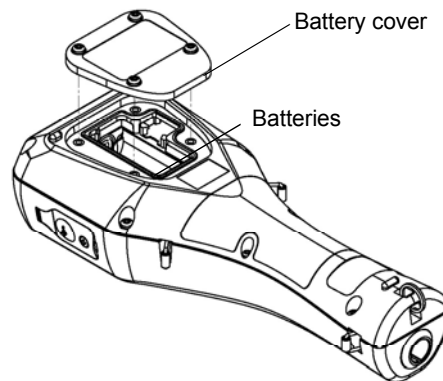
3 Basic Operation

3.1 System setup

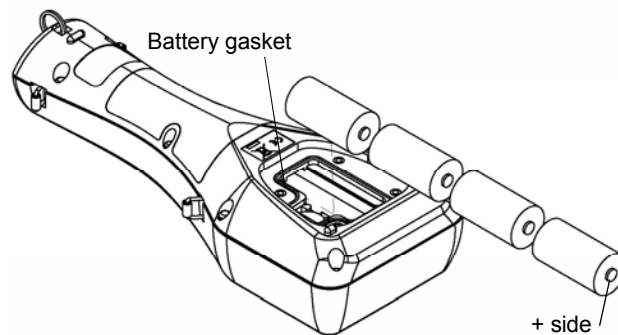
3.1.1 Inserting and replacing the batteries

The control unit is shipped without batteries. Follow the steps below to insert the batteries when using the system for the first time or replacing old batteries.

- 1. Loosen the 4 screws on the battery cover and remove the cover.**
(No. 2 Phillips head screwdriver)



- 2. If replacing the batteries, discard the old batteries.**
- 3. Insert new batteries in the control unit.**
Check that the battery gasket is not dirty or twisted.



- 4. Replace the battery cover and fasten it with the 4 screws.**
Tighten the screws to no more than 0.5 N·m.

Note

- Data and settings will not be lost when the batteries are replaced.
- If dirty or twisted, the battery gasket will fail to keep the batteries dry. Check its condition before closing the cover.
- To ensure long service life, replacing the battery gasket periodically (once a year) is recommended.

Precautions when using dry cell batteries

- Batteries to use: LR14 alkaline dry cell batteries (C-size dry cell batteries) or rechargeable nickel-metal hydride dry cell batteries (C-size)
Do not use manganese batteries.
- Dry cell batteries used incorrectly may leak or burst. Always observe the following
 - Orient the batteries correctly (positive and negative ends in correct positions).
 - Do not combine new and used batteries, or batteries of different types.
 - Remove the batteries when not using the system for a prolonged period.
 - If batteries leak, have the system inspected at your nearest Horiba service station.

● Battery life

- The battery life for continuous operation when using C-size alkaline dry cell batteries is approx. 70 hours.
- Using the backlight consumes a proportionate amount of battery power, shortening battery life.
- Searching position information using the GPS unit consumes a proportionate amount of battery power, shortening battery life.
- Nickel-metal hydride secondary batteries can be used, but the battery life is not guaranteed since it will vary according to usage (number of times data is saved, number of charges and amount of each charge). In general, secondary batteries have one-half to one-third the life of C-size alkaline batteries.
- The 70-hour battery life figure applies to a control unit operating temperature of 20°C or more. The battery characteristics shorten the battery life at operating temperatures lower than 20°C, so check the remaining battery level, and replace the batteries before it reaches Level 1.
- The batteries packed with the system at the time of shipment are for checking operation. Their life is not guaranteed.
- The 70-hour battery life figure is the amount of operating time the batteries can provide until the system stops operating. The system may fail during operation if the remaining battery level is low, so it is a good idea to check the remaining battery level and replace the batteries with new ones well before the batteries run out completely.

U-51/52

Battery life: 70 hours (backlight off)

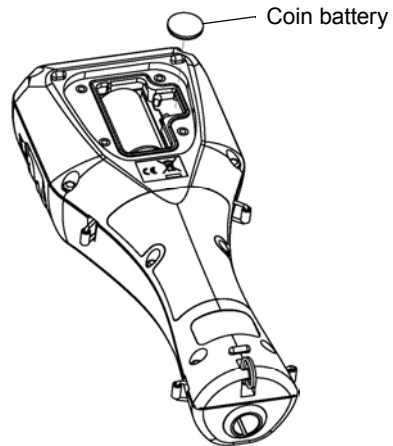
U-53

Battery life: 500 measurements (backlight off)

- Since U-53 is designed for turbidity measurement with wiper, its battery life is estimated in terms of the number of turbidity measurement sequences performed.
- Battery power is also consumed by measurement operations other than turbidity measurement.
- The battery life when turbidity measurement is not performed is approx. 70 hours.

3.1.2 Replacing the coin battery

- Coin battery to use: CR-2032
- The coin battery is only for the clock. It will provide problem-free operation for three years, but when using the clock continuously, it should be replaced every two years as a precaution.
- When replacing the coin battery for the clock, leave the control unit ON. If the coin battery is replaced when the control unit is turned OFF, the clock will be reset to the default settings.



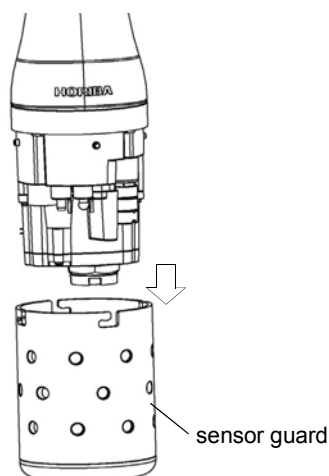
3.1.3 Attaching sensors

Note

- When attaching or replacing a sensor, wipe any moisture off the sensor probe and sensor.
- Be sure to keep water out of sensor connectors. If moisture comes in contact with a sensor connector, blow-dry it with dry air.
- The sensor probe is not waterproof when the sensor is not mounted.
- Take care not to tighten the sensor too much.

● Attaching the pH sensor

1. Remove the sensor guard.

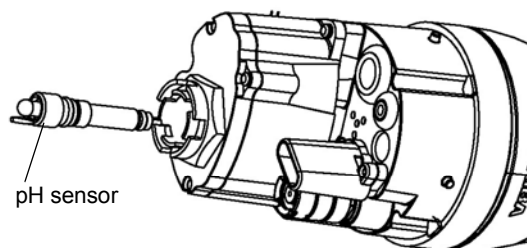


2. Remove the sensor plug.
3. Coat the pH sensor O-ring with a thin layer of silicon grease (part No. 3014017718).

Note

Be sure no grease from the O-ring gets on the sensor connector. If the sensor connector gets grease on it, wipe it off with a soft cloth soaked in alcohol.

4. Make sure there is no moisture on the sensor probe's sensor connector (marked "pH").
5. Fasten the pH sensor securely by hand.



6. Clean the sensor with an alcohol-soaked cloth.

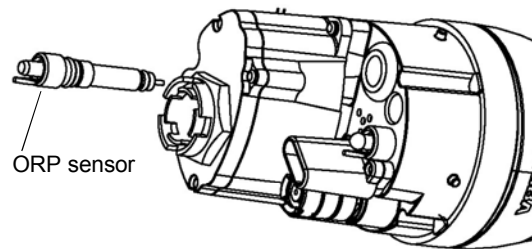
● **Attaching the ORP sensor**

1. Remove the sensor guard.
2. Remove the sensor plug.
3. Coat the ORP sensor O-ring with a thin layer of grease (part No. 3014017718).

Note

Be sure no grease from the O-ring gets on the sensor connector. If the sensor connector gets grease on it, wipe it off with a soft cloth soaked in alcohol.

4. Make sure there is no moisture on the sensor probe's sensor connector (marked "ORP").
5. Fasten the ORP sensor securely by hand.



6. Clean the sensor with an alcohol-soaked cloth.

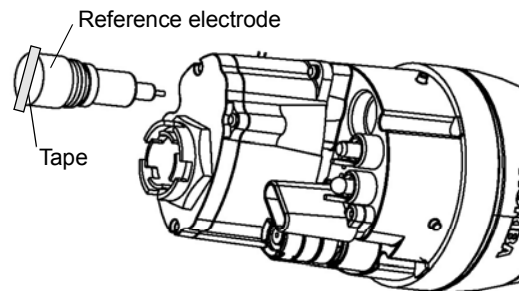
● **Attaching the reference electrode**

1. Remove the sensor guard.
2. Remove the sensor plug.
3. Coat the reference electrode O-ring with a thin layer of grease (part No. 3014017718).

Note

Be sure no grease from the O-ring gets on the sensor connector. If the sensor connector gets grease on it, wipe it off with a soft cloth soaked in alcohol.

4. Make sure there is no moisture on the sensor probe's sensor connector (marked "REF").
5. Fasten the reference electrode securely by hand.
6. Remove the tape from the liquid junction part of the reference electrode.



● **Attaching the dissolved oxygen (DO) sensor**

1. Remove the diaphragm cap mounted on the DO sensor beforehand, and replace it with the new diaphragm cap provided. Replace the internal solution with fresh solution. The main component of the internal solution is potassium chloride (KCl), so the old solution can be disposed of down a sink or other drain.

Reference

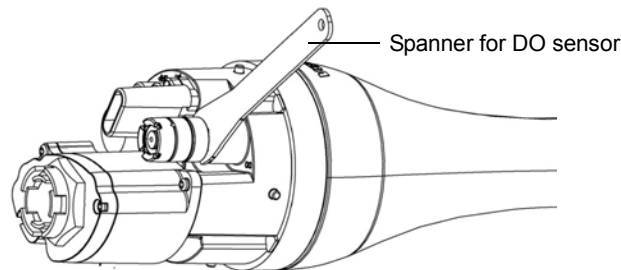
“ 4.5 Replacing the membrane cap ” (page 82)

2. Screw in the DO sensor to attach it, allowing the internal solution to overflow slightly.
3. Use a soft cloth to wipe off the internal solution that overflowed onto the DO sensor.
4. Remove the sensor guard.
5. Remove the sensor plug.
6. Coat the DO sensor O-ring with a thin layer of grease (part No. 3014017718).

Note

Be sure no grease from the O-ring gets on the sensor connector. If the sensor connector gets grease on it, wipe it off with a soft cloth soaked in alcohol.

7. Make sure there is no moisture on the sensor probe's sensor connector (marked "DO").

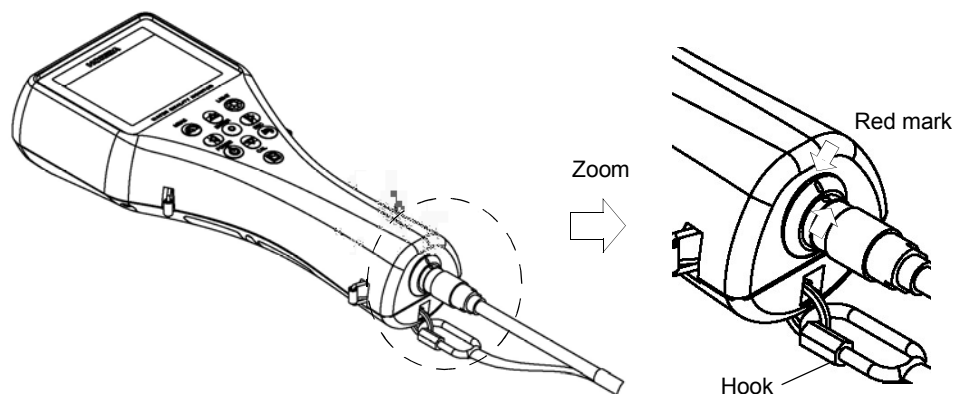


8. Fasten the DO sensor securely using the spanner for DO sensor.

3.1.4 Connecting the control unit and sensor probe

Note

Connect the control unit with its power OFF.

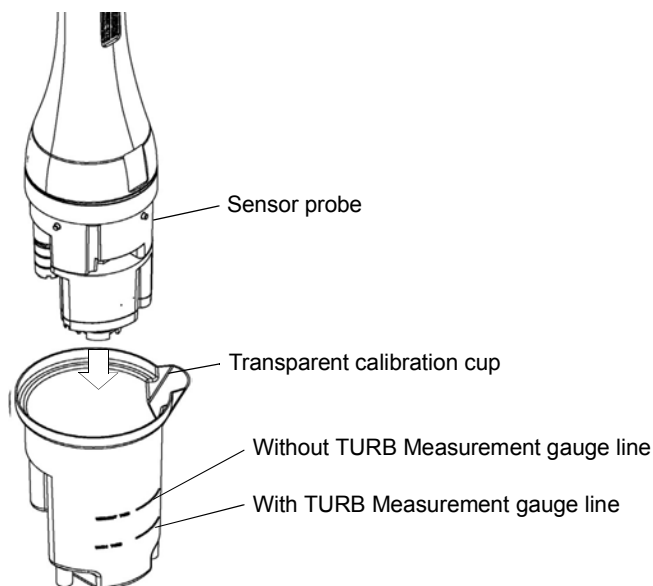


1. Align the red mark on the connector, and press the connector in until you hear it click.
2. Connect the cable's hook to the display.

3.1.5 Conditioning

Carry out the steps below when using the unit for the first time or when the system hasn't been used for 3 months or longer.

1. Fill the transparent calibration cup to the line with pH 4 standard solution.
The transparent calibration cup has With TURB Measurement and Without TURB Measurement gauge lines.
2. Insert the sensor probe in the transparent calibration cup.



Note

Check that all sensors are attached.

3. Press the control unit's **POWER** key to turn the power ON. Leave the unit for at least 20 minutes to condition the sensors.

Tip

The procedure for immersing the sensor probe in the pH standard solution is the same as that described in "3.3.1 Auto calibration" (page 37).

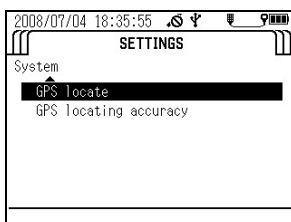
Auto calibration can be performed using the same pH 4 standard solution that was used in the conditioning procedure.

3.1.6 GPS (U-52G, U-53G)

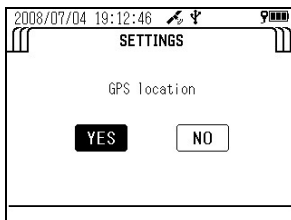
The GPS position measurement precision is proportional to the GPS position measurement time. When the position measurement precision increases, the position measurement time also increases. See "● GPS locating accuracy" (page 16) for how to set the position measurement precision. See "● GPS locate" (page 15) below for how to check acquired GPS data.

● GPS locate

1. Press the right (**▷**) key to switch the display to the "Setting" screen.
2. Press the down (**▽**) key to move the cursor to "System", then press the ENTER key.
3. Press the down (**▽**) key to move the cursor to "GPS locate", then press the ENTER key.

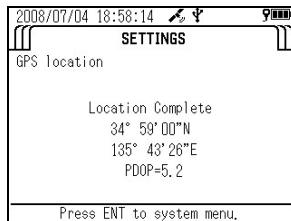


4. The message "Press ENT key to start position measurement." appears. Press the ENTER key.
5. The message "Execute GPS position measurement?" appears. Move the cursor to "YES", then press the ENTER key.

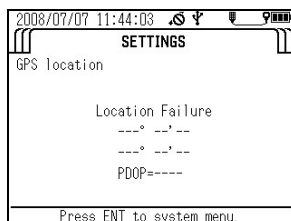


6. The message "Warming up. Please wait." appears. Wait until the system has finished warming up (approx. 20 seconds).

- Position measurement starts automatically when warmup has finished. Position measurement is performed up to 10 times.
- The GPS location complete screen appears after successful position measurement.

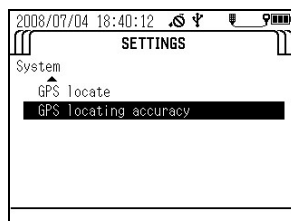


- The GPS location failure screen appears after position measurement has failed. Redo the measurement in a location free from obstacles, or wait for the meteorological conditions to improve before redoing the measurement.

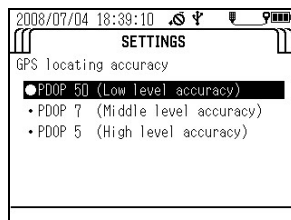


● **GPS locating accuracy**

1. Press the right (\triangleright) key to switch the display to the "Setting" screen.
2. Press the down (∇) key to move the cursor to "System", then press the ENTER key.
3. Press the down (∇) key to move the cursor to "GPS locating accuracy", then press the ENTER key.



4. The screen below appears. Move the cursor to the locating accuracy, then press the ENTER key. The black circle (●) indicates the currently set precision.



3.2 Settings

3.2.1 Setting measurement methods

This section describes how to set the measurement method.

● Measurement methods

● U-51/U-52

Single measurement	Pressing the MEAS key acquires the 5-second average for the selected measurement parameter.
Interval measurement	Pressing the MEAS key acquires and saves data in the set interval. The measurement interval can be set to any value between 10 seconds and 24 hours.

● U-53

The U-53 turbidity sensor uses a tungsten lamp. The lamp lights for approx. 10 seconds, and the average measurement value acquired during this interval is displayed.

Single measurement	Pressing the MEAS key acquires the 5-second average for the selected measurement parameter after wiper operation. The 10-second average is acquired when measuring turbidity.
Interval measurement	Pressing the MEAS key acquires and saves data in the set interval. The measurement interval can be set to any value between 10 seconds (final check of this value required; 30 seconds may be better for U-52) and 24 hour.

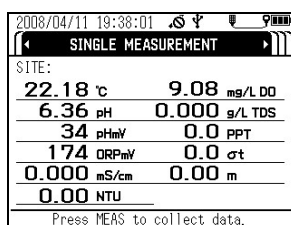
Reference

“ 3.4 Measurement ” (page 58)

● Operation method

1. Press the control unit's POWER key to turn the power ON.

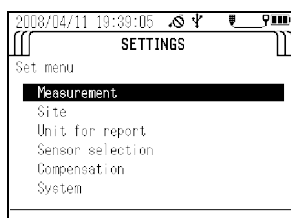
The "Measurement" screen appears after 2 or 3 seconds.



SINGLE MEASUREMENT	
SITE:	
22.18 °C	9.08 mg/L DO
6.36 pH	0.000 g/L TDS
34 pHmV	0.0 PPT
174 ORPmV	0.0 σt
0.000 mS/cm	0.00 m
0.00 NTU	
Press MEAS to collect data.	

2. Press the right (▸) key to switch the display to the "Setting" screen.

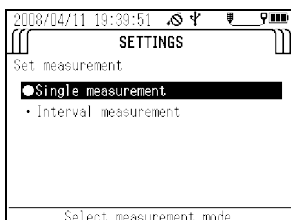
3. Press the down (▾) key to move the cursor to "Measurement", then press the ENTER key.



SETTINGS
Set menu
Measurement
Site
Unit for report
Sensor selection
Compensation
System

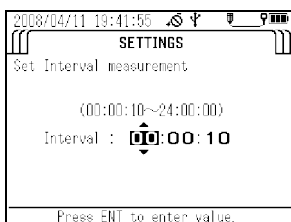
4. Press the down (▽) key to move the cursor to the desired measurement mode. Press the ENTER key to save the setting.

The black circle (●) indicates the currently selected measurement mode.



5. If you selected "Interval measurement", the display switches to the screen used to set the measurement interval. Press the up (△) and down (▽) keys to set the measurement interval.

The measurement interval can be set to any value between 10 seconds and 24 hours in the case of the U-51 and U-52, or between 30 seconds and 24 hours in the case of the U-53.



3.2.2 Setting sites

The site function allows position data to be connected to corresponding measurement data. Sites have the following specifications and features:

- Site names: Text data consisting of up to 20 one-byte alphanumeric characters, spaces, etc.
Site names can be used for control unit searches and as labels for computer processing.
Site names allow measurement data to be saved with a name corresponding to the actual location where it was measured.

You can use site information as a search key when viewing data uploaded by a PC or data saved in the control unit (see "3.5 Data operations" (page 61)).

● Selecting sites

You can select previously created sites. The black circle (●) indicates the name of the currently selected site. No sites are created at new purchasing or after initialization. Select a site after first creating one from the "Create new site" menu.

● Creating new sites

You can create and save new sites. Up to 20 site names can be registered.

● Deleting sites

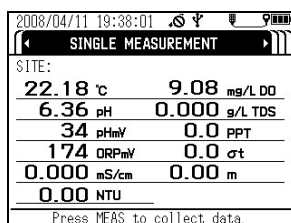
You can select a previously created site and delete it.

● Operation methods

● Selecting a site

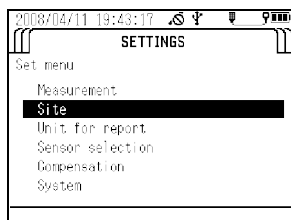
1. Press the control unit's **POWER** key to turn the power ON.

The "Measurement" screen appears after 2 or 3 seconds.



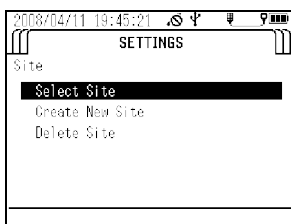
2008/04/11 19:38:01		9mm	
SINGLE MEASUREMENT			
SITE:			
22.18 °C	9.08 mg/L DO		
6.36 pH	0.000 g/L TDS		
34 pHmV	0.0 PPT		
174 ORPmV	0.0 σt		
0.000 mS/cm	0.00 m		
0.00 NTU			
Press MEAS to collect data.			

2. Press the right (►) key to switch the display to the "Setting" screen.
3. Press the down (▼) key to move the cursor to "Site", then press the ENTER key.



2008/04/11 19:43:17		9mm	
SETTINGS			
Set menu			
Measurement			
Site			
Unit for report			
Sensor selection			
Compensation			
System			

- Press the down (▽) key to move the cursor to "Select site", then press the ENTER key to display the names of the currently saved sites.



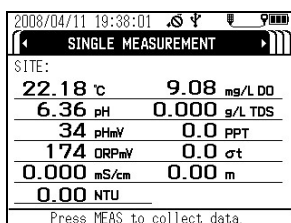
The black circle (●) indicates the currently selected site.



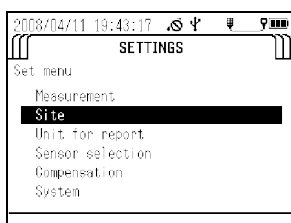
● Creating a new site

- Press the control unit's POWER key to turn the power ON.

The "Measurement" screen appears after 2 or 3 seconds.

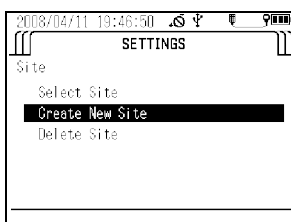


- Press the right (►) key to switch the display to the "Setting" screen.
- Press the down (▽) key to move the cursor to "Site", then press the ENTER key.

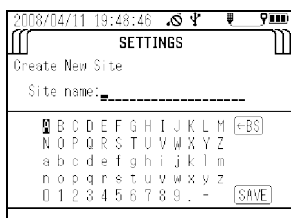


- Press the down (▽) key to move the cursor to "Create new site", then press the ENTER key.

Enter the desired site name (up to 20 alphanumeric non-Asian width characters).

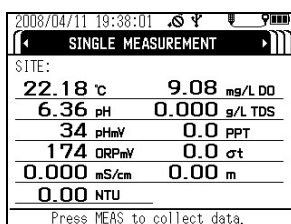


- Press the up (Δ), down (∇), right (\triangleright), and left (\triangleleft) keys to move the cursor to each letter or number to use in the name, then press the ENTER key to confirm the entered characters. To delete incorrectly entered characters, move the cursor to "BS" and press the ENTER key to start deleting from the last character. When you have finished entering the name, save it by moving the cursor to "SAVE" and pressing the ENTER key.

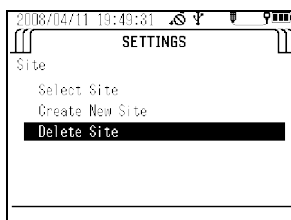


● Deleting a site

- Press the control unit's POWER key to turn the power ON.
The "Measurement" screen appears after 2 or 3 seconds.

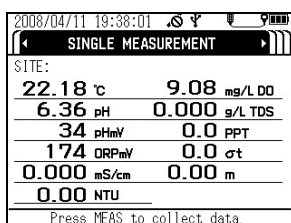


- Press the right (\triangleright) key to switch the display to the "Setting" screen.



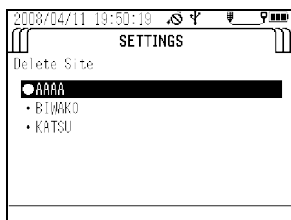
- Press the down (∇) key to move the cursor to "Site", then press the ENTER key.
- Press the down (∇) key to move the cursor to "Delete site", then press the ENTER key.

A list of the currently saved sites appears. The black circle (●) indicates the currently selected site.



5. Press the down (▽) key to move the cursor to the site to delete, then press the ENTER key to delete it.

The currently selected site can be deleted after a different site has been selected from the site selection menu or after all unselected sites have been deleted. The same site name cannot be registered more than once.



3.2.3 Unit for report

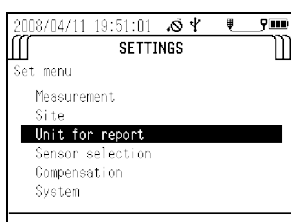
Note

Units can only be selected when the sensor probe is connected.

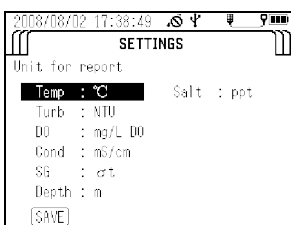
Follow the steps below to set the measurement units of measurement parameters. No units are displayed if a measurement parameter hasn't been selected in the measurement parameter selection screen (see " 3.2.4 Sensor selection " (page 24)).

1. Press the control unit's POWER key to turn the power ON.
The "Measurement" screen appears after 2 or 3 seconds.
2. Press the right (▷) key to switch the display to the "Setting" screen.
3. Press the down (▽) key to move the cursor to "Unit for report", then press the ENTER key.

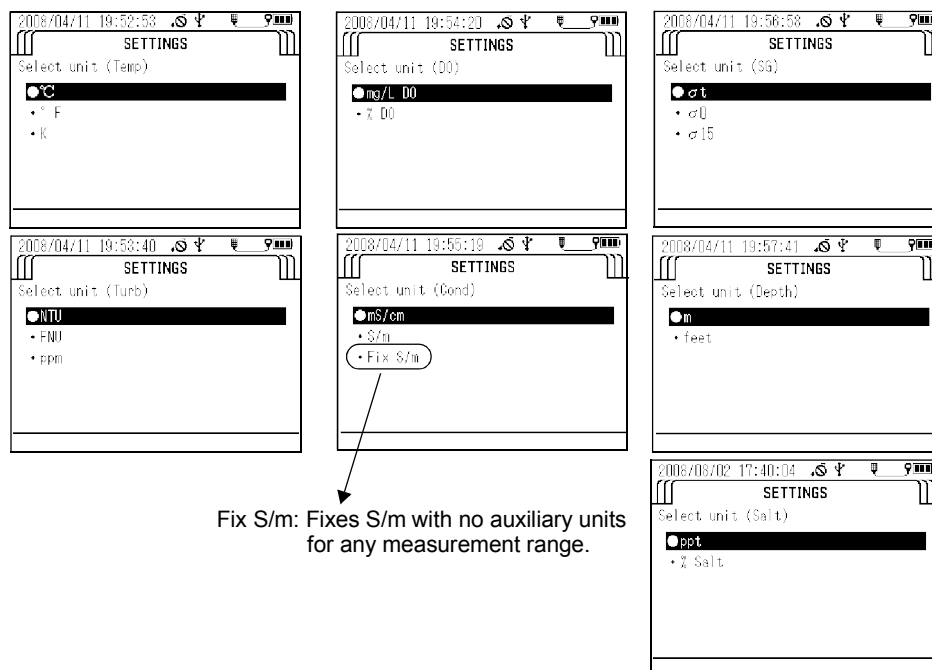
A list of the currently selected measurement parameters and their units appears. Note that measurement parameters not selected (in the measurement parameter selection screen) are not displayed.



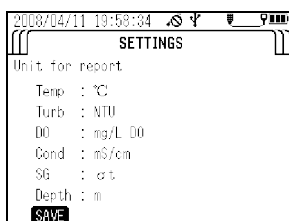
4. Press the up (△) and down (▽) keys to move the cursor to the item to change, then press the ENTER key.



5. A list of the units that can be selected appears. The black circle (●) indicates the currently selected unit. Press the up (Δ) and down (∇) keys to move the cursor to the desired unit, then press the ENTER key.



6. To save the changes, press the up (Δ) and down (∇) keys to move the cursor to **SAVE**, then press the ENTER key. If you don't want to save the changes, press the ESC key.



3.2.4 Sensor selection

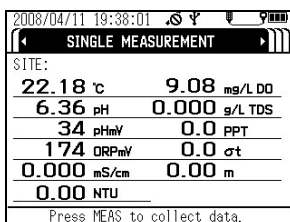
Note

Measurement parameters can only be selected when the sensor probe is connected.

You can set between 1 and 11 measurement parameters to display in the control unit screen. Follow the steps below to select the desired measurement parameters.

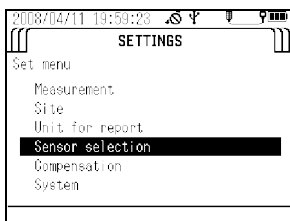
1. Press the control unit's **POWER** key to turn the power ON.

The "Measurement" screen appears after 2 or 3 seconds.

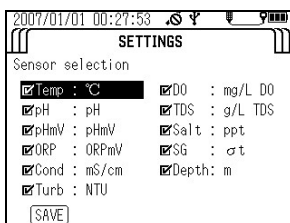


2. Press the right (**▷**) key to switch the display to the "Setting" screen.
3. Press the down (**▽**) key to move the cursor to "Sensor selection", then press the ENTER key.

A list of the measurement parameters that can be set and the currently set units are displayed.



4. Move the cursor to each measurement parameter to change, then press the ENTER key.
A check in the check box of a measurement parameter indicates it will be displayed.
5. To save the changes, press the up (**△**), down (**▽**), left (**◀**) and right (**▶**) keys to move the cursor to **SAVE**, then press the ENTER key. If you don't want to save the changes, press the ESC key.



Note

Available measurement parameters differ according to product specifications.

3.2.5 Compensation

Note

Compensation settings can only be made when the sensor probe is connected.

U-50 series have following functions of compensation.

- Salinity compensation and atmospheric pressure compensation for dissolved oxygen (DO)
- Temperature compensation for conductivity (COND)
- Setting total dissolved solid (TDS) coefficient for TDS

● Salinity compensation (DO)

The dissolved oxygen (DO) value is presented higher than actual value if salinity compensation is not added, because the increase of salinity gives higher DO value. To obtain correct value salinity compensation is needed. The following modes are available for calculation of salinity compensation.

AUTO Salinity compensation is performed automatically with salinity converted from conductivity.

Value input: Press the up (Δ) and down (∇) keys to enter a setting value when the salinity is known.

1. Press the control unit's POWER key to turn the power ON.

The "Measurement" screen appears after 2 or 3 seconds.

2008/04/11 19:38:01	
SINGLE MEASUREMENT	
SITE:	
22.18 °C	9.08 mg/L DO
6.36 pH	0.000 g/L TDS
34 pHmV	0.0 PPT
174 ORPmV	0.0 σt
0.000 mS/cm	0.00 m
0.00 NTU	
Press MEAS to collect data.	

2. Press the right (\triangleright) key to switch the display to the "Setting" screen.

3. Press the down (∇) key to move the cursor to "Compensation", then press the ENTER key.

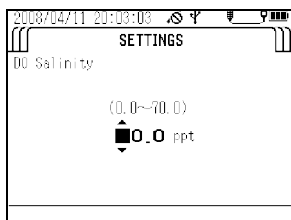
2008/04/11 20:01:14	
SETTINGS	
Set menu	
Measurement	
Site	
Unit for report	
Sensor selection	
Compensation	
System	

4. Press the down (∇) key to move the cursor to "DO salinity compensation", then press the ENTER key to toggle the setting between "Auto" and "Input mode".

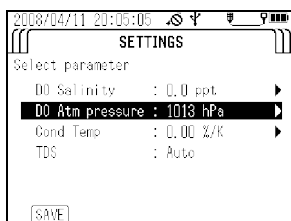
Default: Auto

2008/04/11 20:02:10	
SETTINGS	
Select parameter	
DO Salinity	: 0.0 ppt
DO Atm pressure	: OFF
Cond Temp	: 0.00 Z/K
TDS	: Auto
(SAVE)	

5. If you selected "Input mode", press the right (\triangleright) key to display the compensation value input screen. Press the up (Δ) and down (∇) keys to enter the desired value, then press the ENTER key to set it.



6. To save the change, press the up (Δ) and down (∇) keys to move the cursor to SAVE, then press the ENTER key. If you don't want to save the change, press the ESC key.

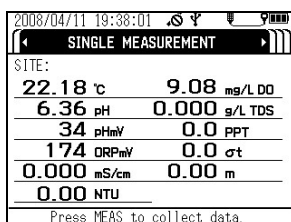


● Atmospheric pressure compensation (DO)

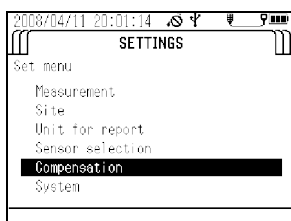
Differences in the atmospheric pressure of the measurement location influence the Dissolved Oxygen (DO) measurement. By setting (input) the actual atmospheric pressure of the measurement location into the control unit, it is possible to standardize the measured Dissolved Oxygen (DO) value to a value at the standard atmospheric pressure (1013 hPa).

1. Press the control unit's POWER key to turn the power ON.

The "Measurement" screen appears after 2 or 3 seconds.

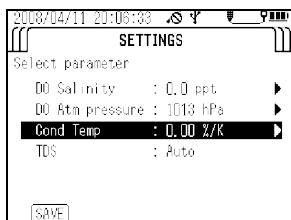


2. Press the right (\triangleright) key to switch the display to the "Setting" screen.
3. Press the down (∇) key to move the cursor to "Compensation", then press the ENTER key.

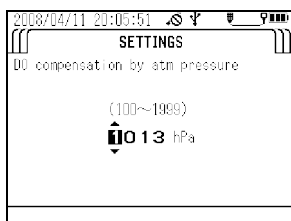


4. Press the down (▽) key to move the cursor to "Cond Temp", then press the ENTER key to toggle the setting between "OFF" and "Input mode".

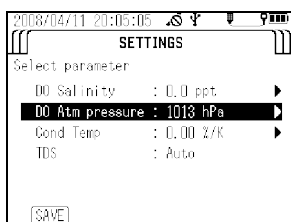
Default: OFF



5. If you selected "Input mode", press the right (▷) key to display the compensation value input screen. Press the up (▲) and down (▼) keys to enter the desired value, then press the ENTER key to set it.



6. To save the change, press the up (▲) and down (▼) keys to move the cursor to SAVE, then press the ENTER key. If you don't want to save the change, press the ESC key.

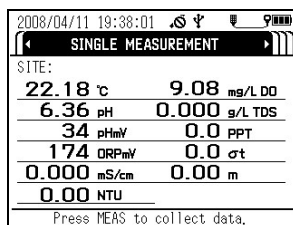


● Temperature compensation for conductivity (COND)

Sample conductivity (COND) varies with temperature, and this control unit uses a temperature compensation coefficient to automatically standardize the conductivity (COND) at 25°C. The initial setting coefficient is 2 %/°C, which is the generally used.

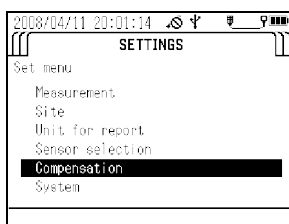
1. Press the control unit's POWER key to turn the power ON.

The "Measurement" screen appears after 2 or 3 seconds.

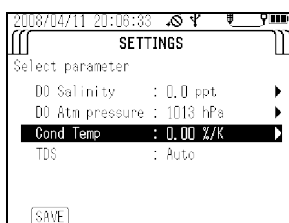


2. Press the right (▷) key to switch the display to the "Setting" screen.

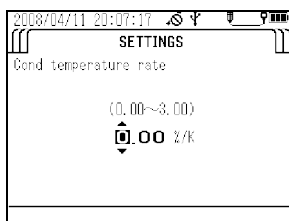
3. Press the down (▽) key to move the cursor to "Compensation", then press the ENTER key.



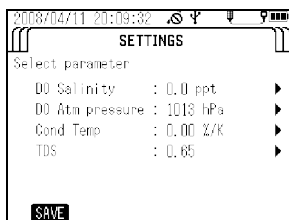
4. Press the down (▽) key to move the cursor to "Cond Temp", then press the ENTER key to toggle the setting between "OFF" and "Input mode".
Default: OFF



5. If you selected "Input mode", press the right (▷) key to display the compensation value input screen. Press the up (△) and down (▽) keys to enter the desired value, then press the ENTER key to set it.



6. To save the change, press the up (△) and down (▽) keys to move the cursor to SAVE, then press the ENTER key.
If you don't want to save the change, press the ESC key.



● Setting a total dissolved solid (TDS) coefficient

The total dissolved solid amount (TDS) is a converted value obtained by multiplying the conductivity (COND) by a known coefficient. The coefficient initially set for the control unit is based on a conversion for KCl and CaCO_3 solutions and it depends on the conductivity (COND) value as shown below.

Conductivity (COND) (S/m)	Conversion coefficient
< 0.05	0.65
0.05 to 0.5	0.64
0.5 to 1	0.63
1 to 3	0.62
3 to 5	0.61
> 5	0.60

1. Press the control unit's POWER key to turn the power ON.

The "Measurement" screen appears after 2 or 3 seconds.

2008/04/11 19:38:01	
SINGLE MEASUREMENT	
SITE:	
22.18 °C	9.08 mg/L DO
6.36 pH	0.000 g/L TDS
34 pHmV	0.0 PPT
174 ORPmV	0.0 σt
0.000 mS/cm	0.00 m
0.00 NTU	
Press MEAS to collect data.	

2. Press the right (▶) key to switch the display to the "Setting" screen.

3. Press the down (▽) key to move the cursor to "Compensation", then press the ENTER key.

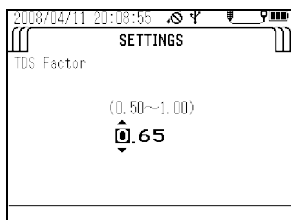
2008/04/11 20:01:14	
SETTINGS	
Set menu	
Measurement	
Site	
Unit for report	
Sensor selection	
Compensation	
System	

4. Press the down (▽) key to move the cursor to "TDS", then press the ENTER key to toggle the setting between "AUTO" and "Input mode".

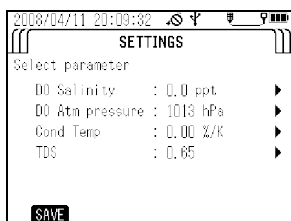
Default: Auto

2008/04/11 20:08:15	
SETTINGS	
Select parameter	
DO Salinity	: 0.0 ppt ▶
DO Atm pressure	: 1013 hPa ▶
Cond Temp	: 0.00 2/K ▶
TDS	: 0.65 ▶
[SAVE]	

5. If you selected "Input mode", press the right (\triangleright) key to display the compensation value input screen. Press the up (Δ) and down (∇) keys to enter the desired value, then press the ENTER key to set it.



6. To save the change, press the up (Δ) and down (∇) keys to move the cursor to SAVE, then press the ENTER key. If you don't want to save the change, press the ESC key.



3.2.6 System settings

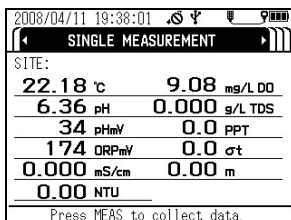
The system settings let you change the display language, check the system software version, set the date/time, set the auto power OFF time, set the display contrast, and initialize the settings.

● Display language

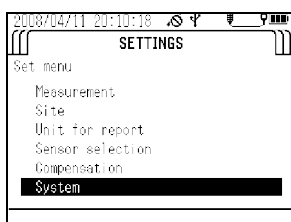
Follow the steps below to select either English or Japanese as the display language.

1. Press the control unit's POWER key to turn the power ON.

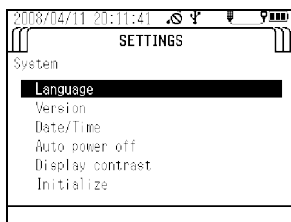
The "Measurement" screen appears after 2 or 3 seconds.



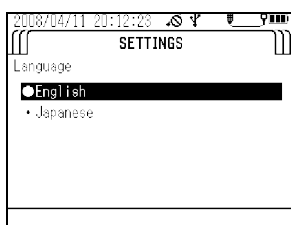
2. Press the right (\triangleright) key to switch the display to the "Setting" screen.
3. Press the down (∇) key to move the cursor to "System", then press the ENTER key.



4. Press the down (▽) key to move the cursor to "Language", then press the ENTER key.



5. A list of the supported display languages appears. Press the up (△) and down (▽) keys to move the cursor to the desired language, then press the ENTER key.
The black circle (●) indicates the currently selected display language.



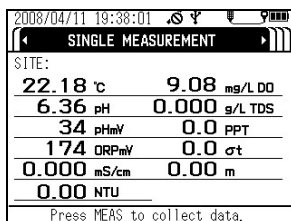
● Version

Follow the steps below to display the program No. and version of the control unit and sensor probe software.

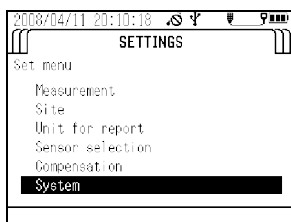
The program No. and version of the sensor probe software will not be displayed if the sensor probe is not connected.

1. Press the control unit's **POWER** key to turn the power ON.

The "Measurement" screen appears after 2 or 3 seconds.

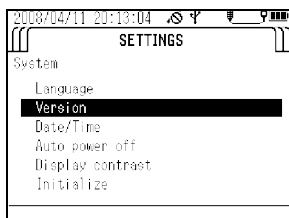


2. Press the right (▷) key to switch the display to the "Setting" screen.
3. Press the down (▽) key to move the cursor to "System", then press the ENTER key.



4. Press the down (▽) key to move the cursor to "Version", then press the ENTER key.

The program No. of the control unit and sensor probe software appears.

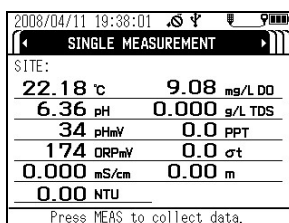


● Setting the date/time

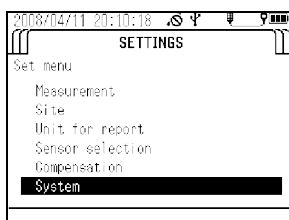
Follow the steps below to set the date and time.

1. Press the control unit's POWER key to turn the power ON.

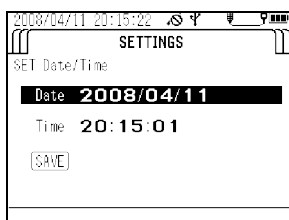
The "Measurement" screen appears after 2 or 3 seconds.



2. Press the right (►) key to switch the display to the "Setting" screen.
3. Press the down (▽) key to move the cursor to "System", then press the ENTER key.

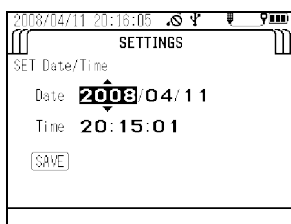


4. Press the down (▽) key to move the cursor to "Date/time", then press the ENTER key.

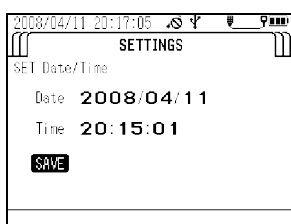


5. Move the cursor to the date, then press the ENTER key.

6. Press the right (\triangleright) key to move the cursor to the year, month, day, hour, minute and second, and press the up (Δ) and down (∇) keys to enter each value.



7. When finished entering settings, press the ENTER key to move the cursor to SAVE, then press the ENTER key again to save the settings.

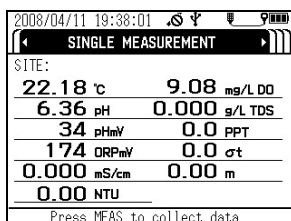


● Setting the auto power OFF time

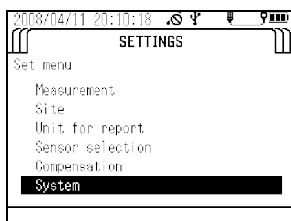
Follow the steps below to set the time for the auto power OFF function (which turns the power OFF automatically when no operation is performed for the preset amount of time).

1. Press the control unit's **POWER** key to turn the power ON.

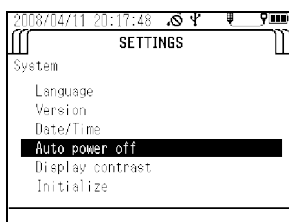
The "Measurement" screen appears after 2 or 3 seconds.



2. Press the right (\triangleright) key to switch the display to the "Setting" screen.
 3. Press the down (∇) key to move the cursor to "System", then press the ENTER key.

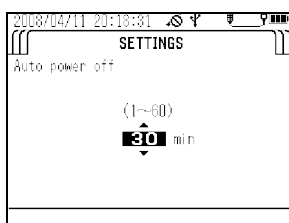


4. Press the down (▽) key to move the cursor to "Auto power OFF", then press the ENTER key.



5. Press the up (△) and down (▽) keys to select the desired time setting, then press the ENTER key.

You can select OFF, or settings of 1, 2, 5, 10, 20, 30 or 60 minutes. Default: 30 minutes

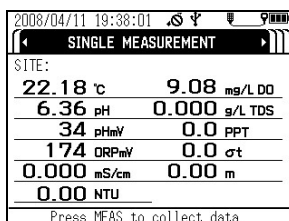


● Display contrast

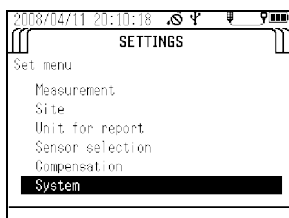
Follow the steps below to adjust the display's contrast.

1. Press the control unit's POWER key to turn the power ON.

The "Measurement" screen appears after 2 or 3 seconds.



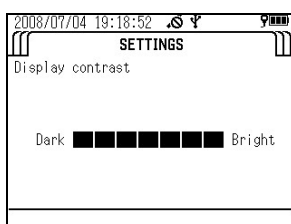
2. Press the right (►) key to switch the display to the "Setting" screen.
3. Press the down (▽) key to move the cursor to "System", then press the ENTER key.



4. Press the down (▽) key to move the cursor to "Display contrast", then press the ENTER key.



5. Press the left (◀) and right (▶) keys to adjust the contrast. Adjustment can be made in 26 steps.



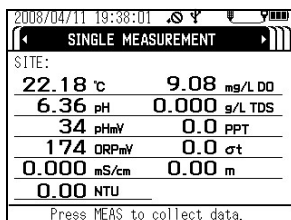
6. Press the ENTER key.

● Initialization

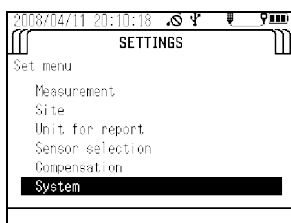
Follow the steps below to restore all the settings except date/time to their factory defaults.

1. Press the control unit's **POWER** key to turn the power ON.

The "Measurement" screen appears after 2 or 3 seconds.



2. Press the right (▶) key to switch the display to the "Setting" screen.
3. Press the down (▽) key to move the cursor to "System", then press the ENTER key.



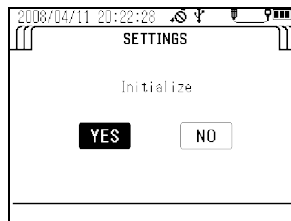
4. Press the down (▾) key to move the cursor to "Initialize", then press the ENTER key.



5. . Press the ENTER key again.



6. A confirmation message appears asking whether to execute initialization. Press the left (◀) key to move the cursor to YES, then press the ENTER key.
The message "Initialize Complete" appears to indicate the process has finished.



3.3 Calibration

To obtain correct measurement values, the sensors need to be calibrated using standard solution before measurement. You can select simultaneous auto calibration of the pH, COND and TURB sensors in pH4 standard solution and DO and DEP sensors simultaneously in air, or manual calibration of individual measurement parameters. You can check the result of the previous calibration using the procedure on “ 3.5.4 Checking the calibration record ” (page 66).

Note

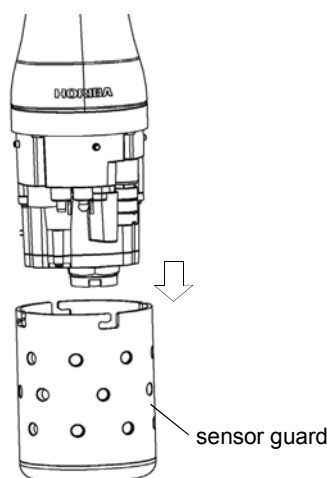
- Wait at least 20 minutes after turning the system power ON before calibrating the DO sensor.
- Make the DO and COND compensation settings before calibration since these settings are applied during calibration.
- You can select only the desired parameters for calibration and calibrate just those parameters (see “ 3.2.4 Sensor selection ” (page 24).
- Use approx. 200 mL of standard solution in the calibration cup.
- Calibration data is stored in the sensor probe.

3.3.1 Auto calibration

Tip

- The following parameters are calibrated (at 25°C):
 pH: Set to 4.01 (zero-point calibration); the span is adjusted to the factory default value.
 COND: 0.449 S/m (4.49 mS/cm, span calibration); the zero point is adjusted to the factory default value.
 TURB: 0 NTU (zero-point calibration); the span is adjusted to the factory default value.
 DO: 8.92 mg/L (span calibration); the zero point is adjusted to the factory default value.
 DEP: 0 m (zero-point calibration); the zero point is adjusted to the factory default value.
- If the air temperature changes, the readout value may not be stable. Wait approx. an hour before calibrating the system.

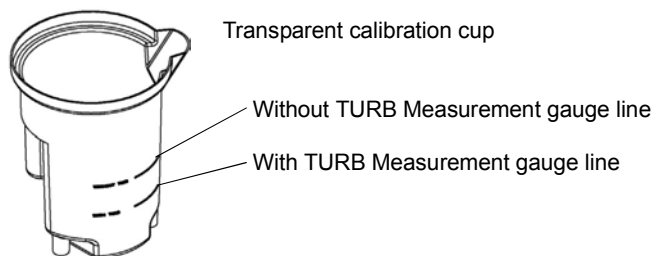
1. Remove the sensor guard and wash the sensor probe 2 or 3 times with deionized water.



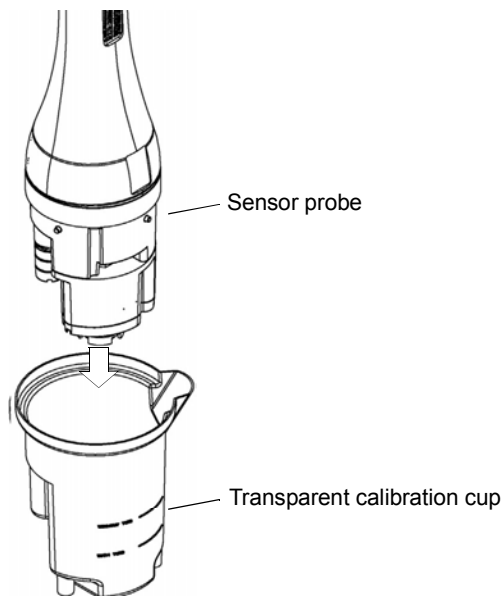
2. Remove the transparent calibration cup.

3. Fill the transparent calibration cup to the line with pH 4 standard solution.

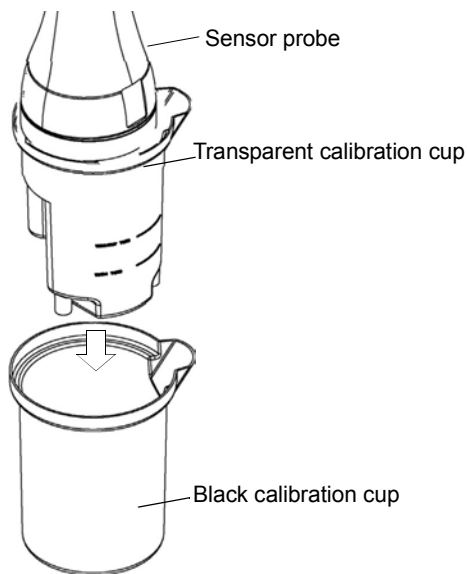
The transparent calibration cup has With TURB Measurement and Without TURB Measurement gauge lines.



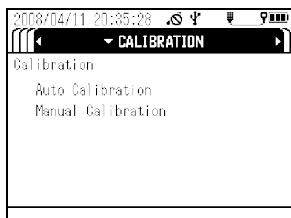
4. Immerse the sensor probe in the transparent calibration cup, and check that there are no air bubbles on the sensor.



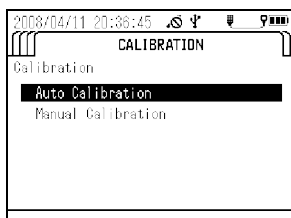
5. With the sensor probe still in the transparent calibration cup, place the transparent calibration cup into the black calibration cup and start calibration.



6. Press the control unit's CAL key to set the calibration mode.



7. Press the down (▽) key to move the cursor to "Auto calibration", then press the ENTER key.



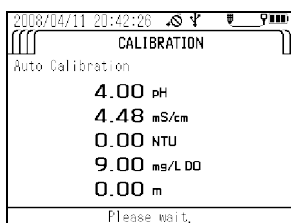
8. Check that the pH sensor, ORP sensor, reference electrode, COND sensor, TURB sensor and temperature sensor are submerged in the pH 4 standard solution, then press the ENTER key.



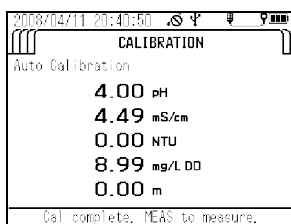
9. When all the sensor values have stabilized, press the ENTER key to start calibration.

Note

Do not remove the sensor probe from the calibration solution. U-53 turbidity data will display "----" until the calibration is completed.



Calibration is finished when the message "Cal complete. MEAS to measure." appears. Press the MEAS key to set the measurement screen, then start measurement.



If a calibration error occurs, start calibration after first resolving the issue according to the instructions in "4.6 Troubleshooting" (page 84).

3.3.2 Manual calibration

The procedures below describe how to calibrate each sensor individually.

Note

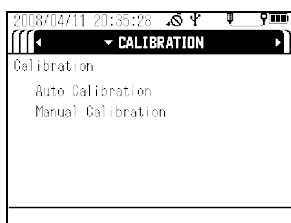
The displayed units are the units set by selecting "Unit for report" in the "Setting" screen.

● Temperature (TEMP) calibration

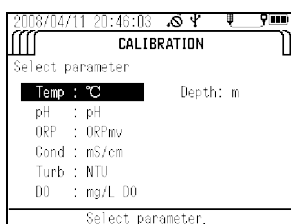
1. Fill a bucket or similar container with water of a known temperature, and insert the sensor probe in it.

Wait 5 minutes before starting calibration to allow the sensor probe temperature to stabilize.

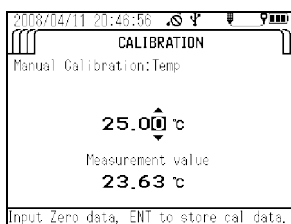
2. Press the control unit's CAL key to set the calibration mode.
3. Press the down (▽) key to move the cursor to "Manual calibration", then press the ENTER key.



4. In the parameter selection screen, move the cursor to "Temp", then press the ENTER key.



5. Press the up (Δ) and down (∇) keys to set the calibration value - the temperature of the water containing the submerged sensor probe.



6. Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.

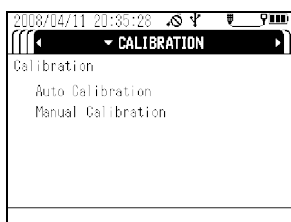
Calibration is finished when the message 'Cal complete. CNT to measure.' appears.

● pH calibration

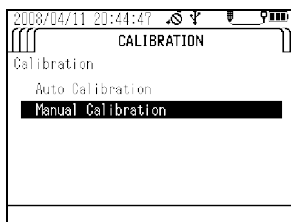
Note

You can select one calibration point (zero-point calibration) or two calibration points (zero-point calibration and span calibration). Carry out two calibration procedures to ensure good measurement precision throughout all measurement ranges.

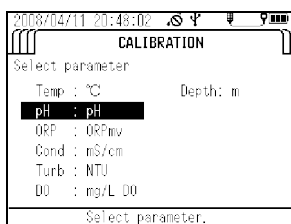
1. First, calibrate the zero point. Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with pH 7 standard solution.
2. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.
3. Press the control unit's CAL key to set the calibration mode.



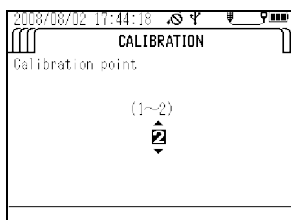
4. Press the down (∇) key to move the cursor to "Manual calibration", then press the ENTER key.



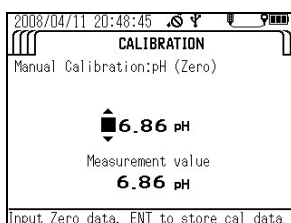
5. In the parameter selection screen, move the cursor to "pH", then press the ENTER key.



6. Set the number of calibration points, then press the ENTER key.



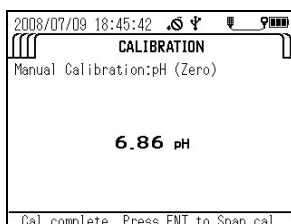
7. Press the up (Δ) and down (∇) keys to set the pH value of the pH 7 standard solution containing the submerged sensor probe at the measurement temperature



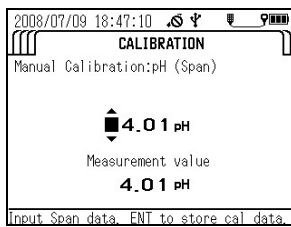
Temp. (°C)	pH 4 standard solution Phthalate	pH 7 standard solution Neutral phosphate	pH 9 standard solution Borate
0	4.01	6.98	9.46
5	4.01	6.95	9.39
10	4.00	6.92	9.33
15	4.00	6.90	9.27
20	4.00	6.88	9.22
25	4.01	6.86	9.18
30	4.01	6.85	9.14
35	4.02	6.84	9.10
40	4.03	6.84	9.07
45	4.04	6.84	9.04

8. Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.

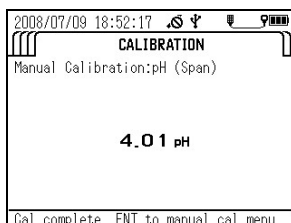
9. Press the ENTER key to start the span calibration procedure when the message "Cal complete. Press ENT to Span cal." appears.



10. Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with pH 4 or pH 9 standard solution.
11. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.
12. Press the up (Δ) and down (∇) keys to set the pH value of the pH 4 or pH 9 standard solution containing the submerged sensor probe at the measurement temperature.



13. Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.
14. Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter

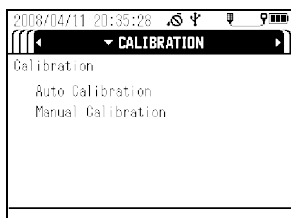


● ORP calibration

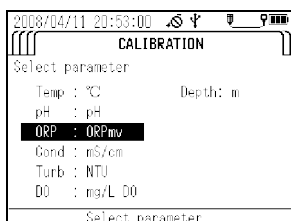
Note

- If the prepared ORP standard solution is left in open air for one hour or more, the solution may be transformed. For this reason ORP standard solution cannot be stored. Calibrate within one hour of preparing the solution.
- When measuring sample with low concentrations of oxidants and reductants after conducting an operational check using a standard substance, the measured values may not stabilize or the results of measurement might not be repeatable. If this is the case, start the measurement after immersing the sensors in the sample water sufficiently.
- Note that when measuring the ORP of solution with extremely low concentrations of oxidants and reductants, such as tap water, well water, or water treated with purifying equipment, there may be less responsiveness, repeatability, and stability, in general.
- When alkaline ion water is left for 5 minutes, its ORP undergoes changes significantly. Always measure alkaline ion water promptly.

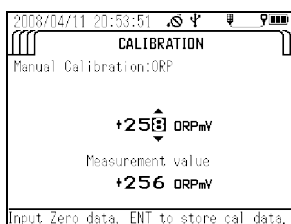
1. Fill a clean beaker with one bag of ORP standard powder No. 160-22 or No. 160-51. Add 250 mL of deionized water and agitate the solution thoroughly (there will be some excess quinhydrone (a black powder) that floats on the surface when agitating the solution). Fill the transparent calibration cup to the reference line with this standard solution.
2. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.
3. Press the control unit's CAL key to set the calibration mode.
4. Press the down (▽) key to move the cursor to "Manual calibration", then press the ENTER key.



5. In the parameter selection screen, move the cursor to ORP, then press the ENTER key.



6. Press the up (△) and down (▽) keys to set the mV value of the ORP standard solution containing the submerged sensor probe at the measurement temperature.



Indicated value of ORP standard solution at various temperatures (mV)

Temperature	160-22	16051
5	+274	+112
10	+271	+107
15	+267	+101
20	+263	+95
25	+258	+89
30	+254	+83
35	+249	+76
40	+244	+69

7. Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.
8. Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.

● Conductivity (COND) calibration

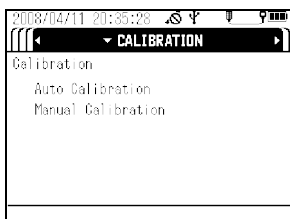
Note

- To support a wide range of sample concentrations, electrical conductivity is divided into three measurement ranges: 0.0 mS/m to 99.9 mS/m, 0.090 S/m to 0.999 S/m, and 0.9 S/m to 9.99 S/m.
- When manually calibrating conductivity, you can select two calibration points (one zero-point calibration point and a span calibration point for one of the three measurement ranges) or four calibration points (one zero-point calibration point and span calibration points for all three measurement ranges). Carry out the four calibration points to ensure good measurement precision throughout all measurement ranges.
- Make the compensation setting before calibration since this setting is applied during calibration. (Refer to “ 6.5.3 Temperature coefficient ” (page 101))

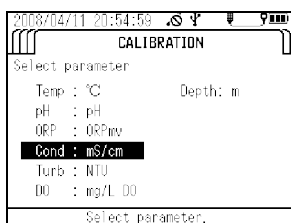
1. First prepare the standard solution. Dry Potassium chloride (KCl) powder (high-grade commercially available) at 105°C for two hours, and leave it to cool in a desiccator.
2. Consult the following table and weigh potassium chloride (KCl), then prepare three standard potassium chloride (KCl) solutions following the procedure below.

Potassium chloride (KCl) standard solution	Conductivity (COND) value	Potassium chloride (KCl) mass (g) at solution temperature of 25 °C	Calibration range
0.005 mol/L	71.8 mS/m (0.718 mS/cm)	0.373	0.0 mS/m to 99.9 mS/m (0.00 mS/cm to 0.999 mS/cm)
0.050 mol/L	0.667 S/m (6.67 mS/cm)	3.73	0.090 S/m to 0.999 S/m (1.00 mS/cm to 9.99 mS/cm)
0.500 mol/L	5.87 S/m (58.7 mS/cm)	37.2	0.9 S/m to 9.99 S/m (10.0 mS/cm to 99.9 mS/cm)

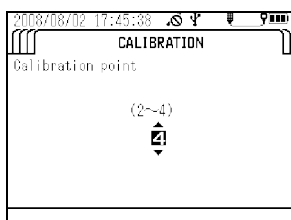
3. Dissolve the weighed Potassium Chloride (KCl) in deionized water.
4. Put the dissolved Potassium Chloride (KCl) into a 1 L measuring flask, and fill to the 1 L mark with deionized water.
5. Next, calibrate the zero point. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then remove all moisture from the sensor probe (it will be calibrated in air).
6. Press the control unit's CAL key to set the calibration mode.
7. Press the down (▽) key to move the cursor to "Manual calibration", then press the ENTER key.



8. In the parameter selection screen, move the cursor to "Cond", then press the ENTER key.

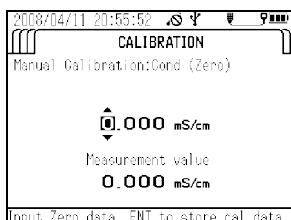


9. Set the number of calibration points, then press the ENTER key.

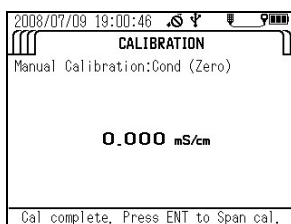


The instructions below assume that four calibration points have been set.

10. Press the up (Δ) and down (∇) keys to set the "Cond" value to 0.0 mS/m (0.000 mS/cm).
11. Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.



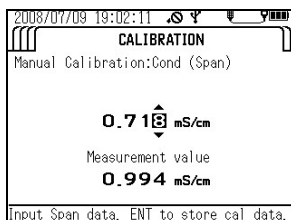
12. When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the first span calibration procedure.



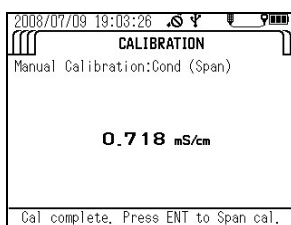
13. Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 71.8 mS/m (0.718 mS/cm) standard solution.
14. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.

15. Press the up (Δ) and down (∇) keys to set the "Cond" value to 71.8 mS/m (0.718 mS/cm).

Calibration range = 0 mS/m to 99.9 mS/m (0 mS/cm to 0.999 mS/cm)

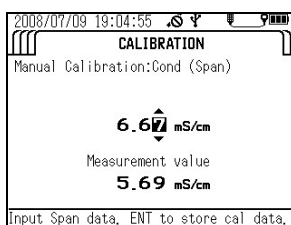


16. Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.
17. When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the next span calibration procedure.

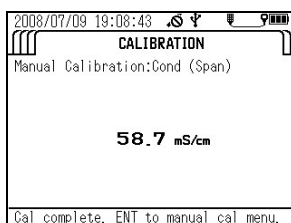


18. Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 0.667 S/m (6.67 mS/cm) standard solution.
19. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.
20. Press the up (Δ) and down (∇) keys to set the "Cond" value to 0.667 S/m (6.67 mS/cm).

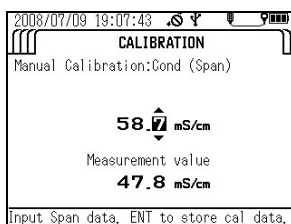
Calibration range = 0.100 S/m to 0.999 S/m (1.00 mS/cm to 9.99 mS/cm)



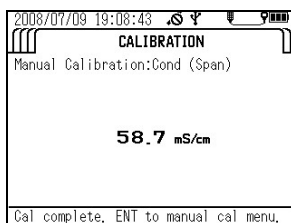
21. Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.
22. When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the next span calibration procedure.



23. Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 5.87 S/m (58.7 mS/cm) standard solution.
24. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.
25. Press the up (Δ) and down (∇) keys to set the "Cond" value to 5.87 S/m (58.7 mS/cm).
Calibration range = 1.00 S/m to 10.00 S/m (10.0 mS/cm to 100.0 mS/cm)



26. Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.
27. Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.



● Turbidity (TURB) calibration

Note

- To support a wide range of sample concentrations, turbidity is divided into three measurement ranges: 0.0 to 9.9 NTU, 10 to 100 NTU, and over 100 NTU.
- When manually calibrating turbidity, you can select two calibration procedures (one zero-point calibration procedure and a span calibration procedure for one of the three measurement ranges), three calibration procedures (one zero-point calibration procedure and a span calibration procedure for two of the three measurement ranges) or four calibration procedures (one zero-point calibration procedure and span calibration procedures for all three measurement ranges). Carry out the four calibration procedures to ensure good measurement precision throughout all measurement ranges.
- Always use the calibration cup provided. Using other containers can create effects from ambient light that cause incorrect calibration.

● Preparing the standard solutions

1. Weigh out 5.0 g of hydrazine sulfate (commercial special grade or above), and dissolve it in 400 mL of deionized water. Dissolve 50 g of hexamethylene tetramine (commercial special grade or above) in 400 mL of deionized water in another flask.
2. Mix the two solutions and add deionized water until the total solution volume is 1000 mL, and mix well. Store this solution at a temperature of $25^{\circ}\text{C} \pm 3^{\circ}\text{C}$ for 48 hours.

The turbidity value (TURB) of this solution is equivalent to 4000 NTU.

3. Dilute 4000 NTU-solution 5 times (use a pipette to measure 50 mL of the 4000 NTU solution and pour it into a 250 mL measuring flask, and fill up to 250 mL meniscus)
The turbidity value (TURB) of this solution is equivalent to 800 NTU.

4. Dilute 800 NTU-solution 10 times (use a pipette to measure 25 mL of the 800 NTU solution and pour it into a 250 mL measuring flask, and fill up to 250 mL meniscus)
The turbidity value (TURB) of this solution is equivalent to 80 NTU.

5. Dilute 80 NTU-solution 10 times (use a pipette to measure 25 mL of the 80 NTU solution and pour it into a 250 mL measuring flask, and fill up to 250 mL meniscus)
The turbidity value (TURB) of this solution is equivalent to 8 NTU.

Note

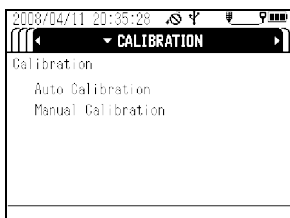
Instead of the standard solutions above, you can use other standard solutions of known concentration measured with other standard instruments.

● U-52, U-53 turbidity calibration

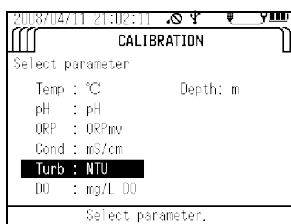
Set the number of calibration points.

You can set between 2 and 4 points.

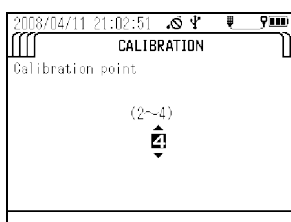
1. Press the control unit's CAL key to set the calibration mode.
2. Press the down (∇) key to move the cursor to "Manual calibration", then press the ENTER key.



3. In the parameter selection screen, move the cursor to "TURB", then press the ENTER key.

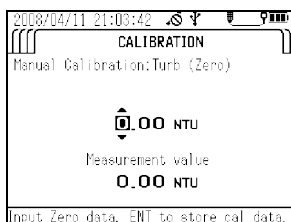


4. Press the up (Δ) and down (∇) keys to set the number of calibration points, then press the ENTER key.

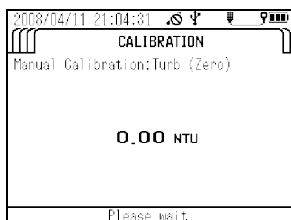


The instructions below assume that four calibration points have been set.

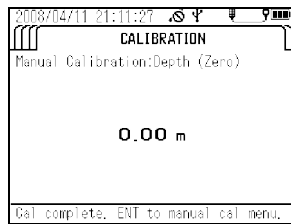
5. Calibrate the zero point. Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with deionized water.
6. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.
7. Press the up (Δ) and down (∇) keys to set the "TURB" value to 0.0 NTU.



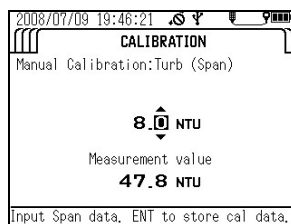
8. Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.



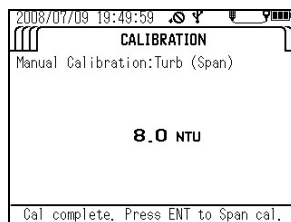
9. When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the first span calibration procedure.



10. Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 8 NTU standard solution, or a standard solution of known concentration between 0.1 and 10 NTU.
11. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.
12. Press the up (Δ) and down (∇) keys to set the "TURB" value to 8 NTU, or to the known concentration of the standard solution between 0.1 and 10 NTU. (Input range = 0 NTU to 9.9 NTU (U-51) or 0 NTU to 9.99 NTU (U-52))

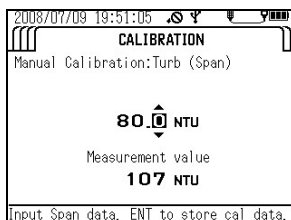


13. Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.
14. When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the next span calibration procedure.

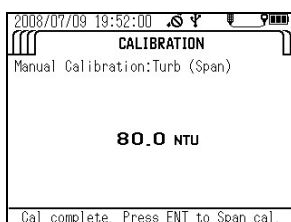


15. Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 80 NTU standard solution, or a standard solution of known concentration between 10 and 100 NTU.
16. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.

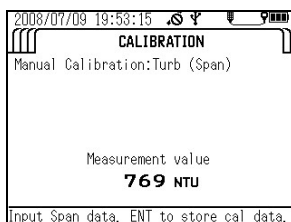
17. Press the up (Δ) and down (∇) keys to set the "TURB" value to 80 NTU, or to the known concentration of the standard solution between 10 and 100 NTU. (Input range = 10.0 NTU to 99.9 NTU)



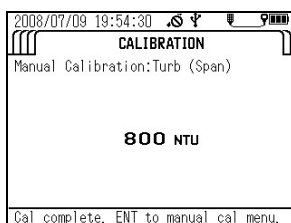
18. Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.
19. When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the next span calibration procedure.



20. Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 800 NTU standard solution, or a standard solution of known concentration 100 NTU above.
21. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.
22. Press the up (Δ) and down (∇) keys to set the "TURB" value to 800 NTU, or to the known concentration of the standard solution 100 NTU above. (Input range = 100 NTU to 800 NTU (U-51), 100 NTU to 1000 NTU (U-52))



23. Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.
24. Calibration is finished when the message "Cal complete. ENT to manual menu." appears. Press the ENTER key to return to the calibration parameter selection screen.



● Dissolved oxygen (DO) calibration

Note

- You can select one calibration procedure (span calibration) or two calibration procedures (zero-point calibration and span calibration). Carry out the two calibration procedures to ensure good measurement precision throughout all measurement ranges.
- It is necessary to prepare new solution before calibration of the Dissolved Oxygen (DO) sensor.
- The calibration cup (included) cannot be used to manually calibrate the DO sensor. Use a suitable bottle in which the DO sensor can be immersed.
- Wait at least 20 minutes after turning the system power ON before calibrating the DO sensor.
- Make the compensation setting before calibration since the setting is applied during calibration.

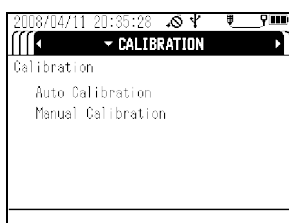
1. Prepare the standard solution.

(1) Add approximately 50 g of sodium sulfite to 1000 mL of water (either deionized water or tap water) and stir the mixture to dissolve the sodium sulfite in it.

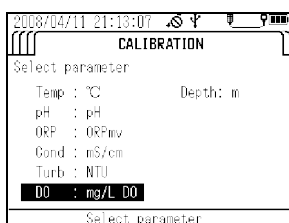
(2) Pour 1 to 2 liters of water into a suitable flask (either deionized water or tap water). Using a air pump, feed air into the water and aerate the solution until oxygen is saturated.

2. First, calibrate the zero point. Press the control unit's CAL key to set the calibration mode.

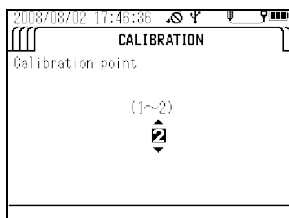
3. Press the down (▽) key to move the cursor to "Manual calibration", then press the ENTER key.



4. In the parameter selection screen, move the cursor to DO, then press the ENTER key.



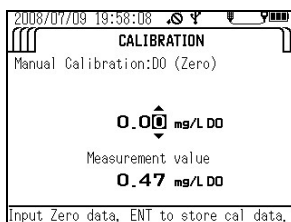
5. Set the number of calibration procedures, then press the ENTER key.



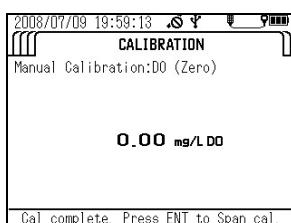
The instructions below assume that two calibration points have been set.

6. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the bottle.

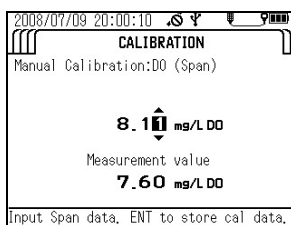
7. Press the up (Δ) and down (∇) keys to set the DO value to 0.00 mg/L.



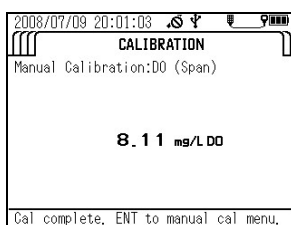
8. Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.
9. When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the span calibration procedure.



10. Wash the sensor probe 2 or 3 times with deionized water to remove any dirt, then submerge the sensor probe in the container filled with the span solution.
11. Press the up (Δ) and down (∇) keys to set the DO value to the saturated dissolved oxygen value of the water at that temperature.



12. Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.
13. Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.



● **Amounts of saturated dissolved oxygen in water at various temperatures
(salinity=0.0%)**

JIS K0101

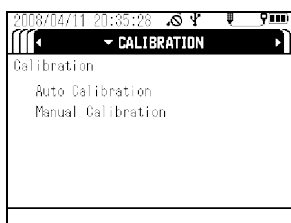
Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)
0	14.16						
1	13.77	11	10.67	21	8.68	31	7.42
2	13.40	12	10.43	22	8.53	32	7.32
3	13.04	13	10.20	23	8.39	33	7.22
4	12.70	14	9.97	24	8.25	34	7.13
5	12.37	15	9.76	25	8.11	35	7.04
6	12.06	16	9.56	26	7.99	36	6.94
7	11.75	17	9.37	27	7.87	37	6.86
8	11.47	18	9.18	28	7.75	38	6.76
9	11.19	19	9.01	29	7.64	39	6.68
10	10.92	20	8.84	30	7.53	40	6.59

ISO5814

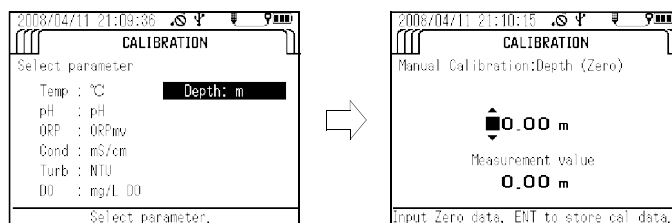
Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)
0	14.62				
1	14.22	11	11.03	21	8.91
2	13.83	12	10.78	22	9.74
3	13.46	13	10.54	23	8.58
4	13.11	14	10.31	24	8.42
5	12.77	15	10.08	25	8.26
6	12.45	16	9.87	26	8.11
7	12.45	17	9.66	27	7.97
8	11.84	18	9.47	28	7.93
9	11.56	19	9.28	29	9.69
10	11.29	20	9.09	30	7.56

● Water depth (DEPTH) calibration

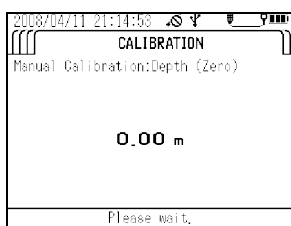
1. Calibrate the zero point. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then remove all moisture from the sensor probe (it will be calibrated in air).
2. Press the control unit's CAL key to set the calibration mode.
3. Press the down (▽) key to move the cursor to "Manual calibration", then press the ENTER key.



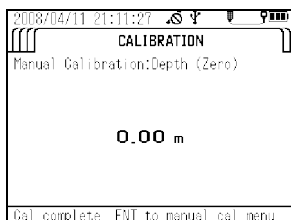
4. In the parameter selection screen, move the cursor to "Depth", then press the ENTER key.



5. Press the up (△) and down (▽) keys to set the "DEPTH" value to 0.00 m.
6. Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.



7. Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.



3.4 Measurement

You can perform measurement by either of the methods below.

- Storing data in memory manually with reference to the measurement value (single measurement)
 - Having data stored in memory automatically and continuously
 - U-51/U-52: Interval measurement (minimum memory interval of 10 seconds)
 - U-53: Interval measurement (minimum memory interval of 30 seconds)
- Select the measurement method that meets your requirements.

Note

- Lower sensor probe slowly when submerging them in samples.
- Sensors may break if sensor probe are dropped from a height of 1 meter or more.
- Do not submerge sensor probe in water depths of over 30 meters. Sensor probe are only resistant to water pressure of up to 30 meters.
- After turning the power ON, check that the DO readout value has stabilized before starting measurement (takes around 20 minutes).

Tip

Press the ENTER key on the measurement screen to enlarge the measured value display.

3.4.1 Storing data in memory manually

Follow the steps below to manually store data in memory while referring to the measurement value to check the readout value is stable.



U-51/U-52

1. Check that each sensor and sensor guard is mounted.
2. Check that "SINGLE MEASUREMENT" has been selected in the measurement screen.

2008/04/11 19:38:01	
SINGLE MEASUREMENT	
SITE:	
22.18 °C	9.08 mg/L DO
6.36 pH	0.000 g/L TDS
34 pHmV	0.0 PPT
174 ORPmV	0.0 σt
0.000 mS/cm	0.00 m
0.00 NTU	
Press MEAS to collect data.	

3. Submerge the sensor probe in the sample, gently shaking them in the sample to remove any air bubbles from the sensors.
4. If the sample is non-flowing, move the sensor probe up and down at a rate of 30 cm (one up-down cycle) every 30 seconds to ensure that fresh sample is continuously supplied to the DO sensor.
5. When the measurement values are stable, press the MEAS key to acquire the 5-second average.

2008/04/02 21:32:56	
SINGLE MEASUREMENT	
SITE:AAAA	
24.86 °C	8.75 mg/L DO
4.01 pH	2.87 g/L TDS
175 pHmV	1.7 PPT
206 ORPmV	0.0 σt
4.49 mS/cm	0.00 m
0.00 NTU	
測定中.	

6. Press the ENTER key to save the held measurement values, or press the ESC key to cancel the operation.

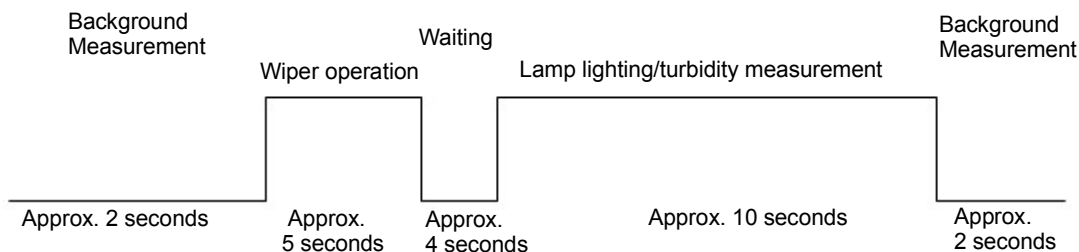
2008/04/02 21:33:35		SINGLE MEASUREMENT	
SITE:AAAA			
24.86 °C	8.75 mg/L DO	24.85 °C	8.75 mg/L DO
4.01 pH	2.87 g/L TDS	4.01 pH	2.87 g/L TDS
175	1.7 PPT	175 pHmV	1.7 PPT
206 ORPmV	0.0 σt	206 ORPmV	0.0 σt
4.49 mS/cm	0.00 m	4.49 mS/cm	0.00 m
0.00 NTU		0.00 NTU	
ENTERキーを押すとデータを保存します。		データ保存完了。MEASキーを押してください。	

U-53

Note

Do not perform turbidity measurement in air as it may damage the wiper.

U-53 turbidity measurement follows the sequence below. The measurement values are held after each sequence.



1. Check that each sensor and sensor guard is mounted.
2. Check that "SINGLE MEASUREMENT" has been selected in the measurement screen.

2008/04/11 19:38:01		SINGLE MEASUREMENT	
SITE:			
22.18 °C	9.08 mg/L DO	22.18 °C	9.08 mg/L DO
6.36 pH	0.000 g/L TDS	6.36 pH	0.000 g/L TDS
34 pHmV	0.0 PPT	34 pHmV	0.0 PPT
174 ORPmV	0.0 σt	174 ORPmV	0.0 σt
0.000 mS/cm	0.00 m	0.000 mS/cm	0.00 m
0.00 NTU		0.00 NTU	
Press MEAS to collect data.			

3. Submerge the sensor probe in the sample, gently shaking them in the sample to remove any air bubbles from the sensors.

If the sample is non-flowing, move the sensor probe up and down at a rate of 30 cm (one up-down cycle) every 30 seconds to ensure that fresh sample is continuously supplied to the DO sensor.

4. When the non-turbidity meter measurement values are stable, press the MEAS key to start the sequence above.

2008/04/11 21:18:58	
SINGLE MEASUREMENT	
SITE:AAAA	
23.40 °C	9.08 mg/L DO
3.85 pH	2.32 g/L TDS
165 pHmV	1.3 ppt
211 ORPmV	0.0 σt
3.63 mS/cm	0.00 m
0.00 NTU	
Collecting data.	

5. When the sequence has finished, hold the measurement values. Press the ENTER key to store the held measurement values, or press the ESC key to cancel the operation.

2008/04/11 21:19:45	
SINGLE MEASUREMENT	
SITE:AAAA	
23.41 °C	9.08 mg/L DO
3.85 pH	2.32 g/L TDS
165 pHmV	1.3 ppt
211 ORPmV	0.0 σt
3.63 mS/cm	0.00 m
0.00 NTU	
Press ENT to store data.	

→

2008/04/11 21:20:00	
SINGLE MEASUREMENT	
SITE:AAAA	
23.43 °C	9.08 mg/L DO
3.85 pH	2.32 g/L TDS
165 pHmV	1.3 ppt
211 ORPmV	0.0 σt
3.62 mS/cm	0.00 m
0.00 NTU	
Store data complete. Press MEAS key.	

3.4.2 Automatic, continuous measurement

● Interval measurement

1. Select the "Interval measurement" measurement setting (see " 3.2.1 Setting measurement methods " (page 17).
2. Press the up (Δ) and down (∇) keys to set the interval value to the desired value (U-51/U-52: minimum interval: 10 seconds, U-53: minimum interval: 30 seconds), then press the ENTER key.

The measurement screen appears automatically, and the system becomes ready for measurement.

3. Check that each sensor and sensor guard is mounted.
4. Submerge the sensor probe in the sample, gently shaking them in the sample to remove any air bubbles from the sensors.

If the sample is non-flowing, move the sensor probe up and down at a rate of 30 cm (one up-down cycle) every 30 seconds to ensure that fresh sample is continuously supplied to the DO sensor.

5. Press the ENTER key to start measurement.

2008/08/02 17:49:20	
INTERVAL MEASUREMENT	
SITE:HORIDA	
27.02 °C	9.13 mg/L DO
8.04 pH	0.000 g/L TDS
-90 pHmV	0.0 ppt
-1 ORPmV	0.0 σt
0.000 mS/cm	0.00 m
0.00 NTU	
Interval measuring. ESC to previous.	

3.5 Data operations

Use the procedures below to retrieve data stored in memory, delete all the data, check the remaining data memory capacity, and check the calibration record.

3.5.1 Displaying data

For maximum efficiency, there are 3 methods of displaying data.

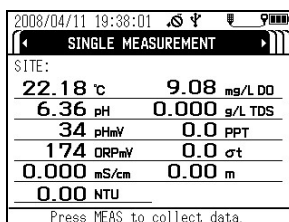
- Displaying the data for a specified site
- Displaying the data for a specified date/time
- Displaying all the data

Use the method that best suits your requirements.

● Displaying the data for a specified site

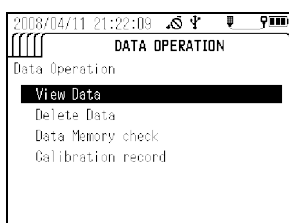
1. Press the control unit's **POWER** key to turn the power ON.

The "Measurement" screen appears after 2 or 3 seconds.



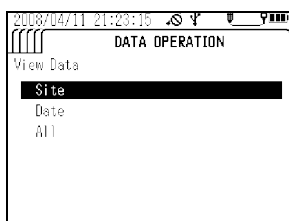
2008/04/11 19:38:01	
SINGLE MEASUREMENT	
SITE:	
22.18 °C	9.08 mg/L DO
6.36 pH	0.000 g/L TDS
34 pHmV	0.0 PPT
174 ORPmV	0.0 σt
0.000 mS/cm	0.00 m
0.00 NTU	
Press MEAS to collect data.	

2. Press the right (**▷**) key 3 times to display the "DATA OPERATION" screen.
3. Press the down (**▽**) key to move the cursor to "View data", then press the ENTER key.



2008/04/11 21:22:09	
DATA OPERATION	
Data Operation	
View Data	
Delete Data	
Data Memory check	
Calibration record	

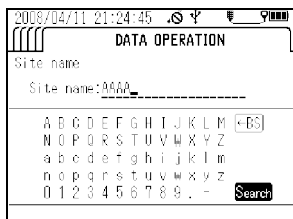
4. Move the cursor to "Site", then press the ENTER key.



2008/04/11 21:23:15	
DATA OPERATION	
View Data	
Site	
Date	
All	

5. Press the up (**△**), down (**▽**), left (**◁**) and right (**▷**) keys to enter the site to retrieve.

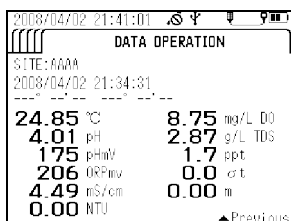
6. Move the cursor to "Search", then press the ENTER key.



All site names that begin with the entered text are displayed.

The most recently measured data for the entered site is displayed.

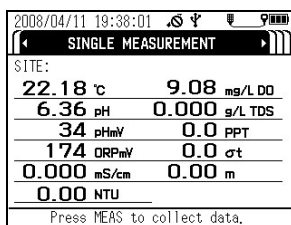
7. Press the up (Δ) and down (∇) keys to display earlier data.



● Displaying the data for a specified date/time

1. Press the control unit's POWER key to turn the power ON.

The "Measurement" screen appears after 2 or 3 seconds.



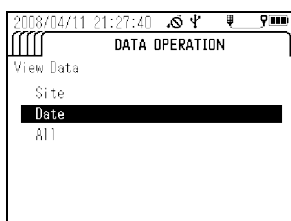
2. Press the right (\triangleright) key 3 times to display the "DATA OPERATION" screen.

3. Press the down (∇) key to move the cursor to "View data", then press the ENTER key.



4. Move the cursor to "Date", then press the ENTER key.

5. With the cursor on the Date, press the ENTER key.



6. Press the up (Δ), down (∇), left (\triangleleft) and right (\triangleright) keys to enter the desired date/time, then press the ENTER key to apply the setting.
7. The cursor moves to "Search". Press the ENTER key to start the search.
8. Press the up (Δ) and down (∇) keys to display earlier data.

● Displaying all the data

1. Press the control unit's POWER key to turn the power ON.
The "Measurement" screen appears after 2 or 3 seconds.

2008/04/11 19:38:01	
SINGLE MEASUREMENT	
SITE:	
22.18 °C	9.08 mg/L DO
6.36 pH	0.000 g/L TDS
34 pHmV	0.0 PPT
174 ORPmV	0.0 σt
0.000 mS/cm	0.00 m
0.00 NTU	
Press MEAS to collect data.	

2. Press the right (\triangleright) key 3 times to display the "DATA OPERATION" screen.
3. Press the down (∇) key to move the cursor to "View data", then press the ENTER key.

2008/04/11 21:22:09	
DATA OPERATION	
Data Operation	
View Data	
Delete Data	
Data Memory check	
Calibration record	

4. Move the cursor to "All", then press the ENTER key.
The most recently measured data is displayed.

2008/04/11 21:29:26	
DATA OPERATION	
View Data	
Site	
Date	
All	

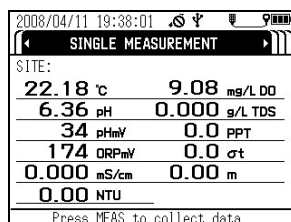
5. Press the up (Δ) and down (∇) keys to display earlier data.

3.5.2 Deleting data

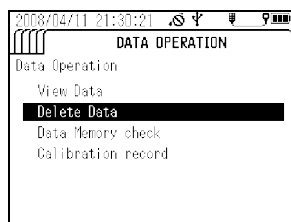
Follow the steps below to delete all the data stored in memory.

1. Press the control unit's **POWER** key to turn the power ON.

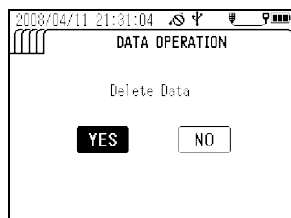
The "Measurement" screen appears after 2 or 3 seconds.



2. Press the right (**▷**) key 3 times to display the "DATA OPERATION" screen.
3. Press the down (**▽**) key to move the cursor to "Delete data", then press the ENTER key.



4. Press the left (**◁**) key to move the cursor to YES, then press the ENTER key.
All the data has been deleted when the indicator appears along with the message "No data exists".



3.5.3 Checking the data memory

You can check the used data capacity and the remaining data capacity.

1. Press the control unit's **POWER** key to turn the power **ON**.

The "Measurement" screen appears after 2 or 3 seconds.

2008/04/11 19:38:01	
SINGLE MEASUREMENT	
SITE:	
22.18 °C	9.08 mg/L DO
6.36 pH	0.000 g/L TDS
34 pHmV	0.0 PPT
174 ORPmV	0.0 σt
0.000 mS/cm	0.00 m
0.00 NTU	
Press MEAS to collect data.	

2. Press the right (\triangleright) key 3 times to display the "DATA OPERATION" screen.
3. Press the down (∇) key to move the cursor to "Data memory check", then press the ENTER key.

2008/04/11 21:32:30	
DATA OPERATION	
Data Operation	
View Data	
Delete Data	
Data Memory check	
Calibration record	

The amount of memory in use and amount of available memory are displayed.

2008/04/11 21:34:21	
DATA OPERATION	
Data Memory check	
Used memory	
0 Data	
Available memory	
10000 Data	

3.5.4 Checking the calibration record

Follow the steps below to check the latest calibration history.

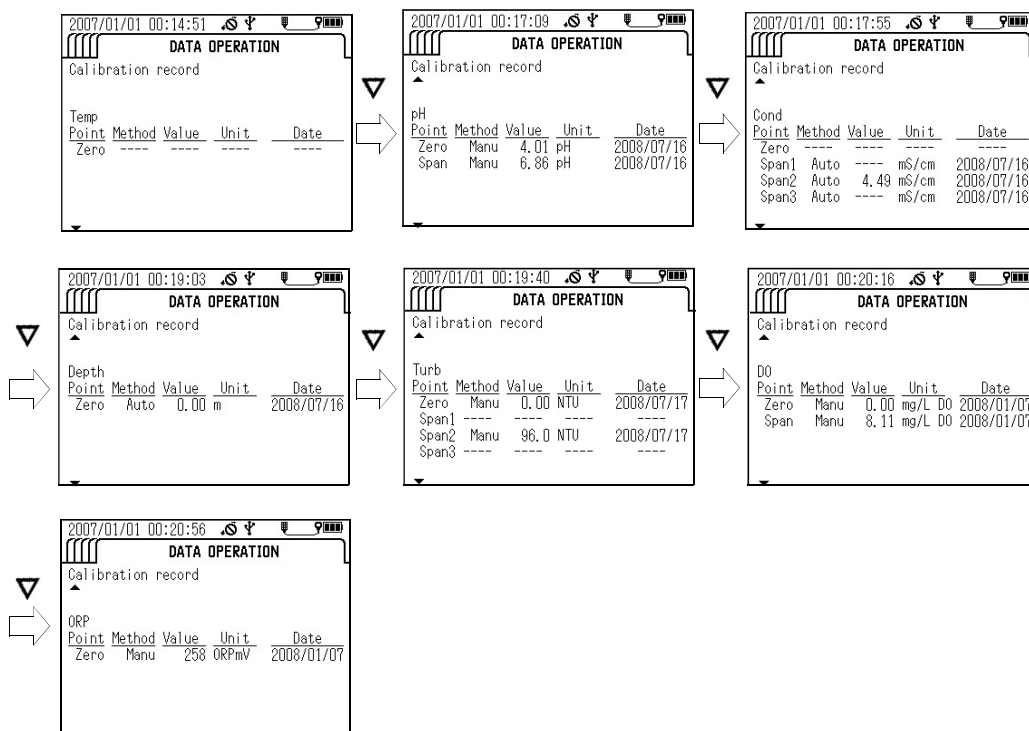
1. Press the control unit's **POWER** key to turn the power ON.

The "Measurement" screen appears after 2 or 3 seconds.

2008/04/11 19:38:01		SINGLE MEASUREMENT	
SITE:			
22.18 °C	9.08	mg/L DO	
6.36 pH	0.000	g/L TDS	
34 pHmV	0.0	PPT	
174 ORPmV	0.0	σt	
0.000 mS/cm	0.00	m	
0.00 NTU			
Press MEAS to collect data.			

2. Press the right (\triangleright) key 3 times to display the "DATA OPERATION" screen.
3. Press the down (∇) key to move the cursor to "Calibration record", then press the ENTER key.

The latest calibration record is displayed.



3.5.5 GPS data operations

The menu for GPS data operations appears on the display to which the GPS unit is mounted.

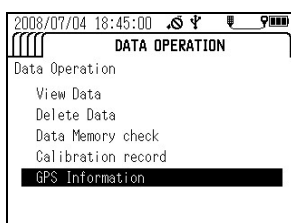
● GPS information

Follow the steps below to display acquired GPS information.

Note

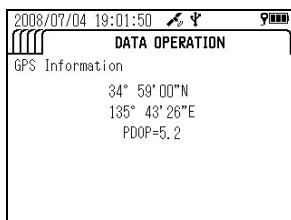
Turning the power OFF erases the GPS information.

1. Press the right (\triangleright) key to switch the display to the "Data Operation" screen.
2. the down (∇) key to move the cursor to "GPS Information", then press the ENTER key.

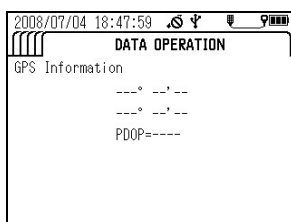


The last GPS information acquired is displayed.

- When received data exists



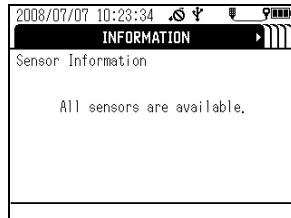
- When no received data exists



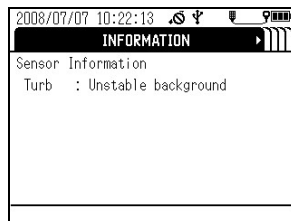
3.6 Sensor information

The "Sensor Information" screen displays the sensor probe's status.

- When the sensor probe is normal, the display below appears.



- When there is a sensor probe problem, individual measurement parameters generate messages such as the one shown below. Follow the troubleshooting information to remove the problem before continuing to operate the system.

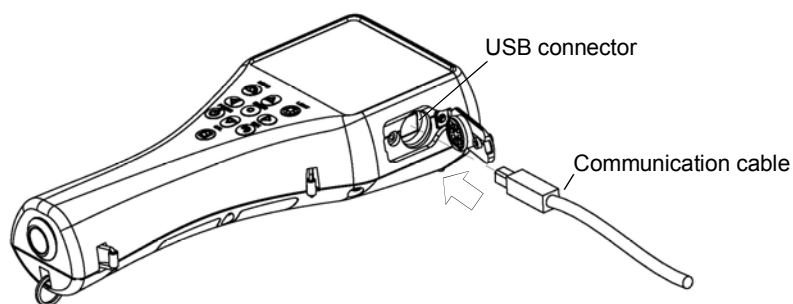


3.7 USB communication

The separately-sold, dedicated PC connection cable comes with data collection software. This software allows data to be downloaded from the control unit in CSV format.

This section contains instructions for communication commands used for USB communication.

● Connecting the cable



Dedicated cable

Part name: Communication cable (with data collection software)

Part no.: 3200174823

● Cautions when using USB communication

Take care to observe the following when using USB communication:

- Use the dedicated cable (with data collection software) or a commercially-available USB cable (A-B type) to connect to a PC.
- Be sure to match the transmission format on the control unit and the computer.
The control unit uses the following transmission format:

Baud rate:	19200 bps
Number of stop bits:	1 bit
Data bit length:	8 bits
Parity:	None
Flow control:	None

— Tip —

If the transmission formats do not match, a communication error occurs and USB communication will not function normally. After changing the transmission format, restart the control unit and the computer.

- If received data is not sent back or an error occurs after a data request has been sent, adjust the program configuration so that it allows a little waiting time before a data request is sent again. This will enable more stable communication.
- The unit does not use DCD, CTS, or DSR signals. Take care of this when creating programs.

3.7.1 Communication settings

Baud rate:	19200 bps
Number of stop bits:	1 bit
Data bit length:	8 bits
Parity:	None
Flow control:	None

3.7.2 Commands

● Instant data requests

● Request command format

#	RD	@	XX	[CR]	[LF]
1	2	3	4		

1	Header	1 character
2	Command	2 characters
3	Delimiter character	1 character
4	Frame check sequence (FCS)	2 characters

The two ASCII-code characters created by converting the 8 bits of data created by successively combining the value of each character from # through @ in an exclusive OR (XOR) operation with the value of the next character.

Example: #RD@

(1)	0	XOR	35	(ASCII code of # symbol)	⇒	35
(2)	35	XOR	82	(ASCII code of R)	⇒	113
(3)	113	XOR	68	(ASCII code of D)	⇒	53
(4)	53	XOR	64	(ASCII code of @ symbol)	⇒	117 (decimal)
					↓	
						75 (hex)
					↓	
						Sets "75".

Example: 35 XOR 82 operation

35 in binary	⇒	0	0	1	0	0	0	1	1	
82 in binary	⇒	0	1	0	1	0	0	1	0	
XOR result		0	1	1	1	0	0	0	1	
										⇒ 113 (decimal)

Note: Set "XX" if you do not want to test for communication frame errors with FCS.

● Response format

#	RD	AAAAAAAAAAAAAAAAAAAA										X	X	XXXX	XX	X	X	XXXXX	X	
1	2	3																		
XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X						
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26						
XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X						
27	28	29	30	31	32	33	34	35	36	37	38	39	40	41						
XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X						
42	43	44	45	46	47	48	49	50	51	52	53	54	55	56						
XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X						

57	58	59	60	61	62	63	64	65	66	67	68	69	70	71					
XX	XX	XX	XX	XX	XX	XX	XX	XX	X	X	XXX	XX	XX	X	X	@	XX	[CR]	[LF]
72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89		

1	Header		1 character
2	Command		2 characters
3	Site name	Upper- and lowercase letters, numbers, periods (.) hyphens (-) and spaces ()	20 characters
4	Probe status	(3) Status code	1 character
5	Probe error	(4) Status error code	1 character
6	Unused		4 characters
7	Parameter 1 code	(1) Parameter code	2 characters
8	Parameter 1 status	(5) Parameter status code	1 character
9	Parameter 1 error	(6) Parameter error code	1 character
10	Parameter 1 data	5 characters including decimal point, right- justified with blanks filled	5 characters
11	Parameter 1 unit	(2) Unit code	1 character
12	Parameter 2 code	(1) Parameter code	2 characters
13	Parameter 2 status	(5) Parameter status code	1 character
14	Parameter 2 error	(6) Parameter error code	1 character
15	Parameter 2 data	5 characters including decimal point, right- justified with blanks filled	5 characters
16	Parameter 2 unit	(2) Unit code	1 character
17	Parameter 3 code	(1) Parameter code	2 characters
18	Parameter 3 status	(5) Parameter status code	1 character
19	Parameter 3 error	(6) Parameter error code	1 character
20	Parameter 3 data	5 characters including decimal point, right- justified with blanks filled	5 characters
21	Parameter 3 unit	(2) Unit code	1 character
22	Parameter 4 code	(1) Parameter code	2 characters
23	Parameter 4 status	(5) Parameter status code	1 character
24	Parameter 4 error	(6) Parameter error code	1 character
25	Parameter 4 data	5 characters including decimal point, right- justified with blanks filled	5 characters
26	Parameter 4 unit	(2) Unit code	1 character
27	Parameter 5 code	(1) Parameter code	2 characters
28	Parameter 5 status	(5) Parameter status code	1 character
29	Parameter 5 error	(6) Parameter error code	1 character
30	Parameter 5 data	5 characters including decimal point, right- justified with blanks filled	5 characters
31	Parameter 5 unit	(2) Unit code	1 character
32	Parameter 6 code	(1) Parameter code	2 characters
33	Parameter 6 status	(5) Parameter status code	1 character
34	Parameter 6 error	(6) Parameter error code	1 character
35	Parameter 6 data	5 characters including decimal point, right- justified with blanks filled	5 characters

36	Parameter 6 unit	(2) Unit code	1 character
37	Parameter 7 code	(1) Parameter code	2 characters
38	Parameter 7 status	(5) Parameter status code	1 character
39	Parameter 7 error	(6) Parameter error code	1 character
40	Parameter 7 data	5 characters including decimal point, right-justified with blanks filled	5 characters
41	Parameter 7 unit	(2) Unit code	1 character
42	Parameter 8 code	(1) Parameter code	2 characters
43	Parameter 8 status	(5) Parameter status code	1 character
44	Parameter 8 error	(6) Parameter error code	1 character
45	Parameter 8 data	5 characters including decimal point, right-justified with blanks filled	5 characters
46	Parameter 8 unit	(2) Unit code	1 character
47	Parameter 9 code	(1) Parameter code	2 characters
48	Parameter 9 status	(5) Parameter status code	1 character
49	Parameter 9 error	(6) Parameter error code	1 character
50	Parameter 9 data	5 characters including decimal point, right-justified with blanks filled	5 characters
51	Parameter 9 unit	(2) Unit code	1 character
52	Parameter 10 code	(1) Parameter code	2 characters
53	Parameter 10 status	(5) Parameter status code	1 character
54	Parameter 10 error	(6) Parameter error code	1 character
55	Parameter 10 data	5 characters including decimal point, right-justified with blanks filled	5 characters
56	Parameter 10 unit	(2) Unit code	1 character
57	Parameter 11 code	(1) Parameter code	2 characters
58	Parameter 11 status	(5) Parameter status code	1 character
59	Parameter 11 error	(6) Parameter error code	1 character
60	Parameter 11 data	5 characters including decimal point, right-justified with blanks filled	5 characters
61	Parameter 11 unit	(2) Unit code	1 character
62	Parameter 12 code	(1) Parameter code	2 characters
63	Parameter 12 status	(5) Parameter status code	1 character
64	Parameter 12 error	(6) Parameter error code	1 character
65	Parameter 12 data	5 characters including decimal point, right-justified with blanks filled	5 characters
66	Parameter 12 unit	(2) Unit code (6) Parameter error code	1 character
67	Parameter 13 code	(1) Parameter code	2 characters
68	Parameter 13 status	(5) Parameter status code	1 character
69	Parameter 13 error	(6) Parameter error code	1 character
70	Parameter 13 data	5 characters including decimal point, right-justified with blanks filled	5 characters
71	Parameter 13 unit	(2) Unit code	1 character
72	Year	00 to 99	2 characters
73	Month	01 to 12	2 characters
74	Day	01 to 31	2 characters

36	Parameter 6 unit	(2) Unit code	1 character
37	Parameter 7 code	(1) Parameter code	2 characters
38	Parameter 7 status	(5) Parameter status code	1 character
39	Parameter 7 error	(6) Parameter error code	1 character
40	Parameter 7 data	5 characters including decimal point, right-justified with blanks filled	5 characters
41	Parameter 7 unit	(2) Unit code	1 character
42	Parameter 8 code	(1) Parameter code	2 characters
43	Parameter 8 status	(5) Parameter status code	1 character
44	Parameter 8 error	(6) Parameter error code	1 character
45	Parameter 8 data	5 characters including decimal point, right-justified with blanks filled	5 characters
46	Parameter 8 unit	(2) Unit code	1 character
47	Parameter 9 code	(1) Parameter code	2 characters
48	Parameter 9 status	(5) Parameter status code	1 character
49	Parameter 9 error	(6) Parameter error code	1 character
50	Parameter 9 data	5 characters including decimal point, right-justified with blanks filled	5 characters
51	Parameter 9 unit	(2) Unit code	1 character
52	Parameter 10 code	(1) Parameter code	2 characters
53	Parameter 10 status	(5) Parameter status code	1 character
54	Parameter 10 error	(6) Parameter error code	1 character
55	Parameter 10 data	5 characters including decimal point, right-justified with blanks filled	5 characters
56	Parameter 10 unit	(2) Unit code	1 character
57	Parameter 11 code	(1) Parameter code	2 characters
58	Parameter 11 status	(5) Parameter status code	1 character
59	Parameter 11 error	(6) Parameter error code	1 character
60	Parameter 11 data	5 characters including decimal point, right-justified with blanks filled	5 characters
61	Parameter 11 unit	(2) Unit code	1 character
62	Parameter 12 code	(1) Parameter code	2 characters
63	Parameter 12 status	(5) Parameter status code	1 character
64	Parameter 12 error	(6) Parameter error code	1 character
65	Parameter 12 data	5 characters including decimal point, right-justified with blanks filled	5 characters
66	Parameter 12 unit	(2) Unit code (6) Parameter error code	1 character
67	Parameter 13 code	(1) Parameter code	2 characters
68	Parameter 13 status	(5) Parameter status code	1 character
69	Parameter 13 error	(6) Parameter error code	1 character
70	Parameter 13 data	5 characters including decimal point, right-justified with blanks filled	5 characters
71	Parameter 13 unit	(2) Unit code	1 character
72	Year	00 to 99	2 characters
73	Month	01 to 12	2 characters
74	Day	01 to 31	2 characters

75	Hour	00 to 23	2 characters
76	Minute	00 to 59	2 characters
77	Second	00 to 59	2 characters
78	Longitude (degrees)	00 to 90 or "--" (no GPS data)	2 characters
79	Longitude (minutes)	00 to 59 or "--" (no GPS data)	2 characters
80	Longitude (seconds)	00 to 59 or "--" (no GPS data)	2 characters
81	Unused	1 character	1 character
82	North latitude/South latitude	N: North; S: South	1 character
83	Latitude (degrees)	000 to 180 or "---" (no GPS data)	3 characters
84	Latitude (minutes)	00 to 59 or "--" (no GPS data)	2 characters
85	Latitude (seconds)	00 to 59 or "--" (no GPS data)	2 characters
86	Unused		1 character
87	East longitude/West longitude	E: East; W: West	1 character
88	Delimiter character		1 character
89	Frame check sequence (FCS)		2 characters

● Memory data requests

● Request command format

```
#  RM  X   X  AAAAAAAAAAAAAAAAAAAAAA  XX  XX  XX  @  XX  [CR]  [LF]
1  2   3   4   5                        6   7   8   9  10
```

1	Header		1 character
2	Command		2 characters
3	Data specification*1	0: Start search; 1: Next data item; 2: Previous data item; 3: Request same data again	1 character
4	Search method specification	0: All data; 1: Site search; 2: Date search	1 character
5	Search site*2	Upper- and lowercase letters, numbers, periods (.) hyphens (-) and spaces ()	20 characters
6	Search year*3	00 to 99	2 characters
7	Search month*3	01 to 12	2 characters
8	Search day*3	01 to 31	2 characters
9	Delimiter character		1 character
10	Frame check sequence (FCS)		2 characters

*1: When sending the RM command, first send 0 [Start search], then 1 [Next data item], 2 [Previous data item] or 3 [Request same data again].

*2: [Search site] is only needed when [Site search] is specified as the search method. If another search method is specified, fill this field with spaces.

*3: [Search year], [Search month] and [Search day] are only needed when [Date search] is specified as the search method. If another search method is specified, fill this field with spaces.

● **Response format**
(when data exists)

```
#  RM  AAAAAAAAAAAAAAAAAAAAAA  XX X  X  XXXXX  X
1  2   3                          4  5  6   7      8

XX X  X  XXXXX  X  XX X  X  XXXXX  X  XX X  X  XXXXX  X
9  10 11 12      13 14 15 16 17      18 19 20 21 22      23

XX X  X  XXXXX  X  XX X  X  XXXXX  X  XX X  X  XXXXX  X
24 25 26 27      28 29 30 31 32      33 34 35 36 37      38

XX X  X  XXXXX  X  XX X  X  XXXXX  X  XX X  X  XXXXX  X
39 40 41 42      43 44 45 46 47      48 49 50 51 52      53

XX X  X  XXXXX  X  XX X  X  XXXXX  X  XX X  X  XXXXX  X
54 55 56 57      58 59 60 61 62      63 64 65 66 67      68

XX XX XX XX XX XX XX XX XX X  X  XXX XX XX X  X  @  XX [CR] [LF]
69 70 71 72 73 74 75 76 77 78 79 80  81 82 83 84 85 86
```

1	Header		1 character
2	Command		2 characters
3	Site name	Upper- and lowercase letters, numbers, periods (.) hyphens (-) and spaces ()	20 characters
4	Parameter 1 code	(1) Parameter code	2 characters
5	Parameter 1 selection	0: No selection; 1: Selection made	1 character
6	Parameter 1 error	(6) Parameter error code	1 character
7	Parameter 1 data	5 characters including decimal point, right-justified with blanks filled	5 characters
8	Parameter 1 unit	(2) Unit code	1 character
9	Parameter 2 code	(1) Parameter code	2 characters
10	Parameter 2 selection	0: No selection; 1: Selection made	1 character
11	Parameter 2 error	(6) Parameter error code	1 character
12	Parameter 2 data	5 characters including decimal point, right-justified with blanks filled	5 characters
13	Parameter 2 unit	(2) Unit code	1 character
14	Parameter 3 code	(1) Parameter code	2 characters
15	Parameter 3 selection	0: No selection; 1: Selection made	1 character
16	Parameter 3 error	(6) Parameter error code	1 character
17	Parameter 3 data	5 characters including decimal point, right-justified with blanks filled	5 characters
18	Parameter 3 unit	(2) Unit code	1 character
19	Parameter 4 code	(1) Parameter code	2 characters
20	Parameter 4 selection	0: No selection; 1: Selection made	1 character

21	Parameter 4 error	(6) Parameter error code	1 character
22	Parameter 4 data	5 characters including decimal point, right-justified with blanks filled	5 characters
23	Parameter 4 unit	(2) Unit code	1 character
24	Parameter 5 code	(1) Parameter code	2 characters
25	Parameter 5 selection	0: No selection; 1: Selection made	1 character
26	Parameter 5 error	(6) Parameter error code	1 character
27	Parameter 5 data	5 characters including decimal point, right-justified with blanks filled	5 characters
28	Parameter 5 unit	(2) Unit code	1 character
29	Parameter 6 code	(1) Parameter code	2 characters
30	Parameter 6 selection	0: No selection; 1: Selection made	1 character
31	Parameter 6 error	(6) Parameter error code	1 character
32	Parameter 6 data	5 characters including decimal point, right-justified with blanks filled	5 characters
33	Parameter 6 unit	(2) Unit code	1 character
34	Parameter 7 code	(1) Parameter code	2 characters
35	Parameter 7 selection	0: No selection; 1: Selection made	1 character
36	Parameter 7 error	(6) Parameter error code	1 character
37	Parameter 7 data	5 characters including decimal point, right-justified with blanks filled	5 characters
38	Parameter 7 unit	(2) Unit code	1 character
39	Parameter 8 code	(1) Parameter code	2 characters
40	Parameter 8 selection	0: No selection; 1: Selection made	1 character
41	Parameter 8 error	(6) Parameter error code	1 character
42	Parameter 8 data	5 characters including decimal point, right-justified with blanks filled	5 characters
43	Parameter 8 unit	(2) Unit code	1 character
44	Parameter 9 code	(1) Parameter code	2 characters
45	Parameter 9 selection	0: No selection; 1: Selection made	1 character
46	Parameter 9 error	(6) Parameter error code	1 character
47	Parameter 9 data	5 characters including decimal point, right-justified with blanks filled	5 characters
48	Parameter 9 unit	(2) Unit code	1 character
49	Parameter 10 code	(1) Parameter code	2 characters
50	Parameter 10 selection	0: No selection; 1: Selection made	1 character
51	Parameter 10 error	(6) Parameter error code	1 character
52	Parameter 10 data	5 characters including decimal point, right-justified with blanks filled	5 characters
53	Parameter 10 unit	(2) Unit code	1 character
54	Parameter 11 code	(1) Parameter code	2 characters
55	Parameter 11 selection	0: No selection; 1: Selection made	1 character
56	Parameter 11 error	(6) Parameter error code	1 character
57	Parameter 11 data	5 characters including decimal point, right-justified with blanks filled	5 characters
58	Parameter 11 unit	(2) Unit code	1 character
59	Parameter 12 code	(1) Parameter code	2 characters

60	Parameter 12 selection	0: No selection; 1: Selection made	1 character
61	Parameter 12 error	(6) Parameter error code	1 character
62	Parameter 12 data	5 characters including decimal point, right-justified with blanks filled	5 characters
63	Parameter 12 unit	(2) Unit code	1 character
64	Parameter 13 code	(1) Parameter code	2 characters
65	Parameter 13 selection	0: No selection; 1: Selection made	1 character
66	Parameter 13 error	(6) Parameter error code	1 character
67	Parameter 13 data	5 characters including decimal point, right-justified with blanks filled	5 characters
68	Parameter 13 unit	(2) Unit code	1 character
69	Year	00 to 99	2 characters
70	Month	01 to 12	2 characters
71	Day	01 to 31	2 characters
72	Hour	00 to 23	2 characters
73	Minute	00 to 59	2 characters
74	Second	00 to 5	2 characters
75	Longitude (degrees)	00 to 90 or "--" (no GPS data)	2 characters
76	Longitude (minutes)	00 to 59 or "--" (no GPS data)	2 characters
77	Longitude (seconds)	00 to 59 or "--" (no GPS data)	2 characters
78	Unused		1 character
79	North latitude/South latitude	N: North; S: South	1 character
80	Latitude (degrees)	000 to 180 or "---" (no GPS data)	3 characters
81	Latitude (minutes)	00 to 59 or "--" (no GPS data)	2 characters
82	Latitude (seconds)	00 to 59 or "--" (no GPS data)	2 characters
83	Unused		1 character
84	East longitude/West longitude	E: East; W: West	1 character
85	Delimiter character		1 character
86	Frame check sequence (FCS)		2 characters

(When no data exists, or memory is at capacity)

#	RM	@	XX	[CR]	[LF]
1	2	3	4		

1	Header	1 character
2	Command	2 characters
3	Delimiter character\	1 character
4	Frame check sequence (FCS)	2 characters

● Memory data count request

● Request command format

#	RN	@	XX	[CR]	[LF]
1	2	3	4		

1	Header	1 character
2	Command	2 characters
3	Delimiter character\	1 character
4	Frame check sequence (FCS)	2 characters

● Response format

#	RN	XXXXX	@	XX	[CR]	[LF]
1	2	3	4	5		

1	Header	1 character
2	Command	2 characters
3	Total data count	0 to 10000 5 characters
4	Delimiter character\	1 character
5	Frame check sequence (FCS)	2 characters

● Command parse failure response

#	??	X	XX	X	@	XX	[CR]	[LF]
1	2	3	4	5	6	7		

1	Header	1 character
2	Command	2 characters
3	Command parse failure reason ^{*4}	1 character
4	Received command ^{*5}	2 characters
5	(3) Status code for probe status ^{*5}	1 character
6	Delimiter character	1 character
7	Frame check sequence (FCS)	2 characters

^{*4}: List of command parse failure reasons

- 1: Frame length error
- 2: FCS mismatch
- 3: Undefined command
- 4: Data error
- 5: Data out of range
- 6: No "@" delimiter character
- 7: No "#" header character
- 8: No [Carriage return] + [Line feed] footer
- 9: Cannot accept command in this timing.

^{*5}: Only set for command parse failure reason 9, [Cannot accept command in this timing]. Otherwise this field is filled with spaces.

4 Maintenance

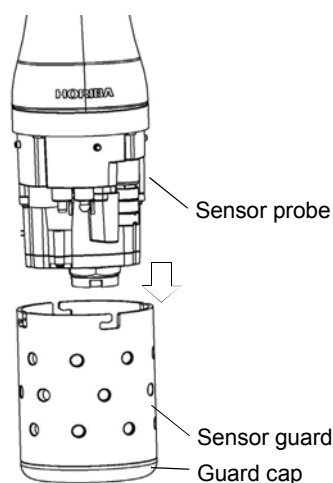
Tip

HORIBA recommends regular manufacturer maintenance checks in order to ensure a long product life.

4.1 Routine care

● After measurement

1. Turn the system's power OFF.
2. Remove the sensor guard, and clean the sensor with tap water.
3. Clean the turbidity sensor with the cleaning brush provided.
4. Remove the COND guard, and use a test tube brush to lightly remove any dirt from the electrical conductivity electrode.
5. Wipe off any dirt with a soft cloth. If parts are very dirty, clean them with neutral detergent, then rinse them. If parts are contaminated by oil, wipe it off with a soft cloth soaked in alcohol.
6. Put the COND guard back in place.
7. Remove the sensor guard's guard cap, wash off any dirt with tap water, then put the guard cap back in place.



4.2 Every 2 months maintenance

● Dissolved oxygen (DO) sensor

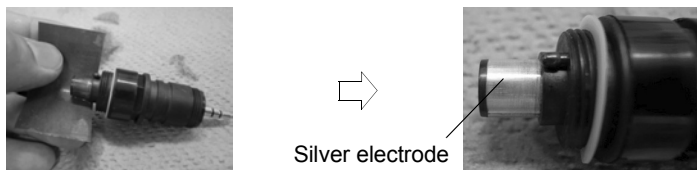
Note

- The DO sensor's internal solution is potassium chloride (KCl). Although KCl is harmless, protective equipment such as gloves and goggles should be worn when working with it.
- Internal solution can be disposed of down a sink.

- Replace the membrane cap.
- Polish the gold and silver electrodes when replacing the membrane cap.
The gold electrode does not need to be polished if it is not dirty.

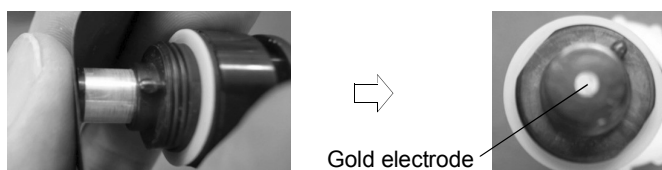
● Silver electrode

Polish a silver electrode part with sandpaper(#500) and then wash metal electrode parts with water.



● Gold electrode

Polish a gold electrode part with sandpaper (blue color) and then wash metal electrode parts with water.



Replace a membrane cap after clean metal electrodes parts.
Refer to “ 4.5 Replacing the membrane cap ” (page 82).

● Reference electrode

Note

- The pH reference internal solution is potassium chloride (KCl). Although KCl is harmless, protective equipment such as gloves and goggles should be worn when working with it.
- Internal solution can be disposed of down a sink.

1. Remove the rubber liquid junction plug from the reference electrode and dispose of the internal solution.
2. To prevent air entering, fill the reference electrode to the brim with its internal solution (No. 330).
3. Put the rubber liquid junction plug back in place.

If the rubber liquid junction plug is dirty, replace the liquid junctions (set of two; No. 9037005100). The reference electrode's internal solution will spill when replacing the liquid junctions. Rinse parts with tap water and dry them with a soft cloth.

4.3 Storage

● Short-term storage

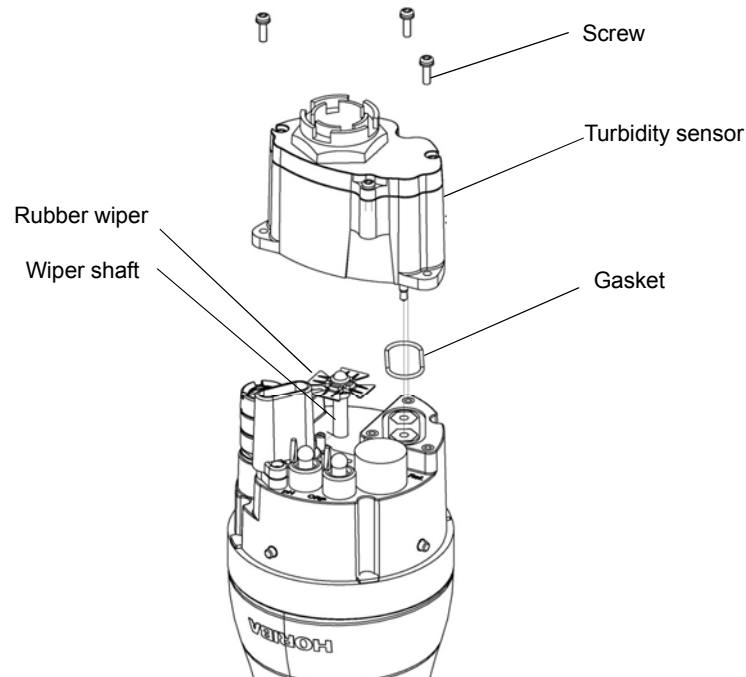
Fill the calibration cup with tap water and submerge the sensor probe in it.

● Long-term storage

- Before storing the system, fill the rubber caps provided with deionized water and cover the pH sensor chip and DO sensor chip with them.
- Prevent internal solution seeping out of the reference chip by taping over the point of seepage with electrical tape.
- Before storing the system, remove the control unit's batteries to prevent battery leakage.

4.4 Replacing the turbidity sensor

1. Turn the system's power OFF.
2. Remove the sensor guard, and clean the sensor probe with tap water.
3. Use dry air to blow away and dry off any moisture.
4. Remove the three screws holding the turbidity sensor.
(No. 2 Phillips head screwdriver)
5. Pull out the turbidity sensor horizontally.
6. Remove the rubber wiper and gasket, and use a soft cloth to wipe off any dirt from the wiper shaft and turbidity sensor attachment. If parts are very dirty, use a soft cloth soaked in neutral detergent or alcohol.
7. Replace the rubber wiper and gasket with new ones. Coat the gasket with a thin layer of grease (No. 3014017718).
8. Attach the new turbidity sensor and fasten it in place with the three screws.
9. Perform four-point calibration before using the sensor.



4.5 Replacing the membrane cap

● Replacement procedure

1. Prepare the DO sensor.

Take a DO sensor out of pack. (newly purchasing)

Undo a DO sensor from Sensor Probe, (After use)



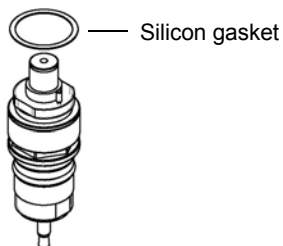
Newly purchasing



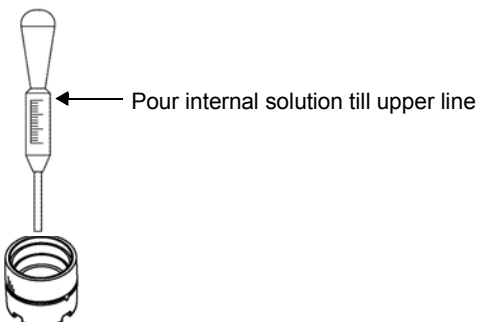
Undo a DO sensor from Sensor Probe

- Twist a Membrane Cap from DO Sensor.
- Wash the gold electrode and silver electrode parts with water.

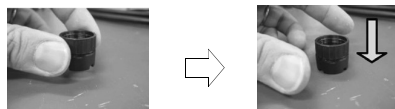
2. Replace the silicone gasket with a new one.



3. Pour internal solution into Membrane Cap with a dropper.

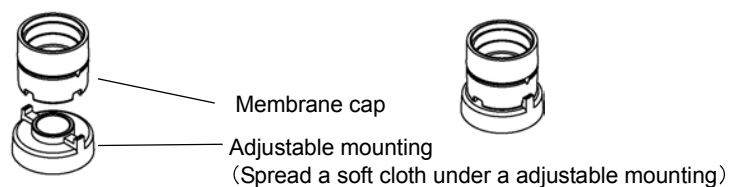


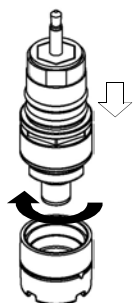
- Check air bubbles in Membrane Cap.



Pick a Cap up and drop it down, if there is air bubbles in internal solution of it.

4. Set up a Cap on a adjustable mounting.

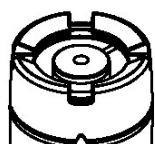


5. Attach a membrane cap to DO sensor

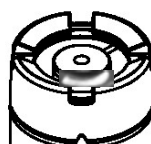
Twist a DO sensor
with holding a Membrane Cap tight.

6. Check for membrane surface

Check air bubbles in Membrane Cap.



Good: Limited air bubbles



NG: Air bubbles of more than 5 mm in diameter

- NG → Replace a Membrane Cap again.
- Check that span calibration can be performed.

If the membrane cap is not attached correctly, sensitivity may be lost or response speed may decrease.

4.6 Troubleshooting

Note

If the sensor probe is removed while the control unit is indicating an error, errors cannot be canceled by using the ESC key. Either reconnect the sensor probe or restart the control unit.

4.6.1 Error displays

Error	Cause	Solution
Probe ADC error	Internal IC failure	Contact your nearest sales outlet to have the sensor probe repaired.
Probe EEPROM error/Factory	Internal IC failure	Turn the power OFF, then restart the system. If the error persists, initialize the system from the "System" menu. If the error still persists, contact your nearest sales outlet to have the sensor probe repaired.
Probe EEPROM error/User	Internal IC failure	Turn the power OFF, then restart the system. If the error persists, initialize the system from the "System" menu. If the error still persists, contact your nearest sales outlet to have the sensor probe repaired.
Turbidity sensor light source error	Turbidity sensor light source failure	Turn the power OFF, wipe off any water droplets on the probe, then remove the turbidity sensor. Check there are no water droplets around the turbidity sensor connector, then mount the sensor again. If the error persists, replace the turbidity sensor.
Turbidity sensor wiper motor error	The turbidity sensor wiper is not operating.	Press the ESC key. Check there are no obstacles near the wiper, then perform the measurement again. If the error persists, the motor will need to be replaced. Contact your nearest sales outlet to have the sensor probe repaired.
Probe capacitor error	Low battery voltage or internal IC failure	Turn the power OFF. Replace the display's batteries. If the error persists, contact your nearest sales outlet to have the sensor probe repaired.
Probe EEPROM error	Internal IC failure	Press the ESC key, then redo the operation. If the error persists, turn the power OFF, then restart the system (the current data will not be saved). If the error still persists, contact your nearest sales outlet to have the display repaired.
Probe board error	Probe board failure	Turn the power OFF. Contact your nearest sales outlet to have the sensor probe repaired.

Error	Cause	Solution
Zero-point calibration error	<p>pH sensor</p> <ol style="list-style-type: none"> 1. The pH standard solution is contaminated. 2. The pH-responsive membrane is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The pH-responsive membrane is torn. 	<p>pH sensor</p> <ol style="list-style-type: none"> 1. Replace the standard solution with new solution. 2. Clean the pH-responsive membrane. 3. Refill the reference electrode's internal solution. 4. Replace the sensor.
	<p>COND sensor</p> <ol style="list-style-type: none"> 1. There is moisture on the sensor. 2. The sensor is dirty. 3. The COND sensor is broken. 	<p>COND sensor</p> <ol style="list-style-type: none"> 1. Blow-dry the moisture off the sensor. 2. Clean the sensor. 3. Contact your nearest sales outlet.
	<p>TURB sensor</p> <ol style="list-style-type: none"> 1. There are air bubbles on the cell. 2. The cell window is dirty. 3. The sensor is being affected by ambient light. 4. The solution is dirty. 5. The TURB sensor has failed. 	<p>TURB sensor</p> <ol style="list-style-type: none"> 1. Shake the sensor probe vigorously. 2. Clean the cell window. 3. Calibrate using the calibration cup provided. 4. Replace the solution with new solution. 5. Replace the TURB sensor.
	<p>DO sensor</p> <ol style="list-style-type: none"> 1. There are air bubbles in the internal solution. 2. The DO sensor has failed. 	<p>DO sensor</p> <ol style="list-style-type: none"> 1. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 2. Replace the DO sensor.
	<p>Water depth sensor</p> <ol style="list-style-type: none"> 1. The water depth sensor is dirty. 2. The water depth sensor has failed. 	<p>Water depth sensor</p> <ol style="list-style-type: none"> 1. Clean the water depth sensor. 2. Contact your nearest sales outlet.

Error	Cause	Solution
Span calibration error	<p>pH sensor</p> <ol style="list-style-type: none"> 1. The pH standard solution is contaminated. 2. The pH-responsive membrane is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The pH-responsive membrane is torn. 	<p>pH sensor</p> <ol style="list-style-type: none"> 1. Replace the standard solution with new solution. 2. Clean the pH-responsive membrane. 3. Refill the reference electrode's internal solution. 4. Replace the sensor.
	<p>ORP sensor</p> <ol style="list-style-type: none"> 1. The ORP standard solution is contaminated. 2. The ORP electrode is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The ORP electrode has failed. 	<p>ORP sensor</p> <ol style="list-style-type: none"> 1. Replace the standard solution with new solution. 2. Clean the ORP electrode. 3. Refill the reference electrode's internal solution. 4. Replace the ORP electrode.
	<p>COND sensor</p> <ol style="list-style-type: none"> 1. The calibration solution is not correct. 2. The sensor is dirty. 3. The COND sensor has failed. 	<p>COND sensor</p> <ol style="list-style-type: none"> 1. Use the correct calibration solution for calibration. 2. Clean the sensor. 3. Contact your nearest sales outlet.
	<p>TURB sensor</p> <ol style="list-style-type: none"> 1. There are air bubbles on the cell. 2. The cell window is dirty. 3. The sensor is being affected by ambient light. 4. The solution is dirty. 5. The TURB sensor has failed. 	<p>TURB sensor</p> <ol style="list-style-type: none"> 1. Shake the sensor probe vigorously. 2. Clean the cell window. 3. Calibrate using the calibration cup provided. 4. Replace the solution with new solution. 5. Replace the TURB sensor.
	<p>DO sensor</p> <ol style="list-style-type: none"> 1. The diaphragm is torn. 2. There are air bubbles in the internal solution. 3. The DO sensor has failed. 	<p>DO sensor</p> <ol style="list-style-type: none"> 1. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 2. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 3. Replace the DO sensor.
	<p>Temperature sensor</p> <p>The temperature sensor has failed.</p>	<p>Temperature sensor</p> <p>Contact your nearest sales outlet.</p>
Calibration stability error	<p>The calibration value of an individual parameter is not stable.</p> <ol style="list-style-type: none"> 1. The sensor is dirty. 2. The sensor has not adjusted to the standard solution. 3. The temperature was unstable during calibration. 	<ol style="list-style-type: none"> 1. Clean the sensor. 2. Fill the transparent calibration cup with pH 4 standard solution, and wait for at least 20 minutes of conditioning before starting calibration. 3. Start calibration after the temperature has stabilized.
Turbidity calibration error	Error in turbidity measurement sequence	Turbidity calibration failed. Redo calibration after removing the displayed error.
Display EEPROM error	Internal IC failure	Contact your nearest sales outlet to have the sensor probe repaired.
Wet check	The cable connector is submerged.	Turn the power OFF and disconnect the cable connector. Wipe or blow-dry off all the water droplets on the probe. If the error persists, contact your nearest sales outlet to have the display and sensor probe repaired.

Error	Cause	Solution
Power voltage error	The display's power board has failed.	This error could also be caused by poor cable contact. Turn the power OFF and disconnect the cable connector. Reconnect the connector and turn the power ON. If the error persists, contact your nearest sales outlet to have the display and sensor probe repaired.
Turbidity lamp power voltage error	The remaining battery level is low.	Turn the power OFF and replace the display's batteries with new ones.
Display RTC error	The time display is incorrect.	Replace the coin battery.
Display FROM error	Internal IC failure	Contact your nearest sales outlet to have the sensor probe repaired.
Display EEPROM error	Internal IC failure	Contact your nearest sales outlet to have the sensor probe repaired.
Display save error	Insufficient memory space	Move data from the display, use the data operations screen to delete data, then redo the measurement.
Measurement sequence error	<p>" When the measurement item is turbidity</p> <ol style="list-style-type: none"> 1. The battery power is low. 2. The wiper is not operating normally. 3. The light source lamp is not lit. <p>" If items other than turbidity are also displayed</p> <ol style="list-style-type: none"> 4. Board failure 	<ol style="list-style-type: none"> 1. Replace the batteries with new ones. 2. Check there are no obstacles near the wiper, then redo the measurement. If the error persists, the motor will need to be replaced. Contact your nearest sales outlet to have the sensor probe repaired. 3. Wipe off any water droplets on the probe, then remove the turbidity sensor. Check there are no water droplets around the turbidity sensor connector, then mount the sensor again. If the error persists, replace the turbidity sensor. 4. Contact your nearest sales outlet to have the sensor probe repaired.
Out of measurement range	The attempted measurement is outside the measurement range supported for that item.	The system must be used within its supported measurement ranges.

4 Maintenance

Error	Cause	Solution
Last zero-point calibration invalid	<p>pH sensor</p> <ol style="list-style-type: none"> 1. The pH standard solution is contaminated. 2. The pH-responsive membrane is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The pH-responsive membrane is torn. 	<p>pH sensor</p> <ol style="list-style-type: none"> 1. Replace the standard solution with new solution. 2. Clean the pH-responsive membrane. 3. Refill the reference electrode's internal solution. 4. Replace the sensor.
	<p>COND sensor</p> <ol style="list-style-type: none"> 1. There is moisture on the sensor. 2. The sensor is dirty. 3. The COND sensor has failed. 	<p>COND sensor</p> <ol style="list-style-type: none"> 1. Blow-dry the moisture off the sensor. 2. Clean the sensor. 3. Contact your nearest sales outlet.
	<p>TURB sensor</p> <ol style="list-style-type: none"> 1. There are air bubbles on the cell. 2. The cell window is dirty. 3. The sensor is being affected by ambient light. 4. The solution is dirty. 5. The TURB sensor has failed. 	<p>TURB sensor</p> <ol style="list-style-type: none"> 1. Shake the sensor probe vigorously. 2. Clean the cell window. 3. Calibrate using the calibration cup provided. 4. Replace the solution with new solution. 5. Replace the TURB sensor.
	<p>DO sensor</p> <ol style="list-style-type: none"> 1. There are air bubbles in the internal solution. 2. The DO sensor has failed. 	<p>DO sensor</p> <ol style="list-style-type: none"> 1. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 2. Replace the DO sensor.
	<p>Water depth sensor</p> <ol style="list-style-type: none"> 1. The water depth sensor is dirty. 2. The water depth sensor has failed. 	<p>Water depth sensor</p> <ol style="list-style-type: none"> 1. Clean the water depth sensor. 2. Contact your nearest sales outlet.
Out of measurement range	[See above.]	[See above.]
Last zero-point calibration invalid		

Error	Cause	Solution
Last span calibration invalid	pH sensor 1. The pH standard solution is contaminated. 2. The pH-responsive membrane is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The pH-responsive membrane is torn.	pH sensor 1. Replace the standard solution with new solution. 2. Clean the pH-responsive membrane. 3. Refill the reference electrode's internal solution. 4. Replace the sensor.
	ORP sensor 1. The ORP standard solution is contaminated. 2. The ORP electrode is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The ORP sensor glass is broken.	ORP sensor 1. Replace the standard solution with new solution. 2. Clean the ORP electrode. 3. Refill the reference electrode's internal solution. 4. Replace the sensor.
	COND sensor 1. The calibration solution is not correct. 2. The sensor is dirty. 3. The COND sensor has failed.	COND sensor 1. Use the correct calibration solution for calibration. 2. Clean the sensor. 3. Contact your nearest sales outlet.
	TURB sensor 1. There are air bubbles on the cell. 2. The cell window is dirty. 3. The sensor is being affected by ambient light. 4. The solution is dirty. 5. The TURB sensor has failed.	TURB sensor 1. Shake the sensor probe vigorously. 2. Clean the cell window. 3. Calibrate using the calibration cup provided. 4. Replace the solution with new solution. 5. Replace the TURB sensor.
	DO sensor 1. The diaphragm is torn. 2. There are air bubbles in the internal solution. 3. The DO sensor has failed.	DO sensor 1. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 2. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 3. Replace the DO sensor.
	Temperature sensor " The temperature sensor has failed.	Temperature sensor " Contact your nearest sales outlet.
Out of measurement range	[See above.]	[See above.]
Last zero-point calibration invalid		
Last span calibration invalid	The calibration value of an individual parameter is not stable. 1. The sensor is dirty. 2. The sensor has not adjusted to the standard solution. 3. The temperature was unstable during calibration.	1. Clean the sensors. 2. Fill the transparent calibration cup with pH 4 standard solution, and wait for at least 20 minutes of conditioning before starting calibration. 3. Start calibration after the temperature has stabilized.
Out of measurement range	[See above.]	[See above.]
Last zero-point calibration invalid		
Calibration value is factory default value.	Internal IC failure	Turn the power OFF, then restart the system. If the error persists, initialize the system from the "System" menu. If the error still persists, contact your nearest sales outlet to have the sensor probe repaired.

Error	Cause	Solution
Sample is unstable.	<ol style="list-style-type: none"> 1. The concentration of the sample is unstable. 2. External light disturbance has affected the sensor. 3. Water has entered the turbidity sensor's connector. 	<ol style="list-style-type: none"> 1. Use a stirrer to agitate the sample during measurement. 2. Perform measurement away from direct sunlight. 3. Turn the power OFF, wipe off any water droplets on the probe, then remove the turbidity sensor. Check there are no water droplets around the turbidity sensor connector, then mount the sensor again. If the error persists, replace the turbidity sensor.

4.6.2 Error displays in sensor information

Error display	Cause	Solution
Measurement sequence error	Measurement sequence error	Turn the power OFF, then restart the system. If the error persists, have the probe repaired.
Out of measurement range	The measurement value is outside the measurement range.	Samples for measurement must be within the measurement range.
Last calibration invalid	The last calibration failed.	Redo calibration.
Calibration invalid	The calibration value is the factory default value.	Redo calibration.
Background unstable	The U-53 turbidity sensor is exposed to direct light.	Mount the guard cap and sensor guard and perform measurement away from direct sunlight.
	The turbidity value changed rapidly during measurement.	Measure a sample that has stable turbidity.

5 Specifications

Specification		Basic value	Model				
			U-51	U-52	U-52G	U-53	U-53G
Sensor probe	Measurement temperature range	−5°C to 55°C	✓	✓	✓	✓	✓
	Maximum sensor outer diameter	Approx. 96 mm					
	Sensor length	Approx. 340 mm					
	Cable length	2 m (standard) 10 m/30 m (options)					
	Mass	Approx. 1800 g					
	Auto calibration function	Uses pH 4 standard solution.					
	Measurement DEPTH	30 m max.	✓	✓	✓	✓	✓
	Wet-part materials	PPS, glass, SUS316L, SUS304, FKM, PEEK, Q, titanium, FEP membrane, POM					
	Waterproofing standard	IP-68					

5 Specifications

Specification		Basic value	Model				
			U-51	U-52	U-52G	U-53	U-53G
Control unit	Outer dimensions (W × D × H)	115 × 65 × 280 mm	✓	✓	—	✓	—
		115 × 65 × 335 mm	—	—	✓	—	✓
	Mass	Approx. 800 g	✓	✓	✓	✓	✓
	LCD	320 × 240 mm graphic LCD (monochrome) with backlight	✓	✓	✓	✓	✓
	Memory data items	10000	✓	✓	✓	✓	✓
	Communication interface	USB peripheral	✓	✓	✓	✓	✓
	Batteries	C-size dry cells (× 4)	✓	✓	✓	✓	✓
	Number of simultaneous display items	—	10	11		11	
	Waterproofing standard	IP-67	✓	✓	✓	✓	✓
	GPS unit	<ul style="list-style-type: none"> ● Reception method (12 channel parallel) ● Measurement precision [With PDOP (high precision): 30 m or less (2 drms)] 	—	—	✓	—	✓
	Estimated battery life	—	70 hours (no backlight)			500 measurements (no backlight)	
	Storage temperature range	−10°C to 60°C	✓	✓	✓	✓	✓
	Ambient temperature range	−5°C to 45°C					
pH measurement Two calibration	Measurement method	Glass electrode method	✓	✓	✓	✓	✓
	Range	pH 0 to 14					
	Resolution	0.01 pH					
	Precision	±0.1 pH					
Dissolved oxygen measurement <ul style="list-style-type: none"> ● Salinity conversion (0 to 70 PPT, automatic) ● Automatic temperature compensation 	Measurement method	Polarographic method	✓	✓	✓	✓	✓
	Film thickness	25 μm					
	Range	0 mg/L to 50.0 mg/L					
	Resolution	0.01 mg/L					
	Precision	0 mg/L to 20 mg/L: ±0.2 mg/L 20 mg/L to 50 mg/L: ±0.5 mg/L					

Specification		Basic value	Model				
			U-51	U-52	U-52G	U-53	U-53G
Electrical conductivity measurement ● Auto range ● Automatic temperature conversion (25°C)	Measurement method	Four-AC-electrode method					
	Range	0 S/m to 10 S/m (0 mS/cm to 100 mS/cm)					
	Resolution	0.000 mS/cm to 0.999 mS/cm: 0.001 1.00 mS/cm to 9.99 mS/cm: 0.01 10.0 mS/cm to 99.9 mS/cm: 0.1 0.0 mS/m to 99.9 mS/m: 0.1 0.100 S/m to 0.999 S/m: 0.001 1.00 S/m to 9.99 S/m: 0.01	✓	✓	✓	✓	✓
	Precision	1% of full-scale (midpoint of two calibration points)					
Salinity measurement	Measurement method	Electrical conductivity conversion					
	Range	0 PPT to 70 PPT (parts per thousand)	✓	✓	✓	✓	✓
	Resolution	0.1 PPT					
	Precision	±3 PPT					
TDS (total dissolved solid) measurement ● Conversion coefficient setting	Measurement method	Electrical conductivity conversion					
	Range	0 g/L to 100 g/L					
	Resolution	0.1% of full-scale	✓	✓	✓	✓	✓
	Repeatability	±2 g/L					
	Precision	±5 g/L					
Seawater specific gravity measurement ● σ_t , σ_0 , σ_{15} display	Measurement method	Electrical conductivity conversion					
	Range	0 σ_t to 50 σ_t	✓	✓	✓	✓	✓
	Resolution	0.1 σ_t					
	Precision	±5 σ_t					
Temperature measurement	Measurement method	Platinum temperature sensor					
	Range	−5°C to 55°C					
	Resolution	0.01°C	✓	✓	✓	✓	✓
	Sensor	Platinum temperature sensor, JIS Class B (0.3 + 0.005 t)					

5 Specifications

Specification		Basic value	Model				
			U-51	U-52	U-52G	U-53	U-53G
Turbidity measurement	Measurement method		—	LED forward 30° transmission/scattering method	Tungsten lamp 90° transmission scattering method		
	Range			0 NTU to 800 NTU	0 NTU to 1000 NTU		
	Resolution			0.1 NTU	0.01 NTU		
	Precision			±5% of readout or ±1 NTU, whichever is larger	● ±0.5NTU (for 0 NTU to 10 NTU measurement range) ● 3% of readout or 1 NTU, whichever is larger (for 10 NTU to 1000 NTU measurement range)		
	Turbidity sensor wiper				—		
Water depth measurement	Measurement method	Pressure method	—	—	✓	✓	✓
	Range	0 m to 30 m					
	Resolution	0.05 m					
	Precision	±0.3 m					
ORP (oxidation reduction potential) measurement	Measurement method	Platinum electrode method	✓	✓	✓	✓	✓
	Range	−2000 ~ +2000 mV					
	Resolution	1 mV					
	Precision	±15 mV					

6 Reference

6.1 Consumable parts

● Sensor

Name	Model	No.	Description
pH sensor	#7112C	3014031013	Standard type pH sensor
pH sensor	#7113	3200170923	pH sensor (TAUPH)
ORP sensor	#7313	3200170920	
Reference electrode	#7210	3200043582	
R bush unit	—	3200169292	Reference electrode liquid junction
TURB cell U-52	#7800	3200172803	For U-52/U-52G
TURB cell U-53	#7801	3200172800	For U-53/U-53G
DO membrane cap	—	3200160299	

● Standard solution and inner solution

Name	Model	No.	Description
pH 4 (For automatic calibration) 500 mL	#100-4	3200043638	Standard solution for auto calibration. Also used for manual pH span calibration.
pH 4 (For automatic calibration) 4 L	#140-4	3200174430	
pH 7 500 mL	#100-7	3200043637	Standard solution for pH zero-point calibration.
pH 9 500 mL	#100-9	3200043636	Standard solution for pH manual span calibration.
Powder for ORP standard solution 10 packs	#160-51	3200043618	For ORP calibration.
Powder for ORP standard solution 10 packs	#160-22	3200043617	
Inner solution for DO sensor, 50 mL	#306	3200170938	Internal solution for DO sensor.
Internal solution for pH, 250 mL	#330	3200043641	Supplementary internal solution for pH reference electrode.

● Others

Name	Model	No.	Description
Silicone grease	—	3014017718	Silicone grease for coating sensor O-ring.
Sponge brush unit	—	3200169531	Brush for cleaning sensor probe.
O-ring set for reference electrode	—	3200169376	O-rings for reference electrode.
O-ring set for DO sensor	—	3200169426	O-rings for DO sensor.
Rubber cap set for sensor guard	—	3200169428	Rubber caps used between sensor guard and sensor probe.
O-ring set for pH and ORP sensor	—	3200169520	O-rings for pH and ORP sensors.
Wiper unit	—	3200169789	Rubber wiper for U-53/U-53G turbidity sensors.
pH protect cap	—	3200175019	Cap attached to tip of pH sensor for sensor probe storage.
DO protect cap unit	—	3200175020	Cap attached to tip of DO sensor for sensor probe storage.

6.2 Options sold separately

Name	Model	No.	Description
Bag	U-5030	3200174772	Storage bag for sensor probes and flow cell. Can be carried in one hand.
Flow cell assy	—	3200156570	Used when collecting measurement samples by pump.
Probe guard	—	3200167002	Used for taking measurements in locations where there is a current or where there is a thick layer of sludge.
Communication cable	—	3200174823	A PC connection cable. Comes with data collection software.

6.3 pH measurement

6.3.1 Principle of pH measurement

U-50 series use the glass electrode method for pH measurements. The glass electrode method measures a potential difference between the glass film for pH and the reference electrode. For more information, refer to JIS Z 8802 pH measurement method.

6.3.2 Temperature compensation

The electromotive force generated by the glass electrode changes depending on the temperature of the solution.

Temperature compensation is used to compensate for the change in electromotive force caused by temperature.

This function does not compensate the change in pH caused by the temperature of the solution. When pH is to be measured, the temperature of the solution must be recorded along with that pH value, even if a pH meter has automatic temperature compensation function. If the solution temperature is not recorded, the results of the pH measurement may be meaningless.

6.3.3 Standard solutions

When measuring pH, the pH meter must be calibrated using standard solution. There are five kinds of standard solutions specified in “JIS Z 8802 pH measurement”. For normal measurement, two of standard solutions with pH of 4, 7, and 9 are sufficient to accurately calibrate the meter.

For standard solutions, refer to “JIS Z 8802 pH measurement”. pH 4 standard solution 0.05 mol/L potassium hydrogen phthalate aqueous solution (Phthalate)

pH 7 standard solution 0.025 mol/L potassium dihydrogenphosphate, 0.025 mol/L disodium

(Neutral phosphate) hydrogenphosphate aqueous solution

pH 9 standard solution 0.01 mol/L sodium tetraborate aqueous solution (Borate)

Table 1 pH values of pH standard solutions at various temperatures settings.

Temp. (°C)	pH 4 standard solution Phthalate	pH 7 standard solution Neutral phosphate	pH 9 standard solution Borate
0	4.01	6.98	9.46
5	4.01	6.95	9.39
10	4.00	6.92	9.33
15	4.00	6.90	9.27
20	4.00	6.88	9.22
25	4.01	6.86	9.18
30	4.01	6.85	9.14
35	4.02	6.84	9.10
40	4.03	6.84	9.07
45	4.04	6.84	9.04

6.4 DO measurement

6.4.1 Principle of DO measurement

Dissolved oxygen (DO) refers to the amount of oxygen that is contained in water.

The concentration of dissolved oxygen is generally given as mg/L or as a percentage value (the dissolved oxygen saturation ratio).

Dissolved oxygen is essential for maintaining the self-purifying ability of rivers and seas and also for fish to live. The concentration of dissolved oxygen acts as an indicator of water quality. It is often measured when processing waste water and managing water quality. Fig. 1 provides an overview of the principles behind dissolved oxygen sensor measurement.

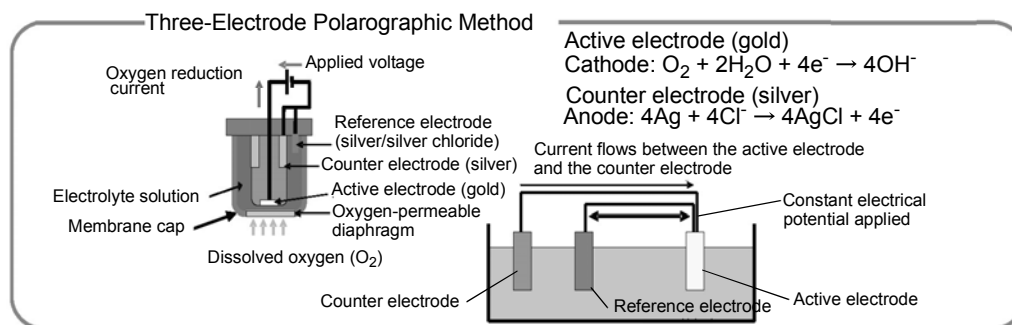


Fig. 1 Overview of principles behind dissolved oxygen sensor

The polarographic oxygen sensor is an enclosed sensor wherein voltage is applied to a cathode made of a precious metal (such as gold or platinum) and an anode also made of a precious metal (such as silver) via an external circuit, and a cap with an oxygen permeable diaphragm (membrane) is filled with electrolyte solution. As indicated in Fig. 1, the concentration of dissolved oxygen can be measured by measuring the current proportional to the amount of reduced oxygen when oxygen that has dispersed through the oxygen permeable diaphragm produces a reductive reaction on the surface of the active electrode (gold). The method of measuring dissolved oxygen based on the above principle is called the Membrane Electrode Method. Compared to the Chemical Analysis Method, which requires complicated pre-processing to alleviate the effect of reduced materials and oxidizing materials, this method allows dissolved oxygen to be measured very easily. It is also easy to remove undesired buildup from the silver electrode by polishing and cleaning if an insulator forms on it due to oxidation, making the method reusable.

6.4.2 Salinity calibration

When the solution and air come into contact and form an equilibrium (i.e. saturation), the relationship between the concentration of dissolved oxygen in the solution, C , [mol/L], and the partial pressure of oxygen in the air, P_s , [MPa/(mg/L)], can be represented by the following formula:

$$C = P_s/H$$

Where H [MPa/(mg/L)] is the Henry constant, a value that changes according to the composition of the solution. As H typically becomes larger as the salinity of the water increases, C becomes smaller.

The DO sensor detects the partial pressure of oxygen (P_s) in the above formula. Accordingly, if the DO sensor is immersed in deionized water saturated with air, or in an aqueous solution containing salt, the output current does not change, resulting in an erroneous measurement. For example, when salt is added to a sample, the amount of oxygen that can be dissolved in the solution decreases, but because the partial pressure of oxygen does not change, the value displayed by the control unit stays the same regardless of salt content. This concept is indicated in graph form below. (Fig. 2)

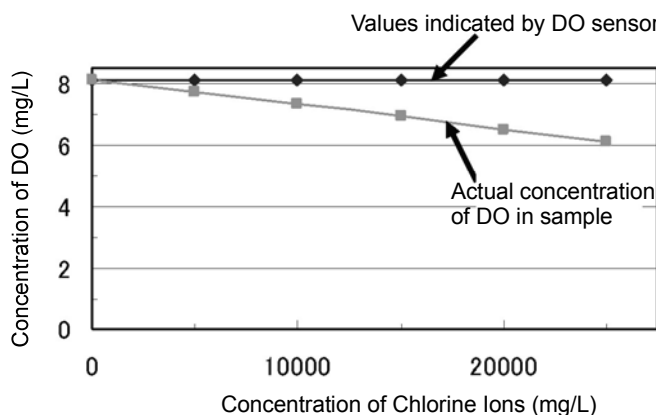


Fig. 2 Relationship between chlorine ion concentration and dissolved oxygen concentration

In samples with a high salt concentration, the solubility of oxygen is lower, but as the partial pressure of oxygen does not change, the value actually indicated on the control unit is higher than the actual value. In order to obtain a measurement of the concentration of dissolved oxygen in an aqueous solution that contains salt, it is therefore necessary to first perform salinity compensation. Conventionally, dissolved oxygen sensors have performed salinity compensation by inputting the salinity of the sample. This is fine as long as the salinity is already known. However, in most cases salinity is unknown, so even if dissolved oxygen sensors contained a salinity compensation function, it was of no practical use.

The U-50 Series can calculate and measure salinity in samples from electrical conductivity values, and can thus be used to automatically compensate for salinity.

6.5 Conductivity (COND) measurement

6.5.1 Four-AC-electrode method

Conductivity is an index of the flow of electrical current in a substance.

Salts dissolved in water are separated into cations and anions. Such solution is called electrolytic solution.

Electrolytic solution has the property of allowing the flow of current according to Ohm's law. This property is referred

to as ionic conductivity, since current flow is caused by ion movement in electrolytic solution.

Metals, on the other hand, allow the flow of current by means of electrons. This property is called electronic conductivity, which is distinguished from ionic conductivity.

A cube with 1 m on each side, as shown in Fig. 3, is used to demonstrate an electrolytic solution. Two electrode plates are placed on opposite sides, and the cube is filled with solution. If the resistance between these two electrode plates is represented by $r(\Omega)$, the conductivity of the solution $L(\text{S}\cdot\text{m}^{-1})$ is represented as $L=1/r$. S stands for Siemens, a unit of measurement of conductance.

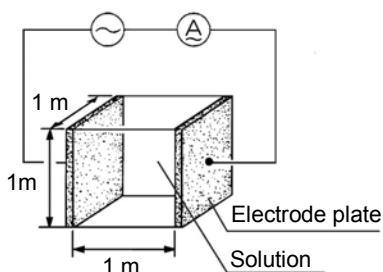


Fig. 3 Definition of conductivity

The most general method for measuring conductivity is based on the above principle, and is called the 2-electrode method.

In the 2-electrode method the influence of polarization cannot be ignored for solutions with high conductivity and conductivity cannot be measured accurately. In addition, contamination on the surface of the electrode increases apparent resistance, resulting in inaccurate measurement of conductivity.

The U-50 series has adopted the 4-electrode method to overcome these disadvantages of the 2-electrode method.

As shown in Fig. 4, the U-50 series uses two voltage-detecting electrodes and two voltage-applying electrodes, for a total of four electrodes. The voltage-detecting electrodes are for detecting AC voltage, and the voltage-applying electrodes are for applying AC voltage.

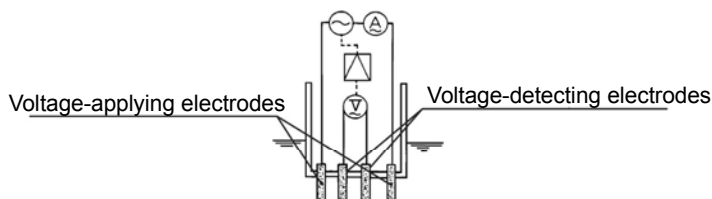


Fig. 4 Principle of the 4-electrode method

Let us assume that the current, $I(A)$, flows in a sample of conductivity L – under automatic control of the voltage-applying electrodes – so that the voltage at the voltage-detecting-electrodes, $E(V)$, remains constant at all times.

Then, the resistance of the sample, $R(\Omega)$, across the voltage-detecting electrodes is represented as $R=E/I$. The resistance, R , of the sample is inversely proportional to its conductivity, L . Accordingly, a measurement of current, I_s ,

of a standard solution of known conductivity, L_s , enables calculation of conductivity of a sample according to the formula $L = L_s (I/I_s)$ from the ratio $L : L_s = I : I_s$.

Even in the 4-electrode method, polarization occurs, since AC current flows in the voltage-applying electrodes. The voltage-detecting electrodes are, however, free from the effects of polarization, since they are separated from the voltage-applying electrodes, and furthermore, current flow is negligible. Therefore, the 4-electrode method is an excellent method to enable measurement of conductivity covering a very high range.

6.5.2 SI units

New measurement units, called SI units, have been in use from 1996. Accordingly, the U-50 series also uses SI units. The following conversion table is provided for people who use the conventional kind of conductivity meter.

Note that along with the change in unit systems, the measurement values and cell counts have also changed.

	Former units	→	SI unit
Measurement value	0.1 mS/cm	→	0.01 S/m
	1 mS/cm	→	0.1 S/m
	100 mS/cm	→	10 S/m

6.5.3 Temperature coefficient

In general, the conductivity of a solution varies largely with its temperature.

The conductivity of a solution depends on the ionic conductivity, described earlier. As the temperature rises, conductivity becomes higher since the movement of the ions becomes more active.

The temperature coefficient shows the change in % of conductivity per °C, with a certain temperature taken as the reference temperature. This is expressed in units of %/°C. The temperature coefficient assumes the premise that the conductivity of a sample changes linearly according to temperature.

Strictly speaking, with actual samples, however, conductivity changes along a curve. Furthermore, the curve varies with the type of sample. In the ranges of smaller temperature changes, however, samples are said to have the temperature coefficient of 2%/°C (at reference temperature 25°C); this holds for most samples, except in certain special cases.

(The temperature coefficients for various types of solutions are listed on the next page.)

The U-50 series uses an automatic temperature conversion function to calculate conductivity at 25°C at a temperature

coefficient of 2 %/°C based on the measured value of the temperature. Results are displayed on the readout.

The U-50 series's temperature conversion function is based on the following formula.

$$L_{25} = L_t / \{ 1 + K (t - 25) \}$$

L_{25} : Conductivity of solution converted to 25°C

t : Temperature of solution at time of measurement (°C)

L_t : Conductivity of solution at t (°C)

K : Temperature coefficient (%/°C)

● **Conductivity and temperature coefficient for various solutions**

Conductivity and related temperature coefficients of representative substances (at 25°C) are shown in the table below.

Substance	Temp. (°C)	Conc. (wt%)	Cond. (S/m)	Temp.coef. (%/°C)	Substance	Temp. (°C)	Conc. (wt%)	Cond. (S/m)	Temp.coef. (%/°C)
NaOH	15	5	19.69	2.01	NaCl	18	5	6.72	2.17
		10	31.24	2.17			10	12.11	2.14
		15	34.63	2.49			15	16.42	2.12
		20	32.70	2.99			20	19.57	2.16
		30	20.22	4.50			25	21.35	2.27
		40	11.64	6.48			5	4.09	2.36
KOH	15	25.2	54.03	2.09	Na ₂ SO ₄	18	10	6.87	2.49
		29.4	54.34	2.21			15	8.86	2.56
		33.6	52.21	2.36			5	4.56	2.52
		42	42.12	2.83	Na ₂ CO ₃	18	10	7.05	2.71
NH ₃	15	0.1	0.0251	2.46			15	8.36	2.94
		1.6	0.0867	2.38			5	6.90	2.01
		4.01	0.1095	2.50	KCl	18	10	13.59	1.88
		8.03	0.1038	2.62			15	20.20	1.79
		16.15	0.0632	3.01			20	26.77	1.68
HF	18	1.5	1.98	7.20			21	28.10	1.66
		4.8	5.93	6.66	KBr	15	5	4.65	2.06
		24.5	28.32	5.83			10	9.28	1.94
HCl	18	5	39.48	1.58			20	19.07	1.77
		10	63.02	1.56	KCN	15	3.25	5.07	2.07
		20	76.15	1.54			6.5	10.26	1.93
		30	66.20	1.52			—	—	—
H ₂ SO ₄	18	5	20.85	1.21	NH ₄ Cl	18	5	9.18	1.98
		10	39.15	1.28			10	17.76	1.86
		20	65.27	1.45			15	25.86	1.71
		40	68.00	1.78			20	33.65	1.61
		50	54.05	1.93			25	40.25	1.54
		60	37.26	2.13	NH ₄ NO ₃	15	5	5.90	2.03
		80	11.05	3.49			10	11.17	1.94
		100.14	1.87	0.30			30	28.41	1.68
		—	—	—			50	36.22	1.56
HNO ₃	18	6.2	31.23	1.47	CuSO ₄	18	2.5	10.90	2.13
		12.4	54.18	1.42			5	18.90	2.16
		31	78.19	1.39			10	32.00	2.18
		49.6	63.41	1.57			15	42.10	2.31
		62	49.64	1.57	CH ₃ COOH	18	10	15.26	1.69
H ₃ PO ₄	15	10	5.66	1.04			15	16.19	1.74
		20	11.29	1.14			20	16.05	1.79
		40	20.70	1.50			30	14.01	1.86
		45	20.87	1.61			40	10.81	1.96
		50	20.73	1.74			60	4.56	2.06

6.6 Salinity (SAL) conversion

The U-50 series is designed to calculate salinity as well as the other parameters.

Note that the “salinity” \pm referred to here is the salinity of sea water. There is a constant relation between conductivity and salinity at certain temperatures.

Therefore, if data on the conductivity and temperature are available, the corresponding salinity can be known. In other words, the salinity measurement of the U-50 series is based on the principle of calculating the salt content, making use of the measured values of conductivity and temperature.

Note therefore, that measured results of all substances whose conductivity is detected are displayed as salinity. For example, the measured result is displayed as NaCl concentration, even if in fact the sample component is, hydrochloric acid (HCl).

6.7 TDS conversion

TDS is short for Total Dissolved Solids and means the total dissolved solid amount.

The conductivity of a solution is affected by the amount of salinity, minerals, and dissolved gases. That is, conductivity is an index that shows the total amount of all substances in the solution. Of these substances, TDS indicates only the amount of dissolved solids.

TDS can be used for a comparison of the state of substances composed of a single component such as NaCl. However, the use of TDS for the comparison of solutions of different types causes serious errors.

Conductivity and TDS are expressed by the following formulas:

Conductivity in SI units (S/m) TDS(g/L) = L (S/m) \times K \times 10

TDS(g/L) = L (mS/m) \times K \div 100

Conductivity in the old units (mS/cm) TDS(g/L) = L (mS/cm) \times K

K = TDS coefficient

Initial settings use the values listed in the table (Page 80) that generally uses TDS coefficients.

For accurate TDS comparisons, find the TDS coefficient from measured conductivity values. Then set the value thus obtained and make measurements.

6.8 σ_t conversion

● Specific gravity of seawater

The density and specific gravity of seawater are equal numerically and generally are not distinguished strictly. Since seawater density ρ is between 1.000 and 1.031, 1 is subtracted from ρ and σ is obtained by multiplying the value by 1000.

The resultant value is used as the specific gravity of seawater.

$$\sigma = (\rho - 1) \times 1000$$

The density of seawater ρ is expressed by function of temperature, hydraulic pressure, and salinity. The density of seawater under the atmospheric pressure is expressed as σ_t . The density of seawater under the atmospheric pressure is determined by temperature and salinity.

The U-50 Series models make salinity measurement through temperature measurements and conductivity conversion and find σ_t through calculations.

In Japan σ_{15} at 15°C is called a standard specific gravity and widely used while in foreign countries σ_0 at 0°C is employed. σ_{15} and σ_0 are determined by the function of salinity.

In ocean surveys, in particular, these values σ_t , σ_{15} , and σ_0 are more widely used than conductivity and salinity and, in the U-50 Series models, newly added as measurement components.

6.9 Turbidity (TURB) measurement

6.9.1 Principle of turbidity measurement

U-52 and U-53 sensors measure turbidity using the Transmitting and Scattering Method shown in Fig. 5. U-52 sensors use a pulse light LED (infra-red emitting diode) as a light source, and detect scattered light from a 30° angle off center. U-53 sensors use a tungsten lamp as a light source and detect scattered light from a 90° angle. Both models display turbidity as a ratio of scattered light to transmitted light to reduce the affect of the color of the sample. The U-53 method conforms to EPA Method 180.1, and employs wipers to reduce the affect of air bubbles.

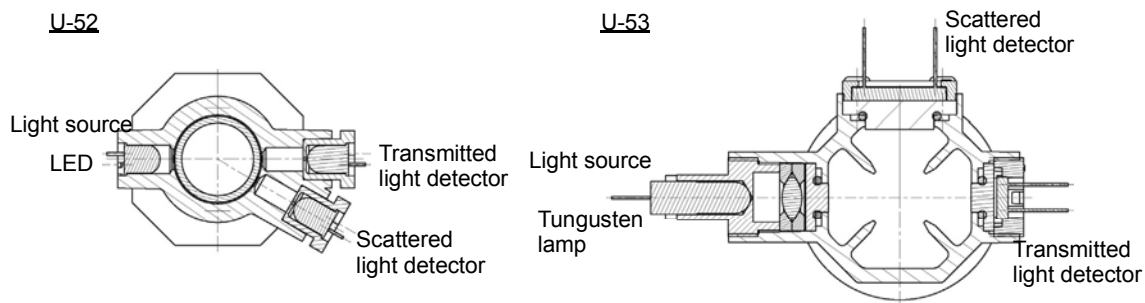


Fig. 5 Turbidity cell

6.9.2 Standard solution

U-50 series can perform calibration using formazin (NTU) or kaolin standard solutions as a turbidity standard solution. However, units for the solution used for calibration should be displayed in measurements. Do not use more than 400 mg/L of kaolin standard solution because it increases precipitation speed, resulting in measurement error.

6.10 Depth (DEPTH) measurement

6.10.1 Principle of depth measurement

For the W-22XD and W-23XD models, depth measurement can be made through use of a pressure gauge. The principle of the depth measurement uses the relation between depth and pressure.

Although the measurement with the depth sensor is affected by atmospheric pressure, the depth sensor, however, makes zero-point adjustments through the automatic calibration before measurements.

6.10.2 Influence of temperature and calibration

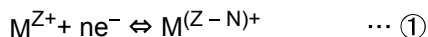
The depth sensor depends greatly on temperature. For a wide difference between the temperature at which the sensor has been automatically calibrated and the temperature of the measurement sample, the sensor can make depth measurements with a higher accuracy by the following method:

1. Immerse the depth sensor of the sensor probe into the sample.
2. Keep the sensor immersed in the sample for approximately 30 minutes until the temperatures of the sensor and the sample are the same.
3. Then make the zero calibration of the sensor manually.

6.11 Oxidation reduction potential (ORP) measurement

6.11.1 Principle of ORP measurement

ORP is an abbreviation for oxidation-reduction potential. ORP is the energy level (potential) determined according to the state of equilibrium between the oxidants (M^{Z+}) and reductants $M^{(Z-N)+}$ that coexist within a solution.



If only the solution, forming the ORP measuring system shown in Fig. 6. The difference of potential between two electrodes is generally expressed by the following equation.

$$E = E_0 - \frac{RT}{nF} \ln \frac{a_{M^{(Z-N)+}}}{a_{M^{Z+}}} \quad \dots \textcircled{2}$$

E: Electric potential E_0 : Constant R: Gas constant T: Absolute temperature
n: Electron count F: Faraday constant a: Activity

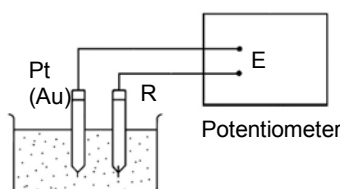
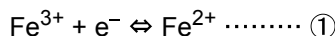


Fig. 6 Measuring mV

For example, for a solution in which trivalent iron ions coexist with bivalent iron ions, equations 1 and 2 would be as follows.



$$E = E_0 - \frac{RT}{F} \ln \frac{a_{Fe^{2+}}}{a_{Fe^{3+}}} \quad \dots \textcircled{2}$$

When only one type of state of equilibrium uniquely by equation (Fe^{3+}) and the reductant (Fe^{2+}) (using the equation $a_{Fe^{2+}}/a_{Fe^{3+}}$). Actually, however many kinds of states of equilibrium exist simultaneously between various kinds of ions, in most solutions. This means that under actual circumstances, ORP cannot be expressed using the simple equation shown above and that the physical and chemical significance with respect to the solution is not very clear.

In this respect, the value of ORP must be understood to be only one indicator of the property of a solution. The measurement of ORP is widely used, however, as an important index in the analysis of solutions (potentiometric titration) and in the waste water treatment.

6.11.2 Standard electrode (reference electrode) types and ORP

The ORP is obtained comparing with corresponding reference electrode employed.

If different kinds of reference electrodes are used for measurement, the ORP value of the same solution may appear to be different. HORIBA's reference electrode uses Ag/AgCl with 3.33 mol/L KCl as inner solution. According to general technical literature, normal hydrogen electrodes (N.H.E.) are often used as the standard electrode.

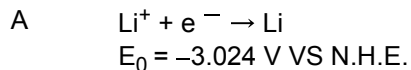
The relationship between N.H.E. and the ORP that is measured using an Ag/AgCl with 3.33 mol/L KCl electrode is expressed by the following equation.

$$E_{N.H.E.} = E + 206 - 0.7(t - 25) \text{ mV} \quad t = 0 - 60^\circ\text{C}$$

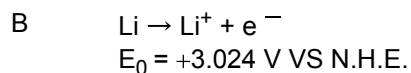
$E_{N.H.E.}$: Measured ORP value using N.H.E. as the reference electrode

E: Measured ORP value using Ag/AgCl with 3.33 mol/L KCl as the reference electrode
Potential sign

Standard ORP is expressed in the following way, in literature related to electrochemistry and analytical chemistry.



However, in some literature, the "+" and "-" signs are reversed.



In expressions like B, above, the reaction is just reversed and there is no essential difference. But this kind of expression does invite confusion. The majority of the world, today, is consistent in its use of the signs as they are used in A, above.

For this reason, HORIBA, too, uses signs concerning ORP that are consistent with A, above.

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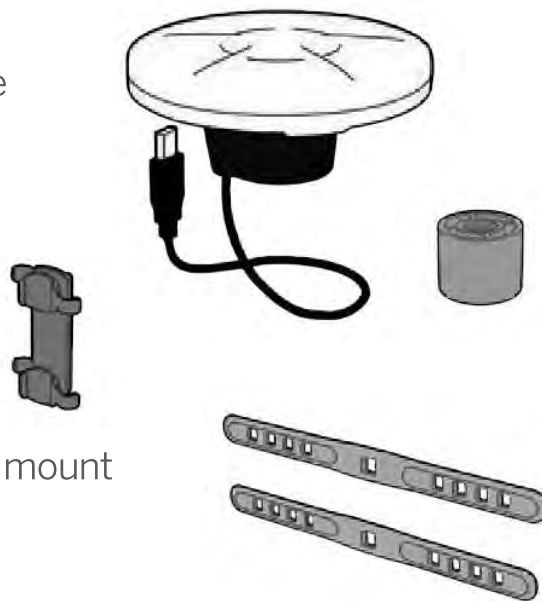
Trimble Catalyst DA2

GNSS RECEIVER

This guide provides an overview of important features and instructions to set up and operate the Trimble® Catalyst™ DA2 GNSS receiver and use it with a subscription to the Trimble Catalyst GNSS service. The receiver uses Bluetooth® technology to connect to a mobile device.

IN THE BOX

- Trimble Catalyst DA2 GNSS receiver, with USB power cable and push-fit mount
- Plastic bracket for battery mount
- Rubber straps (x2) for battery mount
- 5/8" x 11 threaded pole cap adapter (for push-fit mount)
- Quick Start Guide
- Trimble Hardware Warranty Card



NOTE -The DA2 GNSS receiver requires power from a standard USB power pack, purchased separately.

SAFETY AND COMPLIANCE

Before you use the Trimble Catalyst DA2 GNSS receiver, refer to the safety documentation and compliance information at:

geospatial.trimble.com/DA2-Compliance



ATTACHING THE RECEIVER TO A SURVEYING POLE

The DA2 receiver has a convenient push-fit mount for simple attachment to any 1 ¼" diameter pole. A 5/8" x 11 thread adaptor for convenient installation/removal on standard mapping and surveying accessories is also included in the box.

NOTE - Additional mounting accessories are available from Trimble or third party accessory vendors. Contact your Trimble distribution partner for details. Optional Trimble accessories include:

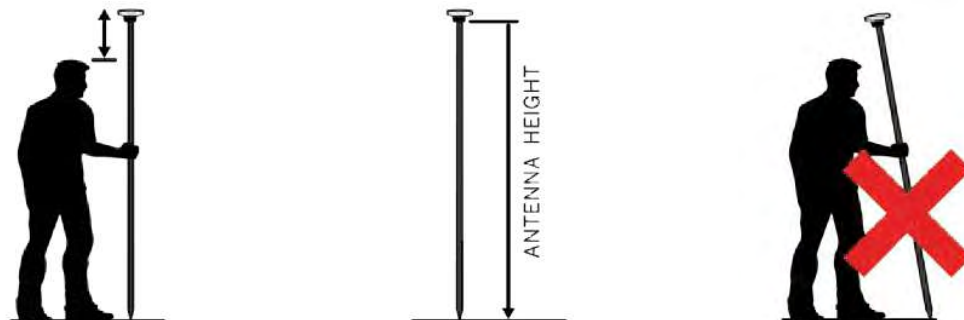
- A DA2 mounting accessory kit that includes:
 - Short ¼" push-fit thread adapter for camera tripods and monopoles
 - Tall and short 5/8" x 11 lock-fit thread adapter for vehicle or high-vibration use
 - Replacement push-fit mounting kit
- Aluminium and carbon-fiber survey poles and accessories

For consistent and accurate results

- If using the receiver on a pole, ensure that it is flat and secure on the pole.
- If using the push-fit 5/8" x 11 thread adapter, ensure that the yellow plastic of the thread adapter is completely concealed in the push-fit mount.



- When you are ready to work, always position the receiver vertically above the point on the ground being surveyed or mapped.
- When setting the receiver height offset in the field application (if supported), measure from the bottom of the push-fit pole mount to the ground.
- When tracking satellites, try to always hold the receiver above head-height, level to the sky, and as vertical as possible to ensure best performance.



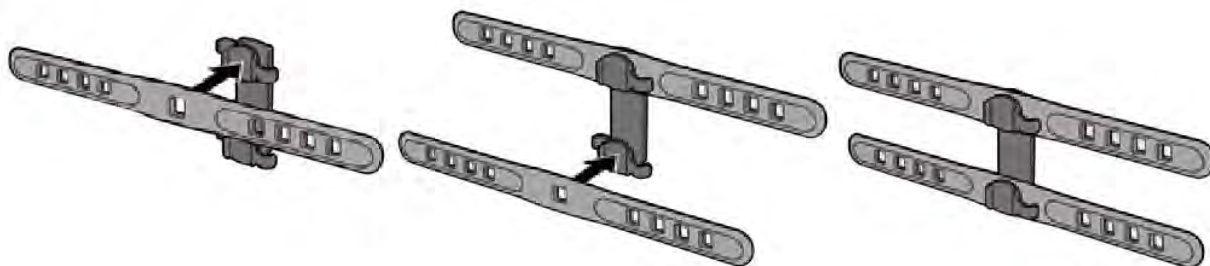
ASSEMBLING THE BATTERY MOUNT

The DA2 receiver is powered by USB. You can attach a standard off-the-shelf single-cell USB power pack to a survey rod using the supplied battery mounting bracket and rubber straps.

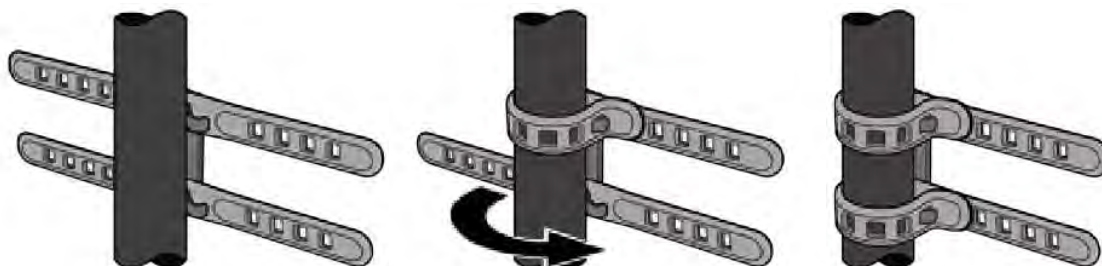
The supplied battery mount is designed to fit a variety of range pole and USB battery pack sizes.

To assemble the battery mount

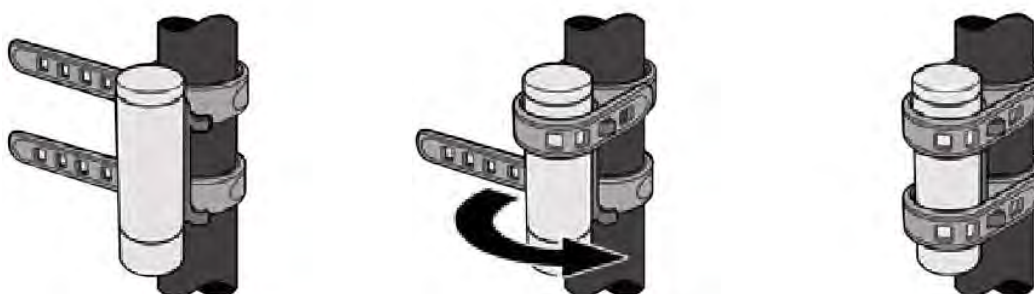
1. Stretch the two rubber straps over the plastic bracket.



2. To attach the battery mount on a range pole, wrap the rubber straps around the pole and secure using the fastening clips.

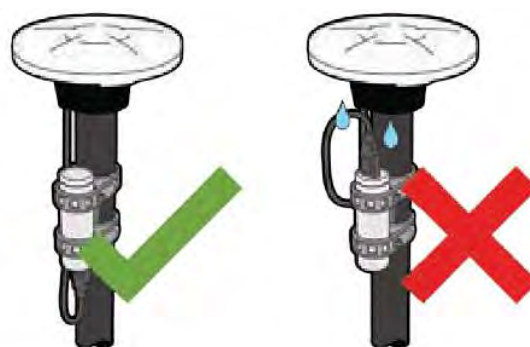


3. Attach a battery pack to the bracket using the clips on the other side.



For maximum rain-resistance, mount the battery with the USB socket facing towards the ground.

Use the supplied USB cable to connect the receiver to the USB battery pack.



TURNING THE RECEIVER ON

Activate the USB battery pack and press the button on the bottom of the DA2 receiver to turn it on.

LED status

- Flashing blue = receiver is discoverable and ready to pair/connect.
- Solid blue = receiver is connected to your field app (on Android), or your device (on iOS),
- Red = Fault. Turn off the receiver, then turn it on again. If the fault indicator persists, contact your Trimble distributor.
- Yellow = receiver software update is in progress

TURNING THE RECEIVER OFF

Briefly press the power button or unplug the power cable.

If the receiver is not connected to a device, it will go to sleep automatically after about 20 minutes.

CONNECTING TO THE DA2 RECEIVER

The DA2 receiver uses Bluetooth to communicate with a phone or tablet device and software.

Connecting on Android

Connect directly to the DA2 receiver using any supported Trimble field app. Third party apps connect to the DA2 receiver using the Trimble Mobile Manager app, available from the Google Play Store.

Connecting on iPhone and iPad

Connect to the DA2 receiver under **Settings** / **Bluetooth**. Search for your DA2 serial number in the devices list, and tap on it to connect. Configure DA2 using your Trimble field app, or the Trimble Mobile Manager app, available from the Apple App Store.



CONFIGURING THE DA2 RECEIVER

Follow the instructions in your field app to configure the DA2 receiver real-time GNSS corrections and output settings.

RESETTING THE DA2 RECEIVER

Resetting the DA2 receiver will force the receiver to forget any previously connected Bluetooth devices. Press and hold the button on the receiver until the light turns off. The receiver will reset itself and turn off. Press the button again to restart it.

SUBSCRIBE TO THE CATALYST GNSS SERVICE

The DA2 receiver is designed for use with the Trimble Catalyst GNSS service. Purchase a subscription to the service from a Trimble Catalyst distribution partner. To find your nearest distributor, go to catalyst.trimble.com.

USING THE RECEIVER WITH A CATALYST GNSS SUBSCRIPTION

To use the Catalyst GNSS service on your phone or tablet, download the Trimble Mobile Manager app. This app manages your access to the Catalyst service, gives you access to configuration settings for the DA2 receiver, and enables other applications on your device to access and use the Catalyst GNSS receiver service.

1. Download the Trimble Mobile Manager app from the Apple App Store or Google Play and install it on your device.
2. Sign in with your Trimble ID to download your Catalyst subscription license.
3. Follow the instructions in Trimble Mobile Manager to configure Catalyst GNSS settings.
4. Share Catalyst GNSS positions directly from Trimble Mobile Manager, or if you are using a Catalyst enabled field app, connect to the DA2 receiver directly from your field app.

For more instructions, refer to the user documentation for your field app.

SERVICING AND CARE

The USB power cable and mounting features are the only serviceable / removable parts of the receiver. Do not attempt to disassemble the receiver. To clean the receiver, wipe clean with a moist cloth.

MORE INFORMATION

For more information about using the receiver and the Trimble Catalyst service, or for documentation in other languages, support and troubleshooting information, go to catalyst.trimble.com.



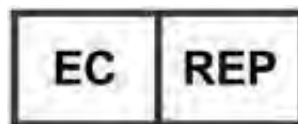
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Revision B. P/N 109696-00-ENG (06/21)



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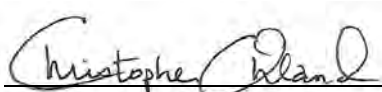
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Fieldwork Documentation

Document Number	FSOP-001
Revision	1
Department	Ahtna Southwest Operations
Previous Document Number	Original Document
Originally Released	April 1, 2022
Effective Date	October 10, 2022


Approvals



Christopher Ohland
SWE Quality Assurance Manager

October 10, 2022

Date



Bruce Wilcer

October 10, 2022

Date

Project-Specific Modification^[1]

05/22/2023: References to Global Positioning System (FSOP-103) do not apply. Ahtna uses a Trimble Catalyst DA2. Manufacturer's instructions: <https://rb.gy/lz13m>

[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

Revision History

Rev 1, 10/10/2022: Revised to include PFAS- friendly supplies and procedures.

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1.0 Introduction

1.1 Purpose

This SOP provides field personnel with the procedures for:

- Recording real-time, chronological logs of field activities and circumstances in field logbooks/notepads, field forms, and digital/electronic media
- Documenting fieldwork and fieldwork variances
- Ensuring documentation is reviewed, organized, and safely stored until the project closed out

Adequate documentation is necessary to describe the work performed and variances to work plans if any. Attention to detail is vital since field documentation protects our client and Ahtna with secure, legally defensible evidence and has been helpful in administrative, legal, and cost-recovery requirements. For example, field documentation may be used as evidence in legal proceedings to defend procedures and techniques employed during site investigations. Therefore, field documentation must be factual, complete, accurate, consistent, and not contain subjective language. These principles also apply when photographic or videography techniques document site activities. The goal of written, digital, and photographic/video graphics documentation is to represent field activities that accurately portray site conditions or procedures.

1.2 Scope

The scope of this SOP includes data entry and format requirements for various field documentation.

When required by the project, use the PFAS-free equipment, materials, and procedures recommended in this SOP which are indicated by [PFAS Project].

Written records

- Field logbooks
- Field notepads
- Field forms

Digital records

- Audio
- Photographic/video
- Data loggers

Digital data entry using field tablets is described in the EQUIS Collect User Guide.

- **Note:** *It is important to review contracts and Performance Work Statements to identify specific documentation and format requirements applicable to your project.*
- **Note:** *Contracts may contain requirements for field records. The typical language states: "The Contractor shall maintain field records sufficiently to recreate all field activities. The information shall be recorded in a permanently bound notebook with sequentially numbered pages. At the end of each workday, the Contractor shall complete a daily log."*

- **Note:** *Contracts issued by the USACE may contain requirements for the project archive, both ongoing and after completion of the contract.*

1.3 Roles and Responsibilities

Field Team. A Field Team is one or more individuals working together. Each Field Team is responsible for maintaining a field log of their activities, as applicable

Field Team Lead (FTL). The FTL provides direction and oversight of the fieldwork. The FTL is responsible for reviewing and confirming the adequacy of the field documentation during fieldwork as soon as possible and before releasing the daily quality control report. The FTL keeps the Project (PL) informed of field variances or problems encountered in the field.

Project Lead (PL). The PL is responsible for providing adequate resources to the field staff and ensuring that field staff has adequate experience and training to comply with this SOP successfully. The PL is responsible for approving and documenting techniques not described in this SOP but are considered the best methods for the current project. The PL documents changes as a variance to the plans and forwards the variance to the Program Manager (PgM) for approval. The PL is also responsible for confirming the adequacy of the field documentation after fieldwork. An entry confirming which information was reviewed must be added to the post-event field documentation package (Section 5.0).

Program Manager (PgM). For each SWE Program, the PgM is responsible for providing written instruction to their Field Team, which complies with the requirements of this SOP and the client-contracted specifications.

Site Supervisor.¹ The Site Supervisor is responsible for maintaining a project-specific FLB/notepad and field forms of their activities, as applicable, and providing copies to the PL for review.

Safety Representative. The Safety Representative meets the experience and training requirements of USACE EM-385-1-1 (USACE, 2014). The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the FTL of safety deficiencies and incidents and actions to correct those. If the circumstance warrants, the FTL approves those actions and notifies the PL and Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of Quality Control. Method described in the project work plans. The QC Lead notifies the PL of quality deficiencies and actions to correct those. The PL approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

SWE Quality Assurance Manager and SWE Field QC Manager report to the SWE Vice-President. When mentioned in this SOP, The “SWE” prefix is shown to distinguish from the QC Lead assignment shown in the project organization chart.

¹ In this context, a Site Supervisor is a person assigned to oversee long-term operations or construction work; the roles and responsibilities are like that of the Field Team Leader.

1.4 Definitions

Field Documentation – The combination of field logbooks/notepads, field forms, digital/electronic forms, and other documentation in the project file.

Field Logbook (FLB) – A portable, bound, weatherproof notebook with consecutively numbered pages.

[PFAS Project]: Use field logbook made of standard/loose plain paper (non-weatherproof), held together by an aluminum or Masonite field clipboard. Alternatively, a spiral-bound notebook with non-weatherproof paper and/or cover can be used.

Field Notepad – An unbound, company notepad containing pre-printed heading block and space (straight-lined, grid lined, or open) for recording information. This can be an alternative to the FLB. The notepad can be paper or electronic (Word, Excel, Access, etc.) as long as a hard copy of the individual sheets is sequentially numbered and maintained in a properly labeled binder/file folder.

Field Forms – Any documentation that preserves an accurate historical record of field activities but is recorded on unbound paper. These forms should be referenced in the FLB. A listing of the most commonly used SWE field forms is provided in Section 2, “Relevant Documents.” Each data entry field should have an entry or indicate that data for that field is not available or not required.

[PFAS Project]: Record of field events will be maintained on loose paper (PFAS-free) secured on Masonite or aluminum clipboards. Plastic clipboards, binders, or spiral hard cover notebooks are not acceptable. Field logbooks are permanently assigned to a specific project.

In addition, Field Form FFRM-004.00 “Daily PFAS Sampling Checklist, must be completed each day of fieldwork when activities may compromise environmental media that is sampled.

Data Loggers – Field equipment providing digital/electronic information to supplement field forms. Examples include water-level transducers for aquifer tests, flow sensors and meters in pump and treat systems, and air monitoring equipment (Section 4.1.7).

Digital/Electronic Files – Any documentation that preserves an accurate historical record of field activities but is recorded electronically through field instruments and digital devices. These records should be referenced in the FLB. Digital/electronic information includes global positioning system (GPS) coordinates, photographs, and videos.

2.0 Relevant Documents

SWE file folder m:\\Environmental\\Quality Control Procedures\\SWE Field Forms\\ has the current, approved form templates.

3.0 Equipment List

[PFAS Project]: Products containing waterproof features (e.g., Post-it-notes, waterproof coated paper) cannot be used on per- and polyfluoroalkyl substances (PFAS) projects.

- Applicable field forms

[PFAS Project]: Work activities will be maintained on loose paper (PFAS-free) secured on Masonite or aluminum clipboards. Plastic clipboards, binders, or spiral hard cover notebooks are not acceptable.

- Bound, waterproof field logbook (FLB; e.g., Rite in the Rain™ or similar) with pre-numbered consecutive pages for field documentation or notepad

[PFAS Project]: Use field logbook made of standard/loose plain paper (non-weatherproof), held together by an aluminum or Masonite field clipboard. Alternatively, a spiral-bound notebook with non-weatherproof paper and/or cover can be used.

- Waterproof, indelible pens/markers in black or blue ink

[PFAS Project]: Ball-point pens: do not use markers, felt pens, or pens with water resistant ink

- Digital camera/video, cell phone, or other devices capable of digital imagery
- Electronic device(s) for recording and storing field-related data (e.g., data loggers and GPS units)
- Batteries and charging blocks

4.0 Procedures

This section describes various mechanisms of recording documentation, including requirements and procedures. Before fieldwork, each project should define project instructions that identify the mechanism for documentation. The instruction is intended to promote procedural consistency, defined roles and responsibilities, and common language across project teams, promoting efficient reviews and cross-team utilization and training. Once established, project staff shall follow the project instruction.

4.1 Document Control and Storage

4.1.1 Project File

While in the field, the fieldwork documentation project file is managed by the FTL and consists of:

- Written records: FLB/notepads, field forms
- Digital/electronic records: photos, videos, GPS records
- Downloads from electronic devices such as data loggers

The PL is responsible for providing the location and details for storage. All field documentation is a part of the project file and should be maintained with safe document handling and archiving procedures. Hardcopy documentation and digital files are official records of fieldwork. Scans of official records are helpful for ease of access to project information and generating reports but are not official records.

The PL is responsible for all forms of field documentation, and scans of paperwork, digital records, and downloads from electronic devices are placed in the m:\ drive project file. All original documents shall be assembled into a data package, submitted to the PL, and archived in the project file. The goal is that all documentation is organized by task/event and stored in a single location.

4.1.2 Problems in the Field and Variances from Project Plans

Variances or problems encountered during the fieldwork that cannot be resolved promptly must be communicated promptly in writing to the FTL /Site Supervisor, who will notify the PL. This may be completed by sending a variance notice by email or other means to promptly communicate the variance or problem and allow for the continuation of the fieldwork. The PL shall provide written approval of recommended solutions or provide an approved alternate solution.

The need for a corrective action addressing variances or problems in the field will be determined by the PL in collaboration with the FTL/Site Supervisor. The PL will notify the PgM and SWE Field QC Manager of any needed corrective action for their concurrence or follow-up.

Documentation of variances to project plans, problems encountered, or corrective actions will be kept in the FLB/notepad or forms.

4.1.3 Field Logbook

Field logbooks can be spiral- or adhesive-bound and are distributed by the PgM or designee. The cover of the FLB is labeled with the project number and name of the Installation/Site(s).

The inside cover of the FLB contains the name, address, phone, and email address of the PgM and a list of projects the FLB is used to record. The information is updated if the project is assigned to another PgM.



The FLB shall be project/task-specific. The Field Team uses the FLB to record details of their responsibility (e.g., sampling, QC, safety, oversight, etc.) and provide them to the FTL/Site Supervisor for their review before submitting daily QC reports (DQCRs).

The FLB records are scanned, and the scan is saved as a PDF file on the Ahtna server in the project folder to create an electronic record for project reports. The PL shall ensure the FLBs are stored safely until project closeout. The field job box could be used for temporary storage.

4.1.4 Field Notepads

Three-ring punched, loose-leaf notepads or individual sheets can be printed on field form SWE-FFRM-001.² Each sheet contains a heading block, and block entries must be filled in on the first page of a new date.

Example Heading Block for Long-Term O&M or Construction

Installation/Site	Sharpe Army Depot/Sitewide	Project Number	05206.000.01.0000
Site Supervisor	Paul Marsden	Date	July 27, 2021
Subject	Telephone Record	Recorded By	Izzy Done

Example Heading Block for Environmental Studies

Project Number	05206.000.01.0000	FTL	Who Dunnit
Installation/Site	MOTCO Site 2	Recorded By	Izzy Done
Event Name	1Q 2021 GW Sampling and LF Inspection	Date	July 27, 2021

Notepads (loose-leaf paper) are used by the Field Team to record details of their responsibility (e.g., sampling, plant operations, QC, safety, oversight, etc.) and provided to the FTL/Site Supervisor for their review before submitting DQCRs.

The PL shall ensure the sheets are stored in three-ring binders or another filing system (Section 5.0), labeled with the Installation/Site name, project number, and a descriptive name of the project. If an FLB or field form is also used, a scanned copy of the FLB pages and original copies of the field forms are stored in the binder. The sheets are sequentially numbered and reviewed by the FTL/Site Supervisor. The PL reviews and approves the Site Supervisor's notepad sheets. The PL is responsible for safely storing the binder or other filing system until project closeout.

The notepad binder will be kept in the site office project file or job box. As soon as possible, the unbound records shall be scanned and saved on the Ahtna server in the m:\\ drive project folder to create an electronic record to ensure document preservation and use in project reports.

4.1.5 Field Forms

SWE-approved field form templates are available at M:\\Environmental\\Quality Control Procedures\\SWE Field Forms\\. Activity-specific SOPs reference the field forms that should be used. If preferred, individual sheets can be printed on pre-punched three-hole paper (or punched later). If the printer is capable, use a heavy paper stock for a durable form. Field forms supplement the FLB/notepad and provide a way to record detailed information using a structured format. When new forms are available, they will be posted

² Project-specific format designs may be used. Computer applications such as Microsoft Word or similar may also be used as long as the header information is shown, and printed copies are stored in three-ring binders.

in the template folder. The SWE Technical Writer oversees version control and will notify SWE staff when the form is posted.

Each sheet contains a heading block to enter the Installation/Site name, descriptive activity name, FTL, project number, and QAPP SOP number for the performed activity-specific fieldwork. Depending on the activity, the names of staff assigned with lead roles, weather conditions, date of recorded information, or other information may appear on the form. The heading block entries must be filled-in for each sheet to bind the field form to the project/activity.

Example Field Form Heading Block

Project Number	05108.001.02	FTL	Jared Wilson
Installation/Site	MOTCO/Site 1	SOP No.	FSOP-002
Activity Name	1Q 2021 GW Sampling and LF Inspection	Date	08/06/2021
Field Team (name/organization)	Jared Wilson/Ahtna, Izzy Done/Forever Waiting		
Weather Forecast	Sunny, 65–80°F, SW winds 5–10 mph		

Field forms are used by the Field Team to record details of their responsibility (e.g., sampling, O&M operations, QC, safety, oversight, etc.) and provided to the FTL/Site Supervisor for their review before submitting DQCRs.

The PL shall ensure the sheets are stored in three-ring binders or another filing system (Section 5.0), labeled with the Installation/Site name, project number, and a descriptive name of the project. If an FLB/notepad is also used, a scanned copy of the FLB/notepad pages and original copies of the field forms are stored in the binder. The sheets are sequentially numbered, reviewed, and approved by the PL. As soon as possible, the unbound forms shall be scanned and saved on the Ahtna server in the m:\ folder to create an electronic record to ensure document preservation and use in project reports.

The PL is responsible for safely storing the binder or other filing system until project closeout.

4.1.6 Electronic Files

Photographs and Video

All original digital field documentation (Section 1.4) shall be downloaded as soon as possible to a designated location for project use. Exclude files that are unnecessary due to unusable image quality or content. As soon as possible, the date/time, location, direction (compass point or radial degree), and purpose of the image should be documented before the information is forgotten. The use of metadata and smartphone applications to gather this information can assist. Files can be edited but maintain the original file and save the edited file with a suffix description. Alternately, use field form SWE-FFRM-002 to log photos. This form is helpful for tasks where few pictures will be taken.

The PL is responsible for providing the location and storage details. Files should be uploaded to the project folders and caption descriptions documented as soon as possible after the fieldwork ends.

Data Loggers

Examples of data loggers include equipment used in combination with:

- Water-level transducers for aquifer tests
- Flow sensors and meters in pump and treat systems
- Air monitoring equipment (e.g., particle counters)

The use of data loggers should be recorded in an FLB/notepad or field form and include the type of logger, make, model, S/N, calibration if required, and any input specifications used.

Document data acquisition activities using data loggers (data logging equipment) and related observations in the FLB/notepad. Written notes provide a permanent record of field activities that support digital data temporarily stored on various data loggers.

Specific steps and guidelines for the data acquisition activity being performed should be reviewed in the respective SOP guiding the activity.

The observations and data will be recorded in the FLB/notepad or field form. Because of the variability of features and operation of various data loggers, each field SOP and manufacturer's instructions should be carefully reviewed before beginning field activities.

The PL is responsible for providing the location and details for storage. Files should be uploaded to the project folders as soon as possible after the fieldwork ends. Files should not be edited. If needed, modifications to the captured data should be noted in the project reports. Hardcopy printouts in comma-delimited format (or similar) are recommended should the source file become corrupt.

Global Positioning Systems

GPS data acquisition activities and related observations will be digitally-recorded and later downloaded, and the file saved as described above.

Alternately, the GPS data can be recorded in field documentation to provide a permanent record of field activities supporting digital data that is temporarily stored on the GPS unit. As applicable, observations and data may be recorded in an FLB/notepad or field forms. The field forms will record the survey location identifier (e.g., well/boring location, structural feature) and corresponding coordinates and elevation.

The GPS operator should also be thoroughly familiar with the manufacturer's instructions and SOP for Global Positioning System (FSOP-103) before performing GPS work in the field.

4.2 Field Logbook

The FLB is the written record of all fieldwork elements, such as Ahtna staff, subcontractors, visitors at the site, weather forecast/conditions, field equipment calibrations, construction activities, and sample collection activities. Fieldwork can be recorded on a notepad or forms described in Sections 4.3 and 4.4. When field forms are used, a brief description of the activity is added to the FLB/notepad, and details are added to the form.

4.2.1 Guidelines

Pages 1 and 2 of the FLB should be reserved to provide a signature page and table of contents. The signature page lists the employee's name, initials, and signature. The printed name and signature bind the employee to their written documentation, and the initial is helpful when limited space is available for writing a full name on subsequent pages. Each initial on page 1 must be unique. Page 2 is not required but helpful to quickly locate information in the FLB. If more space is needed, the back cover pages could be used. An entry for a significant event and the page number that initiates the documentation is typical. Open space on pages 1 and 2 does not need to be lined out, as the list will grow during work execution.

1			2	
Printed Name	Initial	Signature	Table of Contents	
Brittan Carlson	BC	<i>Brittan Carlson</i>	Waste Characterization Well Install	3
Bruce Wilcer	BW	<i>Bruce Wilcer</i>	2Q 2016 GW Monitoring	14
Connor Dunn	CD	<i>Connor Dunn</i>	3Q 2016 GW Monitoring	20
Jay Pu	JP	<i>Jay Pu</i>	Discovery of Alien Spacecraft	26
Sommer Carter	SC	<i>Sommer Carter</i>	4Q 2016 GW Monitoring	32
			2Q 2017 GW Monitoring	39

Field documentation shall adhere to the following guidelines:

- Write entries in blue or black waterproof ballpoint pen (older copier machines do not recognize other colors). Avoid felt tip pens. *Do not use a pencil.*
- List personnel making entries in the FLB and include initials and signatures on the inside cover page.
- Use a table of contents on page 2 (recommended but not required).
- Start a new page at the beginning of each day.
- Entries should be chronological – a time notation should introduce each entry.
- Language should be objective, factual, and free of personal feelings or inappropriate terminology.
- Do not erase or scratch out errors. Draw a single line through the error, then insert the corrected material. The person who corrected it shall initial and date the correction. If an explanation is needed, add that in the next available blank area in the FLB and cross-reference the error and explanation.
- The FLB shall be signed at the end of each day. Signatures shall be written on a single diagonal line drawn across the blank portion of the page following the day's last entry.
- All FLB shall be returned to the FTL/Site Supervisor for review and safe storage. The FTL/Site Supervisor shall review daily as soon as possible and before the DQCR is released.

4.2.2 Entries to Include

Initial daily entries shall include the following:

- **Date and time:** The time shall be based on military time (i.e., 2100 instead of 9 pm)
- **Field Team Leader:** Name of the Field Team Leader or Site Supervisor
- **Safety Representative:** Name of the task Safety Representative (meets EM 385-1-1 requirements)
- **QC Lead:** Name of the task QC Lead

- **Site Personnel:** Full name, title/role, and affiliation of personnel onsite, including visitors and subcontractors, with arrival and departure time noted
- **Planned Activities:** General description of various work activities for the day
- **Weather:** Weather forecast (temperature, cloud cover, wind speed, and direction). Changing weather that impact site conditions should be recorded throughout the day
- **Notes:** Taken By: Name(s) the FLB/notepad author(s)

The following are examples of ongoing daily entries. Use those and others as applicable:

- When field forms are used, record a brief description of the field activity, then record details on the field form. Do not duplicate information referenced on the field forms in the daily field documentation
- Participation in the Site Safety Tailgate Meeting, details can be added to the Site Safety and Tailgate Meeting form
- Level of personal protective equipment (PPE) and describe upgrade and downgrade of PPE levels
- Type of field instrumentation and calibrations performed, details can be added to the equipment calibration form
- Work start/stop times
- Time and location of activities
- Site physical conditions, changing weather conditions, major task decisions, or other valuable site investigation information and other essential observations
- Level of PPE and describe upgrade and downgrade of PPE levels
- All relevant field observations, major task decisions, or other valuable site investigation information
- Location of work areas if the survey has not been completed
- Survey and location of any sampling points, including swing-tie measurements
- Decontamination times and methods
- All field measurements. If field measurements of this type are being recorded on dedicated field forms, it is not necessary to record in the FLB, but the use of the form should be noted
- Type, amount, method, and location of storing and disposal for investigation-derived waste
- Changes/deviations/variances from the work plan and reason for deviations change/variance.
- Thoroughly document all FTL/Site Supervisor or PL-approved directives, guidance, or potential corrective actions from client and oversight government personnel. Directives that give personnel specific authority to make critical decisions must be documented in the FLB
- Communications with the FTL, Site Supervisor, or PL or client about decisions being made in the field
- Work deficiencies and corrective actions
- Approved work variances
- Persons contacted and topics discussed

4.2.3 Documentation of Project Variances

Thoroughly document all variances from the Performance Work Statements, Work Plans, and QAPP or changes in fieldwork procedures. Problems, delays, or any unusual occurrences such as improper equipment or breakdowns should be included, along with PL-approved resolutions. Summarize the content and conclusions of all relevant meetings, discussions, and telephone conversations that involve you.

4.2.4 References to Locations

This section applies to new locations. Established locations are referred to by the location name or code. Previously established locations are typically shown on site maps/figures.

Whenever an activity (sample collection, field measurement/monitoring, etc.) is performed at a new location (i.e., the location has not been surveyed and shown in a figure), mark the location with a survey stake or similar marker, a detailed description of the location must be recorded in the FLB/notepad or field form and accompanied by a photo, sketch, or point on an attached map as part of the daily field documentation package (sketches with accompanying photographs when appropriate, with north arrow and approximate scale). Record unusual site physical conditions or signs of contamination such as oily discharges, discolored surfaces, unusual odors, dead or distressed vegetation, including types of plants, if possible.

4.3 Notepads

When notepads are used, the requirement and procedures for the FLB (Section 4.2) also apply to the notepad documentation.

4.4 Field Forms

Field forms are used in addition to FLBs/notepads. Field forms are activity-specific and may be completed for each location/sample/well, etc., or one per field event as appropriate. Each form contains a heading block to bind the field form to the FLB/notepad. Field forms augment but do not replace the FLB/notepads. Avoid duplicating information recorded in the FLB/notepad and field form.

The forms include space (check box, table cell, and underlined space) for recording the information necessary for the project to ensure complete and proper information is recorded. Each space must be completed on a field form, and if not needed, then struck out or listing “not applicable.” Blank space can be misunderstood as missing information. Version-controlled template files of the forms are stored in the M:\Environmental\Quality Control Procedures\SWE Field Forms.

Field forms may be modified for project-specific use with the SWE Quality Assurance Manager’s approval.

All unbound data documentation is a part of the field records and should be maintained with safe document handling and archiving procedures. These records should be recorded in the same manner as notes in the FLB/field notepad using black or blue waterproof, indelible ink, and on weatherproof paper as necessary (projects testing for PFAS cannot use products with fluorinated constituents).

4.5 Field Documentation Data Package

After a short-term, specific event (e.g., well installation, sample collection, landfill inspection, and similar), copies of the FLB pages and hardcopies of loose-leaf documentation and relevant correspondence (emails and phone records) should be organized assembled into an event-based data package. The package should include a cover page listing the Installation/Site, project number, and event description.

The PL is responsible for the safe storage of the data package until project closeout. A copy of the package should be scanned and saved in the m:\ drive project folder. The scan file could replace other scanned files described in the project instructions (Section 4.0).

If the fieldwork is a long-term task such as operating an O&M treatment system, remedial actions (e.g., excavation and disposal), or other qualifying fieldwork, the timeframe for producing the data package should be defined in the PgMs project instructions, but that period should not exceed one per year or end of the contract period.

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control Method described in the project work plans.

Quality Assurance (QA) and QC procedures for field documentation review will be performed by the FTL/Site Supervisor and checked by the PL to ensure the content and level of detail comply with this SOP. The FTL/Site Supervisor can approve variances and fieldwork problems in coordination with the PL. The FTL/Site Supervisor should try to resolve the issue so that work can continue; however, should the variance/incident/problem affect the contracted scope of work or a project decision made from the evaluation of data, the resolution must be coordinated with PgM and SWE Field QC Manager if corrective action is needed. The PgM should notify the SWE Quality Assurance Manager of all corrective actions.

6.0 Documentation Review

The FTL is responsible for the daily review of the fieldwork documentation for compliance with requirements (Section 4.0 "Procedures") and legibility. Errors and omissions should be explained and revisions to an entry signed and dated by the FTL.

The PL is responsible for reviewing and signing approved documents stored in the project file (Section 4.1).

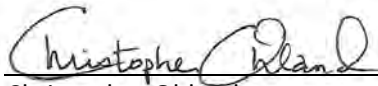
7.0 References

U.S. Department of Defense, 2013. *DoD Environmental Field Sampling Handbook, Revision 1.0*. April.

Sample Management

Document Number	SWE-FSOP-002
Revision	1
Department	Southwest Operations
Previous Document Number	Original Document
Originally Released	October 10, 2022
Effective Date	April 1, 2022

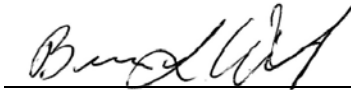
Approvals



Christopher Ohland
SWE Quality Assurance Manager

October 10, 2022

Date



Bruce Wilcer
SWE Field Quality Control Manager

October 10, 2022

Date

Project-Specific Modification^[1]

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[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

Revision History

Rev 1, 10/10/2022: Revised to include PFAS-friendly supplies and procedures.
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1.0 Introduction

1.1 Purpose

The purpose of this standard operating procedure (SOP) is to direct field staff in the proper techniques and documentation requirements to maintain sample custody and the labeling, packaging, and shipping of multimedia samples after they are collected.

Proper sample management from sample collection to laboratory receipt is essential to ensure the legal defensibility of the sample. Sample management is also needed to maintain sample integrity and successfully transport samples to the testing laboratory in an acceptable condition.

1.2 Scope

The scope of this SOP applies to field staff collecting samples. The field staff may be employed by Ahtna or by a subcontractor. Trained environmental professionals will be engaged in or directly supervise the subcontractors' collection and handling of environmental samples.

When required by the project, use the PFAS-free equipment, materials, and procedures recommended in this SOP which are indicated by [PFAS Project].

1.3 Responsibilities

Field Team. A Field Team is one or more individuals working together. The Field Team is responsible for the oversight of and/or collection of groundwater samples as specified in this SOP.

Field Team Lead (FTL). The FTL is responsible for reviewing project work plans to understand the health and safety needs, procedural specifications, and field documentation requirements. The FTL is responsible for reviewing and confirming the adequacy of the fieldwork documentation.

Project Lead (PL). The PL is responsible for providing adequate resources to the field staff and ensuring the Field Team has adequate experience and training to comply with the SOP successfully. The PL is responsible for approving and documenting techniques not described in this SOP but are considered the best methods for the current project.

Safety Representative. The Safety Representative meets the experience and training requirements of USACE EM-385-1-1 (USACE, 2014). The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the FTL of safety deficiencies and incidents and actions to correct those. The FTL approves those actions or, if the circumstance warrants, notifies the PL and Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of the Quality Control method described in the project work plans. The QC Lead notifies the PL of quality deficiencies and actions to correct those. The PL approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

1.4 Definitions

Air or Ground Waybill. A shipping document that identifies the sender and addressee, transport carrier, size, and priority of a shipment transported by aircraft.

Chain of Custody. In legal contexts, is the chronological documentation or paper trail that records the sequence of custody, control, transfer, analysis, and disposition of materials, including physical or electronic evidence.

Dangerous Goods. Under the International Air Transport Association (IATA) definition, dangerous goods are articles or substances that can pose a hazard to health, safety, property, or the environment and are shown in the list of dangerous goods in the IATA regulations (IATA 1.0).

Environmental sample. According to the Department of Transportation (DOT) 49 Code of Federal Regulations (CFR) Section 172.101 Appendix A, any sample that has less than reportable quantities of any hazardous constituents.

Excepted Quantity (DOT & IATA Definition). A hazardous substance whose class is permitted on passenger aircraft but in such a small defined amount poses a low risk during transport by aircraft. Hazardous substances that meet the definition of Excepted Quantity may be exempted from documentation, packaging, marking, and labeling requirements typically required when presenting hazardous materials for passenger air transportation. Items shipped as excepted quantities are limited to volumes as specified in IATA Dangerous Goods Regulations, Table 2.6.A and DOT 49 CFR 173.4a.

Hazardous materials. DOT defines a hazardous material as any item or chemical which, when being transported or moved in commerce, is a risk to public safety or the environment and is regulated as such under its Pipeline and Hazardous Materials Safety Administration regulations (49 CFR 100-199), which includes the Hazardous Materials Regulations (49 CFR 171-180).

Sample label. An adhesive paper placed on sample containers or a tag tied to a sample container to designate a sample identification number and other identifying information.

2.0 Relevant Documents

This SOP is intended to be used in conjunction with the following SOPs, and as such, the equipment and materials needed for those activities are not included in this SOP:

Standard Operating Procedures

- SWE-FSOP-001, Field Documentation
- SWE-FSOP-400 Series, various sampling SOPs

Field Forms

- SWE-FFRM-004, Daily PFAS Sampling Checklist
- SWE-FFRM-002, Chain of Custody

3.0 Equipment List

- Gel or bag ice (determine which is appropriate)
[PFAS Project]: Ice in polyethylene bags
- Bubble wrap and/or foam inserts
[PFAS Project]: Avoid packing materials that contain PFAS and materials that absorb water, including paper, cardboard, and styrofoam; as they become soggy, they lose cushioning properties.
- Clear, strapping, or duct tape
[PFAS Project]: Use PFAS-free tape
- Coolers
- Heavy-duty plastic bags
[PFAS Project]: Use HDPE bags¹
- Plastic zip-top bags (i.e., quart and gallon)
[PFAS Project]: Use HDPE bags¹
- Air or Ground Waybills
- Sample container labels
- Custody seals for coolers

4.0 Procedures

4.1 Sample Custody

Five aspects of sample custody.

- Use appropriate sampling equipment
- Properly handle and document samples, starting from the time of collection
- Keep samples within temperature controls and safely located until offsite transport
- Properly pack and transport samples from the field site to the laboratory
- Verify laboratory receipt of samples
- Ensure laboratory has a custody program (subcontractor responsibility)

4.2 Proper Sampling Equipment

The supplies needed to collect samples must be made of material that will not release contaminants to the sample or hold contaminants to the sampling equipment. Equipment specifications are described in

¹ [PFAS Project]: LDPE bags may be used for bagging samples if special precautions are taken. LDPE bags should be kept separate from other sampling supplies in the staging area and should not come into direct contact with the sample media. Gloves should be changed after handling LDPE bags.

project work plans. Shipping coolers should be inspected for defects and must be decontaminated before use.

[PFAS Projects]: Surfaces in contact with the sampled media should not contain Teflon® or other PFAS-containing material.

Use new, certified sample containers suitable for the media being analyzed. Containers should be provided by the analytical lab or supplier in the appropriate quantity to accommodate required volumes for the field sample, duplicates, and any amounts required for laboratory QC processes. Certification requirements are specified in the USEPA *Specifications and Guidance for Contaminant Free Sample Containers* (EPA, 1992).

4.3 Sample Collection and Handling

Each person handling the samples must document from whom and when the item was received and to whom and when it was delivered. Documentation of handling samples is part of the custody record, which provides the mechanism for tracking samples from the time of sample collection thru laboratory analysis and disposal.

A sample is considered to be “in custody” for legal proceedings if it is:

- In a person’s actual possession
- In view after being in physical possession
- Locked up so that no one can tamper with it after having been in physical custody
- In a secured area, restricted to authorized personnel only.

If any one of these is not in place at all times, sample custody is broken. The FTL should notify the PL of actions taken and document the PL decision. If corrective action is needed, the Program Manager and SWE Field Quality Control Manager should be notified.

Sampling procedures are described in the SWE-FSOP-400 series of SOPs. The Field Team is responsible for logging the sample collection in field logbooks/notepads or field forms as described in SWE-FSOP-001, “Field Documentation.”

Sample custody begins at the time of sample collection, and its custody is assigned to the Field Team sample custodian. Custody transfers must be documented. Typical transfers include:

- Transfer of samples from contractors, if used, to Ahtna staff
- Transfer of samples to a transporter
- Transfer of samples to the laboratory
- Transfer of samples within the laboratory

When samples are transferred, the transfer is noted in the field logbook/notepad or field form SWE-FFRM-002, “Chain of Custody,” or similar form. The name of the organization/individual and date/time of the transfer and organization/name and date/time of the recipient. For samples shipped by ground or air carrier, the unique airbill number or bill of lading should be recorded.

4.4 Sample Integrity

To reduce the possibility of invalidating the results, all collected samples must be placed in laboratory-supplied containers and labeled (Figure 1).

Sample preservation before laboratory analysis is accomplished by adding the sample into pre-preserved sample containers or adding the preservative after filling the container. Preservation requirements are described in Worksheet# 19/30 of the project Quality Assurance Project Plan (QAPP).


	Site: Titan 1A Loc Code: MW-11 Samp ID: MW-11-NS1-2108
Lab: TASEA	Cont.: glass w/Teflon lined septa 40 ML
Flt: N	Prsv.: HCL
Analysis: VOCs SW8260D LL	
Sampler: _____ Date/Time: _____	

Figure 1. Example Container Label

With few exceptions (i.e., metal analyses), samples must be cooled as soon as possible after sample collection, and after that, maintained between 0°C–6°C. Samples must be kept in the custodians' possession or stored safely at all times.

Sample containers should be pre-labeled as much as practical before sample collection. Labels should be affixed to the sample container before or at sampling and must adhere firmly to the container. Labels can be further secured by placing clear packaging tape over the label, but not for volatile organic compounds (VOC) or gasoline range organics (GRO) analyses.

Sample containers that are weighed by the laboratory before use should not have any additional labels placed on the container, affecting the weight. For those containers, use the label already provided on the jar. Only one label should be placed on each sample container.

Use the specifications defined in the project work plans. Unless the QAPP specifies otherwise, sample labels should be written in indelible ink and contain, at a minimum, the following information:

- Project number/Site
- Field sample ID
- Container type and preservative
- Filtered (Y/N)
- Laboratory name
- Analysis requested (abbreviated)
- Sampler's organization and initials
- Collection date and time (24-hour clock)

4.5 Sample Packing

The following steps must be followed when packing sample containers for shipment:

1. Choose a cooler with structural integrity that will withstand shipment. Ensure the cooler is large enough to contain all the samples to be shipped along with the appropriate amount of ice. Use a cooler that has been pre-cooled and not one that has been in a hot vehicle or out in the sun. Secure and tape the cooler drain plug with duct tape.

[PFAS Project]: Use ice in polyethylene bags.

2. Be sure that the caps on all sample containers are tight and do not leak but do not overtighten.
3. Fill out a chain of custody (COC) form or use the COC form filled out in the field. The COC should only list the samples and bottles (specific to analyses requested) added to the cooler. Check to ensure that the sample labels are intact, completed with the correct information, and that sample identification matches the COC record exactly. An original signed copy of the COC is sealed in a water proof zip-top bag taped to the lid of the cooler.

[PFAS Project]: The COC record will be placed in a re-sealable plastic zip-lock bag, the bag sealed shut to prevent water intrusion from the bagged wet ice in the cooler, and the bag taped (using PFAS-free tape) to the inside lid of the cooler.

A copy of the COC is kept with the field logbook/notepad or field form.

4. Wrap and package containers sufficiently to prevent cross-contamination or exposure to melt water and ensure that containers remain intact during shipment.

[PFAS Project]: Seal each sample container in a HDPE bag to prevent melt water from getting into the sample or degrading the sample label. Taping the end of bags with Duct tape will provide added protection against melt water.¹

5. Place the containers into the cooler with caps up. No containers should be placed on their sides, as there is significantly less chance of breakage when packed vertically.
6. Use enough ice (double-bagged) to ensure that samples are received by the laboratory at the proper temperature of 0°C–6°C. For temperature-sensitive analyses, it may be necessary to cool the samples in onsite chillers. Refer to the project work plans.

Recommended ice arrangement:

- Place a layer of ice on the bottom of the cooler.
- Place a bag of ice vertically on one end of the cooler, followed by a set of samples. Follow this with another vertical bag of ice and repeat until the cooler is full. Make sure all samples are lined on both sides with ice.
- Place more bags of ice flat on top of the samples.
- Cover this with an insulating layer, such as bubble wrap.

[PFAS Project]: Avoid packing materials that contain PFAS and materials that absorb water, including paper, cardboard, and Styrofoam; as they become soggy, they lose cushioning properties

7. Place a temperature blank in the cooler, and VOC/GRO trip blank is needed.
8. Fill excess space between sample containers and walls of the cooler with additional bubble wrap.
9. Place a signed and dated custody seal on the outside spanning the area where the cooler lid meets the cooler's body.

[PFAS Project]: Custody seals will be pre-printed on PFAS-free paper.

10. Secure the cooler with packing tape over the Custody Seal.

[PFAS Project]: PFAS-free tape will be placed over the seals to ensure that seals are not accidentally broken during shipment.

4.6 Offsite Transport

Samples taken over multiple days should be sent to the laboratory with sufficient time to allow the laboratory to meet holding time requirements. If the requested analyses have a short holding time (less than 48 hours), samples should be delivered to the laboratory for analysis as soon as possible following sample collection: preferably same day or overnight for morning delivery. Notify the laboratory Project Manager when short holding times are anticipated.

Samples can be stored onsite if sample custody is maintained and the samples are placed in transport containers (e.g., cooler or shipping box) for protection from breakage, contamination, and loss and in an appropriate controlled-temperature device (e.g., ice-packed cooler or onsite refrigerator)

Sample coolers are typically transported by a laboratory employee or air carrier. Only reliable services that provide a tracking number should be used when using professional services to transport physical samples. A copy of the shipping receipt and tracking number should be logged in the field logbook/notepad. The package should be addressed to the "Sample Custodian."

Transportation regulations followed by air carriers are airline-specific; some use only IATA, and others allow either IATA or DOT. Ground and vessel transportation is guided by DOT regulations. If shipping by highway or rail, no shipping paperwork is required as stated in 49 CFR 173.4a(h)1. These regulations have requirements to identify, document, label, and package samples if the shipment contains dangerous goods.

- **Note:** *United Parcel Service and Federal Express follow IATA for air shipments and DOT for ground shipments*

The shipper is responsible for identifying, documenting, and packaging samples for air shipment that contains dangerous goods or whether the shipment is exempted for limited quantities. Because most multimedia samples collected for environmental projects returned in preserved containers are exempted, specific procedures are not provided in this SOP. Contact the Field QC Manager if dangerous goods shipment is suspected.

Shipments of the following may contain dangerous goods:

- If the hazardous material has a UN code
- Unknown hazardous waste from drums, sludges, or appears suspicious
- Odor, PID measurements, and physical characteristics indicate a hazard

- Explosives or radioactive materials

Keep in mind that IATA requirements and the FAA and TSA “Prohibited Items List” will not allow shippers to check dangerous goods, in any quantity, as baggage on a commercial flight.

Each sample collected will be recorded on a COC form. Each COC form(s) in a cooler or shipping container should be specific to the samples in the cooler and not samples in multiple/other coolers.

4.7 Laboratory Acknowledgment

Once the samples arrive at the laboratory, the laboratory Sample Custodian checks the shipment for:

- Levels of liquid samples to assess whether leaks have occurred
- Shipment contents match the COC form
- Check the cooler temperature and pH if preserved.

Note: VOC/GRO analyses are checked at the sample analysis time.

The laboratory will provide notification of sample acknowledgment. The notification summarizes the work order, sample login discrepancies and resolution, and discussions between the laboratory Project Manager and the Field Team. The FTL is responsible for reviewing the notification for completeness and accuracy.

4.8 Document Control

Sampling field forms should be completed in their entirety. If an entry is not applicable, indicate “n/a” (not applicable) or line out the entry.

After a task or project, all field documentation, including the field logbook, field datasheets, and electronic data, shall be scanned and placed in the appropriate folder on the server. All original documents shall be submitted to the PL and kept in the project file. See FSOP-001 (Field Documentation).

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control method described in the project work plans.

Verify the laboratory notice of sample acknowledgment.

6.0 Documentation Review

The FTL is responsible for daily review of the field sample management and fieldwork documentation for compliance with requirements (Section 4.0) and legibility. Errors and omissions should be explained and revisions to an entry signed and dated by the FTL.

7.0 References

International Air Transport Association (IATA), 2019. Dangerous Goods Regulations.

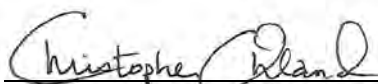
Code of Federal Regulations, 49 CFR 173.4a. Excepted Quantities

USEPA Specifications and Guidance for Contaminant Free Sample Containers. EPA540/R-93/051.
(December 1992)

Investigation Derived Waste Management

Document Number	SWE-FSOP-802
Revision	0
Department	Southwest Operations
Previous Document Number	Original Document
Originally Released	April 1, 2022
Effective Date	April 1, 2022

Approvals



Christopher Ohland
SWE Quality Assurance Manager

April 1, 2022

Date



Bruce Wilcer
SWE Field Quality Control Manager

April 1, 2022

Date

Project-Specific Modification^[1]

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[1] Document project-specific modifications in this section. No other modification to the SOP is authorized.

Revision History

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1.0 Introduction

1.1 Purpose

The purpose of this standard operating procedure (SOP) is to direct field staff in the proper techniques, and documentation for handling, labeling, tracking, and disposing of investigation derived waste (IDW) encountered or generated during environmental field activities. This SOP gives descriptions of equipment, field development procedures, field data collection, and personnel responsibilities.

1.2 Scope

The scope of this SOP is to describe procedures for projects that generate IDW.

Materials that may become IDW include but are not limited to:

- Personal protective equipment (PPE) includes disposable coveralls, gloves, booties, respirator canisters, splash suits, and other non-soil, solid wastes
- Disposable equipment and items include plastic ground and equipment covers, aluminum foil, conduit pipe, disposal samplers (e.g., bailers), tubing, and others
- Soil cuttings/spoils from boreholes/trenches and other soil wastes generated during sampling
- Drilling mud or water used or generated during drilling
- Groundwater obtained through well development or well purging
- Cleaning fluids such as spent solvents and wash water
- Packing and shipping materials
- Sediment from surface water bodies (rivers, lakes, ponds)
- Wash and rinse waste from decontamination activities

These types of IDW may require classification as non-hazardous or hazardous waste and should be containerized, stored, profiled, transported, and disposed of appropriately according to regulatory and client-specific requirements. Review project-specific work plans and waste management plans to confirm appropriate procedures for each site.

1.3 Responsibilities

Field Team. A Field Team is one or more individuals working together. The Field Team is responsible for the oversight of IDW as specified in this SOP.

Field Team Lead (FTL). The FTL is responsible for reviewing project work plans to understand the health and safety needs, procedural specifications, and field documentation requirements. The FTL is responsible for reviewing and confirming the adequacy of the fieldwork documentation.

Project Lead (PL). The PL is responsible for providing adequate resources to the field staff and ensuring the Field Team has adequate experience and training to comply with the SOP successfully. The PL is responsible for approving and documenting techniques not described in this SOP but are considered the best methods for the current project.

Safety Representative. The Safety Representative meets the experience and training requirements of USACE EM-385-1-1 (USACE, 2014). The Safety Representative oversees site-specific health and safety activities and ensures compliance with the project requirements. The Safety Representative notifies the

FTL of safety deficiencies and incidents and actions to correct those. The FTL approves those actions or, if the circumstance warrants, notifies the PL and Site Safety and Health Officer for their approval.

Quality Control Lead (QC Lead). The QC Lead ensures work inspections are performed using the 3-Phases of Quality Control method described in the project work plans. The QC Lead notifies the PL of quality deficiencies and actions to correct those. The PL approves those actions or notifies the SWE Field QC Manager for their approval if the circumstance warrants involvement.

1.4 Definitions

Field Documentation – The combination of field logbooks/notepads, field forms, digital/electronic forms, and other documentation in the project file.

Field Forms – Any documentation that preserves an accurate historical record of field activities but is recorded on unbound paper. These forms should be referenced in the FLB. Each data entry field should have an entry or indicate that data for that field is not available or not required.

Field Logbook (FLB) – A portable, bound, weatherproof notebook with consecutively numbered pages.

Field Notepad – A unbound notepad or loose-leaf paper with consecutively numbered pages.

Investigation Derived Waste (IDW). Waste that is generated in the process of investigating or examining a contaminated site.

Personal Protective Equipment (PPE). Personal health and safety equipment is used to protect the individual from contaminant exposure and physical injury.

2.0 Relevant Documents

This SOP focuses on the IDW management task and applications and should be used in conjunction with other applicable SOPs and forms, including the following:

2.1.1 Standard Operating Procedures

- SWE-FSOP-001, Field Documentation
- SWE-FSOP-801, Equipment Decontamination

3.0 Equipment List

The following materials and equipment may be needed for IDW management:

- Bound field logbook (FLB) with consecutive page numbers and waterproof, indelible pens/markers
- PPE as outlined in site-specific Accident Prevention Plans (APPs)
- Decontamination equipment and supplies (e.g., wash/rinse tubs, brushes, Liquinox™, plastic sheeting, paper towels, sponges, garden-type water sprayers, large plastic bags (minimum 0.85 mil), potable water, distilled water, and deionized water)
- Department of Transportation (DOT)-rated 55-gallon drums or other approved containers for containing soil cuttings, decontamination water, and formation water
- Drum/bung wrench and drum funnel

- Heavy equipment forklift or vehicle with drum grapppler (as necessary)
- Photoionization detector (PID)
- Vendor-supplied roll-off bin(s), with liners if applicable
- Laboratory-supplied sample containers
- Wood pallets (as necessary)
- Non-porous (e.g., stainless steel) trowels
- Field notebook/notepad and waterproof permanent marking pens
- Waste manifests
- Secondary containment materials (i.e., spill containment platform/pallet with drain, absorbent pads)

4.0 Procedures

The procedures below are provided for managing non-liquid and liquid IDW generated during field activities.

4.1 IDW Staging Area

Identify an onsite area for staging drums, bins, and other storage containers. The area should be large enough to allow temporary storage and safe access to the drums and bins of IDW. If IDW is left onsite without supervision, then the area must be secured from unauthorized access and containers labeled appropriately. Hazardous IDW may not be accumulated for more than 90 days.

4.2 Soil IDW

Place IDW (soil cuttings/spoils generated during drilling, trenching, soil sampling, or other) into DOT-rated 55-gallon drums, appropriately-sized containers/bins, or stockpiles at the point of generation. In most cases, mixing the cuttings from several borings or sampling locations is permissible to fill the containers or entire stockpiles but must be confirmed in advance by the PL/FTL. Ask the FTL whether potentially hazardous solids should be segregated from non-hazardous.

When drums or containers are full or daily activities are completed, the drum lids and rings will be fastened. Full drums or containers will be transported to the designated IDW accumulation area regularly to avoid the accumulation of drums or containers at investigation sites for extended periods.

Waste profiling analyses will be performed before disposal (Section 4.5). Each project may have unique waste profiling, storage, and disposal—review project-specific work plans and coordinate activities between the PL and client.

Unless approved, hazardous soil cuttings and excavation spoils must not be used to fill boreholes, test pits, or excavations. Place soil cuttings/spoils on plastic sheets or containerize them when generated; dispose of the plastic sheets with the used PPE or soil cuttings.

4.3 Liquid IDW

Contain liquids in DOT-rated drums or appropriately-sized watertight containers at the point of generation. Mixing the water from several sampling locations, decontamination water, process water,

and other IDW sources may be permissible to fill the drums but should be confirmed in advance with the PL or FTL. Ask the FTL whether potentially hazardous liquids should be segregated from non-hazardous.

When drums or containers are full or daily activities are completed, the drum lids and rings will be fastened. Full drums or containers will be transported to the designated IDW accumulation area regularly to avoid accumulating drums or containers at investigation sites for extended periods. All drums or containers will be labeled appropriately at the end of each day's activities. Perform waste profiling before disposal (Section 4.5). Each project may have unique requirements for waste profiling, storage, and disposal—review project-specific plans and coordinate activities with the PL or FTL.

4.4 PPE and Other Consumable Supplies

Inspect equipment and PPE (e.g., plastic sheets, screens, coveralls, boot covers, or other) to determine proper disposal procedures. If there is no evidence of contamination, materials can be disposed of with regular trash.

Decontaminate and discard PPE and other used supplies in plastic bags and sealed in metal barrels for final storage, transport, and disposal. Decontamination procedures consist of brushing off or using small amounts of water to scrub off potential gross contamination (see SWE-FSOP-801, Equipment Decontamination).

4.5 Waste Profiling

Waste profiling requirements will be coordinated by the PL with the client and disposal facility. At a minimum, a representative sample of the solid and aqueous IDW will be collected and analyzed for all chemicals of potential concern. When approved by the PL, generator knowledge is an acceptable alternative to laboratory testing. The PL will also coordinate with the client, disposal facility, and waste transporter to manage the completion of the waste manifest and ensure that an adequate number of manifests are available for the amounts and types of material to be disposed of. An example manifest is provided in Attachment 1.

Waste manifests are signed by the client or client's representative (usually identified on the manifest as the "owner" and/or "generator"). Field personnel are not allowed to sign manifests under any circumstances.

4.6 Labeling

Apply a label immediately after adding soil or groundwater to drums or soil to bins. If the waste generated has not been profiled, apply a "Pending Analysis" label (Figure 1). Add the contents, date(s) of generation, the origin of materials, address of generation, and contact information to the label. Because drum and container labels may be exposed to the elements, it is essential to use waterproof markers to fill in the information on labels and possibly clear packaging tape over the labels to preserve the information.

Once the material has been profiled, remove the "Pending Analysis" label and add the appropriate "Non-Hazardous" (Figure 2) or "Hazardous" label (Figure 3). Add the shipper, address, date(s) of generation, contents, and contact information to the label.

THIS CONTAINER
ON HOLD
PENDING ANALYSIS

ON HOLD

CONTENTS:

ORIGIN OF MATERIALS:

ADDRESS:

CONTACT:

DO NOT TAMPER WITH CONTAINER
AUTHORIZED PERSONNEL ONLY

Figure 1 – Label: Pending Analysis

NON-
HAZARDOUS
WASTE

OPTIONAL INFORMATION

SHIPPER:

ADDRESS:

CITY, STATE, ZIP:

CONTENTS:

NON-
HAZARDOUS
WASTE

Figure 2– Label: Non-Hazardous

HAZARDOUS WASTE

FEDERAL LAWS PROHIBIT IMPROPER DISPOSAL.
IF FOUND, CONTACT THE NEAREST POLICE OR PUBLIC SAFETY
AUTHORITY OR THE U.S. ENVIRONMENTAL PROTECTION AGENCY.

GENERATOR'S INFORMATION:

Shipper: _____ Phone: _____

Address: _____ State, ZIP: _____

City: _____ EPA ID No. _____ EPA Waste No. _____

Accumulation Start Date: _____ Manifest Tracking No. _____

UN/NA No. With Prefix: []

DOT Proper Shipping Name: []

HANDLE WITH CARE!

Item F10001 • productlabels.com • Printed in the USA

Figure 3– Label: Hazardous

4.7 Disposal of IDW

Soil and groundwater IDW will be placed in drums or appropriately configured bins and stored in a designated hazardous/non-hazardous waste storage area, the location and use of which will be coordinated with the client. Manifesting and disposal of IDW during field activities will be coordinated with the client before the initiation of field activities. As applicable, field activities that generate IDW will be conducted consistent with sustainable practices (e.g., reducing the volume of routine waste or IDW generated by decreasing materials consumption).

4.8 Document Control

The FTL is responsible for documenting or reviewing field team documentation of IDW management, including collection, sampling, labeling (if applicable), staging, and ultimate disposition of IDW.

Disposition may include manifesting the waste and transportation offsite or releasing the waste to the client for ultimate disposal. The information entered in field documentation concerning IDW should include the following:

- Project Name
- Names of personnel
- Site location
- Type of activities
- Date waste generated
- Boring, well, or site number(s)
- Matrix
- Type of container(s)
- Estimated volume
- Disposition of contents
- Comments (field evidence of contamination [e.g., PID reading, odors])
- Any variance to procedures described in this SOP

After completing a task or project, all field documentation, including the field logbook, field datasheets, and electronic data, shall be scanned and placed on the server in the appropriate folder. All original documents shall be submitted to the PL and kept in the project file. See FSOP-001 (Field Documentation).

5.0 Quality Assurance/Quality Control

Conduct the 3-Phases of Quality Control method described in the project work plans.

Quality Assurance (QA) and Quality Control (QC) procedures for IDW field documentation review will be performed by the PL and QC Manager to confirm that content and level of detail comply with the applicable planning documents. Identification of errors and corrections made during QA/QC reviews will follow documentation requirements described in SWE-FSOP-001 (Fieldwork Documentation).

6.0 Documentation Review

The FTL is responsible for reviewing hazardous waste characteristics, ensuring the disposal facility is licensed to receive the IDW, and reviewing waste manifests and bills of lading.

The FTL is responsible for the daily review of fieldwork documentation for compliance with requirements (Section 4.0) and legibility. Errors and omissions should be explained and revisions to an entry signed and dated by the FTL.

7.0 References

None cited.

Attachments

**Attachment 1.
Uniform Hazardous Waste Manifest**

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)										A7 2002939203-001		SC PPW 12/9/2008		Form Approved: OMB No.2050-0039	
UNIFORM HAZARDOUS WASTE MANIFEST		1. Generator ID Number			2. Page 1 of 1		3. Emergency Response Phone			4. Manifest Tracking Number					
5. Generator's Name and Mailing Address							Generator's Site Address (if different than mailing address)								
Generator's Phone:															
6. Transporter 1 Company Name							U.S. EPA ID Number								
7. Transporter 2 Company Name							U.S. EPA ID Number								
8. Designated Facility Name and Site Address							U.S. EPA ID Number								
Facility's Phone:															
9a. HM	9b. U.S. DOT Description (Including Proper Shipping Name, Hazard Class, ID Number, and Packing Group (if any))					10. Containers No. Type		11. Total Quantity	12. Unit Wt./Vol.	13. Waste Codes					
14. Special Handling Instructions and Additional Information															
Contract retained by generator confers agency authority on initial transporter to add or substitute additional transporters on generator's behalf for purposes of transportation efficiency, convenience, or safety															
15. GENERATION'S/OFFEROR'S CERTIFICATION: I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name, and are classified, packaged, marked and labeled/placarded, and are in all respects in proper condition for transport according to applicable International and national governmental regulations. If export shipment and I am the Primary Exporter, I certify that the contents of this consignment conform to the terms of the attached EPA Acknowledgment of Consent. I certify that the waste minimization statement identified in 40 CFR 262.27(a) (if I am a large quantity generator) or (b) (if I am a small quantity generator) is true.															
Generator's/Offeror's Printed/Typed Name						Signature			Month Day Year						
16. International Shipments		<input type="checkbox"/> Import to U.S.		<input type="checkbox"/> Export from U.S.		Port of entry/exit: _____ Date leaving U.S.: _____									
Transporter Signature (for exports only): _____															
17. Transporter Acknowledgement of Receipt of Materials															
Transporter 1 Printed/Typed Name						Signature			Month Day Year						
Transporter 2 Printed/Typed Name						Signature			Month Day Year						
18. Discrepancy															
18a. Discrepancy Indication Space		<input type="checkbox"/> Quantity		<input type="checkbox"/> Type		<input type="checkbox"/> Residue		<input type="checkbox"/> Partial Rejection		<input type="checkbox"/> Full Rejection					
										Manifest Reference Number:					
18b. Alternate Facility (or Generator)										U.S. EPA ID Number					
Facility's Phone:															
18c. Signature of Alternate Facility (or Generator)										Month Day Year					
19. Hazardous Waste Report Management Method Codes (i.e., codes for hazardous waste treatment, disposal, and recycling systems)															
1.		2.		3.		4.									
20. Designated Facility Owner or Operator: Certification of receipt of hazardous materials covered by the manifest except as noted in Item 18a.															
Printed/Typed Name						Signature			Month Day Year						
EPA Form 5700-22v (Rev. 3-05) Previous editions are obsolete.															

Analytical SOPs

SOP Number	SOP Title
1. MS010.10	Analysis of Volatile Organics by GC/MS Select Ion Monitoring (SIM) (VOCs by 8260 SIM)
2. MET108.06	Metals by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP) (Metals by 6010D)
3. GN237-03	Determination of Inorganic Anions by Ion Chromatography (Chloride by 9056A)
4. SAM101.22	Sample Receipt and Storage
5. SAM108.11	Sample and Laboratory Waste Disposal



ANALYSIS OF VOLATILE ORGANICS BY GC/MS SELECT ION MONITORING (SIM)

Prepared by: Norm Farmer Date: 03/09/2022

Approved by: Chelsea Vandenburg Date: 03/14/2022

Annual Review

Reviewed by: Neil Christiana Date: 07/17/2023

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Document Control

Issued to: QA Department - digital Date: 03/15/2022

Issued to: MS Volatile Department - digital Date: * 03/15/2022

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Effective 7 days after "*" date

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TITLE: ANALYSIS OF VOLATILE ORGANICS BY GC/MS SELECT ION MONITORING (SIM)

REFERENCES: SW846 8260B, 8260C and 8260D

REVISED SECTIONS: 1.1.8, 1.2.1, 2.1.4, 6.3, 6.6, 7.2, 7.3, 9.1.1 and 12.0

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 select 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.

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- 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 5.1, Table B-4; QSM 5.3 or QSM 5.4 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, 8260C, and 8260D.
- 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 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 must 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 $\leq 6^{\circ}\text{C}$ 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 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 must 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 Orlando monitors 3 ions per compound.

3.6 Historically 1,4-dioxane was used as a stabilizer for various chlorinated solvents such as trichloroethene 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.

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- 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.x 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 must 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 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.
- 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.

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- 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-d₄
Toluene-d₈
- 5.8 Internal standards – (varies based on analytes being reported)
- Fluorobenzene
Chlorobenzene-d₅
1,4-Dioxane-d₈

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 (or less) of Bromofluorobenzene (BFB).

For this method it also must be capable of operating in Select Ion Mode (SIM). The selected ions are nominal ions but may have small mass defect, usually less than 0.2 amu, in their spectra. The acquisition table must be set to include these mass defects. The dwell time may be automatically calculated by the laboratory's GC/MS software. The total scan time must be less than 1,000 msec and produce at least 5 to 10 scans per chromatographic peak.

The mass spectrometer must be capable of analyzing multiple groups for up to 30 specific ions. Use the primary ion for quantitation and the secondary ions for confirmation. The start and end of each group must be time programmable and can be determined from the full scan analysis. Each group of specific ions is referred to as a descriptor.

6.3 Purge and Trap – OI Analytical 4660 with OI Analytical 4552/4551A or EST Evolution/Evolution2 with EST Centurion.

6.3.1 The following autosampler models are used for purging, trapping and desorbing the sample onto GC column.

- O.I. Model 4660 sample concentrator with 4552 Water/Soil multisampler
- O.I. Model 4660 sample concentrator with 4551A Water multisampler
- EST Evolution sample concentrator with Centurion Water/Soil 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 must 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 must 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.
Trap – Vocab 3000 (K) or equivalent: Carbopack B, Carboxen 1000, Carboxen 1001

The trap should be conditioned according to the manufacturer's recommendations.
- 6.6 Columns – RTX-VMS or equivalent: 20m X 0.18mm 1.0um.
– 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 must 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	0.8-1.0 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 – 35 °C for 1.0 minutes (RTX-VMS 20m)
10 °C/min to 80 °C for 0 minutes
18.5 °C/min to 150 °C for 0 minutes
30 °C/min to 220 °C for 1.0 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

	OI Autosampler	EST Autosampler
Purge Gas	He or N2	He or N2
Purge Flow	35-40 ml/min	35-40 ml/min
Sample Temp.	Ambient - 40 C	Ambient - 45 C
Trap Temp.	< 25 C	< 35 C
Purge Time	6 or 11 min	6 or 11 min
Desorb Time / Temp	0.5-2.0 min @ 190 C	0.5-2.0 min @ 250 C
Bake Time / Temp	4-6 min @ 210 C	4-6 min @ 260 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.

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7.5.1.1 Tune Verification (BFB)

The instrument must 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 must 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 must 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.

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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 Orlando 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 must be documented in the run log.

Response factors (RF) for each analyte are determined as follows:

$$RF = (A_{\text{analyte}} \times C_{\text{istd}}) / (A_{\text{istd}} \times C_{\text{analyte}})$$

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:

$$\%RSD = (\text{Standard Deviation of RF} \times 100) / \text{Mean RF}$$

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.

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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 ≥ 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

$$\% \text{ ERR} = (x_i - x'_i) / x_i * 100$$

x'_i = Measured amount of analyte at calibration level i , in mass or concentration units.

x_i = 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 $\leq 30\%$ for all standards. For some data uses, $\leq 50\%$ may be acceptable for the lowest calibration point.

Calculation of Relative Standard Error (%RSE)

$$RSE = 100 \times \sqrt{\sum_{i=1}^n \left[\frac{x'_i - x_i}{x_i} \right]^2 / (n - p)}$$

x'_i = Measured amount of analyte at calibration level i , in mass or concentration units.

x_i = 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 $\leq 15\%$ for good performing compounds and $\leq 30\%$ 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 must be prepared from a second source at a mid-range concentration.

The %D for all analytes of interest should be $\leq 20\%$. 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 $\leq 20\%$. 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 criteria, a fresh standard must be prepared. If this ICV meets criteria, proceed with sample analysis. If the ICV still does not meet criteria, analyze an ICV prepared from a third source or different lot. 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 must 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 $\leq 20\%$ 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.

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Rationale for second standard such as instrument maintenance, clipped column, remade standard, etc. must 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 have 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.x compliance, an additional CCV must be analyzed at the end of each run. The closing CCV must be within the 12-hour Tune window.

The $\%D$ for all target compounds in this CCV should be $\leq 50\%$. If the $\%D > 50\%$ for any target compound, then the samples must 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.x 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.

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- 7.5.2.5 If any of the internal standard response changes by more than a factor of two (-50% to +100%) or retention time changes by more than 30 seconds (10 seconds for DOD QSM 5.x 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 (OI) or five microliter (EST) 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 must be present in the sample spectrum.

The relative intensities of these ions must agree within $\pm 30\%$ 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 must 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, Chlorobenzene-d₅, and 1,4-Dioxane-d₈ may be used as the internal standards for this method. The response of the internal standard in all subsequent runs must 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 must 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-d₄ and Toluene-d₈ 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:

$$\% \text{ Recovery} = (\text{Sample Amount} / \text{Amount Spiked}) \times 100$$

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 must 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 clean sand (depending upon sample matrix) to which the surrogate standard has been added. An appropriate aliquot of methanol must 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.

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- 9.3.2 If the MB is contaminated but the samples are non-detect, then the source of contamination must be investigated and documented. The sample results can be reported. **For any DoD QSM projects the resulting data must be qualified accordingly.**
- 9.3.3 If the MB is contaminated but the samples results are > 10 times the contamination level, the source of the contamination must 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 must be investigated and documented. The samples must 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 must 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 clean sand (depending upon sample matrix) to which the surrogate standard and spike standard have been added. An appropriate aliquot of methanol must 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 must fall within the established control limits for the results to be acceptable.

NOTE: A secondary check against 70-130% limits must 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 must 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:

$$\% \text{ Recovery} = ([\text{Spike Amount} - \text{Sample Amount}] / \text{Amount Spiked}) \times 100$$

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:

$$\text{Water (ug/l)} = (\text{CONC}_{\text{inst}}) \times \text{DF}$$

$$\text{Soil (ug/kg)} = [(\text{CONC}_{\text{inst}}) \times (5 / W_i)] / \% \text{solids (low level soils)}$$

$$\text{Soil (ug/kg)} = [(\text{CONC}_{\text{inst}}) \times (V_F / V_A) \times (5 / W_i) \times \text{DF}] / \% \text{solids (high level soils)}$$

CONC _{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:

$$V_F = \{\text{ml of solvent} + [(\% \text{moisture} \times W_i) / 100]\} \times 1000 \text{ ul/ml}$$

11.0 SAFETY AND POLLUTION PREVENTION

11.1 Safety

The analyst must 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 must 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 must 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.

Dilution waste and purged aqueous samples and standards are rinsed down the drain with large amounts of water.

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

SW846 Method 8260C Revision 3, August 2006

SW846 Method 8260D Revision 4, June 2018

DOD Quality Systems Manual (QSM) for Environmental Laboratories, Revision 5.4, Oct. 2021

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 ISTD	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-d5 ISTD	117	82		
Toluene-d8 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-d8 ISTD	96	64		
1,4-Dioxane	88	58	43	

ANALYSIS OF VOLATILE ORGANICS BY GC/MS SELECT ION MONITORING (SIM)

SOP Acknowledgement Form

I have read and understand this SOP. I will not knowingly deviate from this approved SOP without approval of the Department Supervisor, QA Officer, or Technical Director. If I notice any discrepancies between this SOP and the routine procedure, I will notify the Department Supervisor so that either the SOP or procedure can be changed. Furthermore, I understand that this SOP is property of SGS North America Inc. – Orlando and may not be printed nor duplicated in any manner.

Internal SOPs referenced within this SOP: GC001, OP020, OP021 and QA029

Print Name	Signature	Date

Print the SOP Acknowledgement Form, sign, and submit to the SGS Orlando QA department.

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METALS BY INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROMETRY (ICP)

Prepared by: David Metzgar III Date: 04/05/2022

Approved by: Svetlana Izosimova Date: 04/20/2022

Annual Review

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Internal Document Control

Issued to: QA Department - Digital Date: 04/20/2022

Issued to: Metals - Digital Date: * 04/20/2022

Issued to: _____ Date: _____

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Issued to: _____ Date: _____

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TITLE: METALS BY INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROMETRY (ICP)

REFERENCES:

TNI 2016 Standards
DoD QSM 5 - Series
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 # 052018A560 SSTRACE 2

SUGGESTED WAVELENGTH (S): TABLE 2

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. Please refer to current version of DoD QSM 5 for quality control criteria.

- 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, Boron, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Molybdenum, Nickel, Potassium, Selenium, Silica, Silver, Sodium, Strontium, Titanium, Thallium, Tin, Vanadium, and Zinc.
- 1.2 Sample matrices are pretreated following SW846 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.

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- 1.4 Reporting limits (RL) 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 Method Detection Limit: MDL is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is distinguishable from method blank results. Experimentally determine MDLs using the procedure specified in 40 CFR, Part 136, Appendix B, Rev. 2. For further details on the procedure refer to SOP QA020, current revision
- 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

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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 $\leq 6^{\circ}\text{C}$ upon receipt. Refer to SOP SAM101, current revision for further instruction.

All bottle ware 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 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 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 2.8.0.97
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. These standards and reagents must be accompanied by the Certificate of Analysis (CoA). The CoA is examined for accuracy and completeness of the information, including verification of the reagent/standard normality/concentration. For further details refer to SOP QA017, current revision. Refer to Acid Certificate of Analysis Electronic Logbook for Certificates of Analysis and compliance with the specifications of the grade listed. Refer to the Metals Department Electronic 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 be determined by a blank and a series of six non-zero standards representing the elements of interest.

- 6.1 Reagent Water – Water that has been generated by any method which shall meet method specified requirements. TNI 2016 definition. Reagent water is used exclusively for laboratory purposes. Refer to SOP QA037, current revision for more information regarding testing and monitoring.
- 6.2 Yttrium and Indium internal standard, made from ICP quality standard.
- 6.3 Hydrochloric acid, trace metals grade.
- 6.4 Nitric Acid, trace metals grade.
- 6.5 Analytical Quality Control Solutions

ICP quality standard stock solutions are available from Inorganic Ventures, Spex, Plasma Pure, Ultra, Environmental Express, or equivalent.

All 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; which is 3% HNO₃ + 5% HCL unless instructed otherwise by supervisor.

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.

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6.5.1 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. Standards must be prepared so that there is minimal spectral interference between analytes.

6.5.2 Blank (Calibration, ICB, CCB)

6.5.3 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.

6.5.4 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.

6.5.5 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.

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. Levels for the SIC and mixed SIC can be found on tables 9 and 10.

6.5.6 CRIA Standard Solution

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.

6.5.7 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.

6.6 Liquid Argon or Argon Gas. (99.999% purity)

7.0 ANALYTICAL PROCEDURE

Note: Please refer to section 8 and or QC criteria summary page of this SOP for further detail on quality control criteria. 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°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 six 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 ≥ 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.

7.11 After analyzing the ICV, the ICB must be analyzed.

7.12 Before analyzing any real world samples the CRIA must be analyzed.

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.

7.14 After the initial analytical quality control has been analyzed, the samples and the preparation batch matrix quality control shall be analyzed. This includes the Method blank, blank spike, duplicate, matrix spike, matrix spike duplicate, serial dilution, and post digestion spike. 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 (CCV) and the continuing calibration blank (CCB) after initial calibration, every tenth sample and at the end of the sample run.

7.16 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.

7.17 After the instrument is optimized and all initial QC has been run, click on **Run Auto-Session** Icon to start the analytical run sequence.

7.17.1 If you need to add or delete samples once the run is started, follow the steps shown below.

7.17.2 Click on **Sequence** tab, then click on **List View** Icon at the tool bar. There is the sequence table shown on the display area.

- 7.17.3 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.
- 7.17.4 On the Samplename column type in the sample I.D., correction factors, and check tables. **Click on Auto Locate All**.
- 7.17.5 The added samples will be analyzed at the end of the original sequence run order unless they are assigned a different run order.
- 7.17.6 Deleting Samples
- 7.17.7 Click on **Sequence** tab, and then click on **List View** Icon under the sequence display area.
- 7.17.8 Highlight all samples that need to be deleted and then click on the **Delete Samples** icon.
- 7.18 When the analysis is completed export the data to LIMS following the procedure outlined below.
 - 7.18.1 Double click on **ePrint** Icon on desktop. There will be a **LEADTOOLS ePRINT** pop up box, click on **Finish Jobs** and **OK** boxes.
 - 7.18.2 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.
 - 7.18.3 Drop the raw data to the **LIMS Data Drop** icon located on the desktop.
 - 7.18.4 By completing the above steps, the raw data (i.e.: MA9000) can be viewed and/or printed from the Raw Data Search function.
 - 7.18.5 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.
- 7.19 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.
- 7.20 At the end of the analysis day the ICP must be shutdown using the following sequence.

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- 7.20.1 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.
- 7.20.2 Turn off the plasma by clicking on the **Plasma** Icon and then by clicking **Plasma Off**.
- 7.20.3 Close all iTeva programs/windows.
- 7.20.4 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 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 for all samples to greater than two times the background concentration.

8.3 Low Standard Check (CRIA). Also referred to as LLCCV, LOQ, LLOQ

Before analyzing any real world samples, the CRIA must be analyzed. The CRIA contains elements of interest at the reporting limit. The CRIA will be analyzed at the beginning 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.

8.4 ICSA (Mixed SIC Solution) and Single Element Interference checks

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 reporting limit. 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 these criteria cannot be met then sample analysis may not proceed until the problem is corrected, or the reporting limit 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.

Single element interference checks – At a minimum, single element SIC checks should be performed for the following elements on initial instrument setup and every six months: 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.

The absolute value of the concentration observed for any unspiked analyte in the single element SIC checks must be less than 2 times the reporting limit. 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.

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 after the initial calibration, after every 10th sample, and at the end of the analytical 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 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 to greater than two times the background concentration. All samples associated with an out of compliance method blank shall be qualified and footnoted in LIMS as well as the case narrative.

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. 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 criteria 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.

$$\frac{(\text{Spiked Sample Result} - \text{Sample Result}) \times 100}{\text{Amount Spiked}} = \text{matrix spike recovery}$$

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 assessed and must be ≤ 20 percent for sample results at or above the reporting limit. 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. 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.

$$\frac{(|\text{Sample Result} - \text{Duplicate Result}|) \times 100}{(\text{Sample Result} + \text{Duplicate Result})/2} = \text{Duplicate RPD}$$

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 RL). 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.

$$\frac{(\text{Sample Result} - \text{Serial Dil. Result}) \times 100}{\text{Sample Result}} = \text{Serial Dilution RPD}$$

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, 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.

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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.

8.16 Percent Relative Error

The laboratory shall use and document a measure of relative error in the calibration;

- i. For calibrations evaluated using an average response, the determination of the relative standard deviation (RSD) is the measure of the relative error.
- ii. For calibrations evaluated using correlation coefficient or coefficient of determination, the laboratory shall evaluate relative error by either:
 - a. Measurement of the Relative Error (%RE)

Relative error is calculated using the following equation:

$$\% \text{ Relative Error} = \frac{X'_i - X_i}{X_i} \times 100$$

X_i = True value for the calibration standard

X'_i = Measured concentration of the calibration standard

This calculation shall be performed for two calibration levels: the standard at or near the mid-point of the initial calibration and the standard at the lowest level.

The Relative Error at both of these levels shall meet the criteria specified in the method. If no criteria for the lowest calibration standard is specified in the method, the criteria and the procedure for deriving the criteria shall be specified in the SOP.

SGS Orlando has established the % Relative Error as follows:

LLCCV must be within 20%.

MidPoint must be within 10%.

If these criteria cannot be met then rerun calibration standards, and/or prepare new calibration standards and recalibrate the instrument.

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 HEALTH AND SAFETY

11.1 The analyst should follow normal safety procedures as outlined in the SGS Health and Safety Program and SGS Orlando SOP QA033 (Laboratory Safety Procedure), current revision, which includes the use of safety glasses and lab coats. Gloves should be worn. 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.

11.2 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.

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) =

$\frac{(\text{conc. in the digestate (ug/l)}) \times (\text{final digestate volume (ml)})}{(\text{initial sample volume (ml)})}$
--

For soil samples, the following calculations must be used.

Concentration of the metal in the dry sample (mg/kg) =

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$\frac{(\text{conc. in the digestate (mg/l)} \times \text{final digestate volume(L)})}{(\text{sample wt. (kg)}) \times (\% \text{ solids}/100)}$
--

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.

QC Criteria Summary

Quality Control	Frequency	Acceptance Criteria	Corrective Action
Initial Calibration: r = coefficient of correlation	Daily	≥ 0.995	Rerun calibration standards, and/or prepare new calibration standards and recalibrate the instrument, or document why the data are acceptable.
Percent Relative Error (%RE)	Each initial calibration	80 – 120 % of the lowest cal. standard's true value. 90-110% of the calibration standard at or near the mid-point's true value	Rerun calibration standards, and/or prepare new calibration standards and recalibrate the instrument.
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.
Continuing Calibration Verification standard (CCV)	After initial calibration, every tenth sample, and at end.	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.
Blanks (MB)(ICB)(CCB)	(MB) One per batch (ICB) After initial calibration (CCB) After initial calibration, every 10 th sample, and at the end.	$< \frac{1}{2}RL$	Reanalyze, and/or stop the run and determine the source of contamination, or document why the data are acceptable.
Blank Spike (BS or LCS)	One per batch	80-120%	Determine and correct the problem, reanalyze samples, if necessary, or document why data are acceptable. For DoD, assess against DoD criteria.
Sample RSD	NA	Elements >5x RL, RSD<5%	Reanalyze sample, or document why the data are acceptable.

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Quality Control	Frequency	Acceptance Criteria	Corrective Action
MS/MSD/DUP	5% of matrix	80-120%, %RPD \leq 20%	If the results are outside these criteria then matrix interference should be suspected, and the proper footnote entered into LIMS. For DoD, assess against DoD criteria.
Linear Calibration Range (LCR)	Highest calibration standard or LCR analyzed within daily run.	\pm 10% of the standard's true value	See section 8.11 for more detail
Low level CCV (CRIA)	One per calibration	80-120% of the standard's true value.	Rerun standard, and/or prepare new standard, and/or recalibrate instrument, or document why the data are acceptable.
Mixed Interference Solution (SIC)	One per calibration	Concentration measured for any target analyte must be < RL. For spiked elements, results must be within 20% of standard's true value.	Rerun standard, and/or prepare new standard, and/or recalibrate instrument, or document why the data are acceptable.
Serial Dilution (SDL)	One per batch	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 RL).	If the results are outside these criteria then matrix interference should be suspected, and the proper footnote entered into LIMS.
Internal Standard	All samples and standards	60-125% referenced against ICB	Dilute sample until internal standard are within range. Footnote data accordingly in LIMS.

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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: Calibration Levels

Element	CRIA	LowA	Low	LowMid	Mid	High
	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l
Al	200	5000	10000	20000	40000	80000
As	10	250	500	1000	2000	4000
Ca	1000	5000	10000	20000	40000	80000
Fe	300	5000	10000	20000	40000	80000
Mg	5000	5000	10000	20000	40000	80000
Mn	15	250	500	1000	2000	4000
Pb	5	250	500	1000	2000	4000
Se	10	250	500	1000	2000	4000
Tl	10	250	500	1000	2000	4000
V	50	250	500	1000	2000	4000
Ag	10	31.2	62.5	125	250	500
Ba	200	250	500	1000	2000	4000
Be	4	250	500	1000	2000	4000
Cd	5	250	500	1000	2000	4000
Co	50	250	500	1000	2000	4000
Cr	10	250	500	1000	2000	4000
Cu	25	250	500	1000	2000	4000
K	5000	5000	10000	20000	40000	80000
Na	5000	5000	10000	20000	40000	80000
Ni	40	250	500	1000	2000	4000
Sb	5	250	500	1000	2000	4000
Zn	20	250	500	1000	2000	4000
Mo	50	250	500	1000	2000	4000
Sn	50	250	500	1000	2000	4000
Sr	10	250	500	1000	2000	4000
Ti	10	250	500	1000	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 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
Cria/RL
LowA
Low
LowMid
Mid
High
HIGH STD Readback
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
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 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

REVISION HISTORY

Revision Date	Revision Number	Affected Section(s)	Revision Description
12/2020	05	“Revised Sections”	Added Revision History and removed Revised Sections.
4/5/2022	06	1.1	Added elements
4/5/2022	06	1.5	Updated MDL procedure
4/5/2022	06	5.8	Updated software version
4/5/2022	06	6.0	Updated calibration curve information
4/5/2022	06	6.1	Added reagent water
4/5/2022	06	Table 3	Updated to include additional calibration standards
4/5/2022	06	7.12	Removed reference to CRIA at end
4/5/2022	06	8.3	Removed reference to CRIA at end
4/5/2022	06	8.16	Created % RE section
4/5/2022	06	References	Added TNI 2016 and DoD QSM 5 series to references
4/5/2022	06	Control Document Cover	Added “Digital”
4/5/2022	06	General	Added SOP acknowledgement Form
4/5/2022	06	Table 8	Revised to include additional calibration standards
4/5/2022	06	General	Added QC Criteria table
4/5/2022	06	6 and 7	Remove QC criteria references. See section 8 and QC Summary for QC criteria.
4/5/2022	06	6	Formatting
4/5/2022	06	7	7.14 Added matrix quality control standards, removed section 7.16

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4/5/2022	6	8.4	Added in single element interference check criteria
4/5/2022	6	11	Updated health and safety
4/5/2022	6	6.5	Added acid matrix concentration

METALS BY INDUCTIVELY COUPLED PLASMA ATOMIC EMISSION SPECTROMETRY (ICP)

SOP Acknowledgement Form

I have read and understand this SOP. I will not knowingly deviate from this approved SOP without approval of the Department Supervisor, QA Officer, or Technical Manager. If I notice any discrepancies between this SOP and the routine procedure, I will notify the Department Supervisor so that either the SOP or procedure can be changed. Furthermore, I understand that this SOP is property of SGS North America Inc. – Orlando and may not be **printed nor** duplicated in any manner.

Internal SOPs referenced within this SOP: QA020, QA006, QA017, QA033, QA037, SAM101, SAM104, SAM108

Print Name	Signature	Date

Print the SOP Acknowledgement Form, sign, and submit to the SGS Orlando QA department.

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DETERMINATION OF INORGANIC ANIONS BY ION CHROMATOGRAPHY

Prepared by: Jordynn Rice Date: 04/21/2023

Approved by: Elizabeth Kent Date: 04/26/2023

Annual Review

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Internal Document Control

Issued to: QA Department (digital) Date: 04/26/2023

Issued to: General Chemistry Department (digital) Date: * 04/26/2023

Issued to: _____ Date: _____

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DETERMINATION OF INORGANIC ANIONS BY ION CHROMATOGRAPHY

REFERENCES: EPA 300.0, Revision 2.1, 1993; SW846 9056A,
Revision 1, 2007

1.0 SCOPE AND APPLICATION

- 1.1 This method is for the measurement of anions such as bromide, chloride, fluoride, nitrate, nitrite, ortho-phosphate, 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 This method addresses the sequential determination of the anions: fluoride, chloride, nitrite-N, bromide, nitrate-N, ortho-phosphate-P, and sulfate found in aqueous and solid samples. A small volume of aqueous sample is injected into an ion chromatograph to flush and fill a constant-volume sample loop. The sample is then injected into a flowing stream of carbonate-bicarbonate eluent. The sample is pumped through two different ion exchange columns, then a conductivity suppressor device, and into a conductivity detector. The two ion exchange columns, a precolumn or guard column and a separator column, are packed with an anion exchange resin. Ions are separated into discrete bands based on their affinity for the exchange sites of the resin. The suppressor is an ion exchange-based device that reduces the background conductivity of the eluent to a low or negligible level and simultaneously converts the anions in the sample to their more conductive acid forms. The separated anions in their acid forms are measured using an electrical conductivity cell. Anion identification is based on the comparison of analyte signal peak retention times relative to those of known standards. Quantitation is accomplished by measuring the peak area and comparing it to a calibration curve generated from known standards.

REPORTING LIMIT AND METHOD DETECTION LIMIT

- 3.1 Reporting Limit. The reporting limits for this method are supported by the lowest concentration of standards in the initial calibration. Detected concentrations below this concentration are not reported unless MDL reporting is being done. Reporting limits were set as follows:

Analyte	Reporting Limit
Fluoride	0.20 mg/L
Chloride	2.00 mg/L
Nitrite-N	0.10 mg/L
Bromide	0.50 mg/L

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Analyte	Reporting Limit
Nitrate-N	0.10 mg/L
Ortho-Phosphate-P	0.10 mg/L
Sulfate	2.00 mg/L

- 3.2 **Method Detection Limit.** Determine MDLs using the procedure specified in 40 CFR, Part 136, Appendix B, Rev. 2, 2016. This value represents the lowest reportable concentration of an individual compound that meets the method qualitative identification criteria. 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

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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 distinguishable from method blank results. 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 process, which shall meet method-specified requirements.
- 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.
- 4.17 **Linear Calibration Range (LCR):** The calibration range over which the instrument response is linear.

5.0 HEALTH & SAFETY

- 5.1 The analyst should follow normal safety procedures as outlined in the SGS North America, Inc. Health and Safety Program which includes the use of safety glasses and lab coats. Gloves should be worn. 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 a temperature above the freezing point of water to 6°C at the time of collection.
- 6.2 Bromide, Chloride, Fluoride, and Sulfate must all be analyzed within 28 days. Nitrite, Nitrate and Ortho-phosphate 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 Metrohm 930 Compact IC Flex and associated 858 Autosampler. System is equipped with an Ultrafiltration cell that filters all samples to 0.20 µm. The eluent used is dependent upon column selection and should be based off the supporting literature. Any augmentation/changes made to the suggested eluent should be properly recorded in the solution prep log, and Section 8 of this document updated accordingly. 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 Metrohm 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 Suppressors, Primary suppression is accomplished by use of the Metrohm MSM Chemical Suppression Module, and CO₂ suppression is accomplished by use of the Metrohm MCS module.
 - 7.1.2 Guard Column, Metrosep A Supp 4/5 Guard (or equivalent). Metrohm PN 61006500.
 - 7.1.3 Analytical Column, Metrosep A Supp 5-150 (or equivalent). Metrohm PN 61006520
 - 7.1.4 Data System, MagIC Net version 3.2 Build 123 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. Refer to SOP QA005, current revision.
- 7.3 Analytical balance capable of accurately weighing to the nearest 0.0001 g. The balance calibration must be verified each day before use with Class 1 certified weights. At a minimum the balance undergoes annual maintenance and recertification by qualified outside contractor, or whenever performance becomes suspect. Refer to SOP QA005, current revision.
- 7.4 Centrifuge Centra CL2, or equivalent

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- 7.5 Class 1 weights
- 7.6 Volumetric glassware, Class A. Alternately, 50mL digestion tubes may be used to prepare solutions in smaller volumes provided these tubes are certified Class A equivalent.
- 7.7 IC vials and caps (Metrohm PN SNG-IC31000)
- 7.8 Volumetric pipettes, Class A or auto pipettors. Note: If auto-pipettes are used, make sure that the calibration is checked before use as specified in SOP QA006, current revision.
- 7.9 Nylon 0.45µm membrane filters or equivalent.
- 7.10 Disposable syringes, for sample filtering of soil extracts and extremely solid-laden aqueous samples. Pre-filtration is not necessary for most samples. The IC system has inline filtration of all samples to 0.20 µm.
- 7.11 Ultrafiltration membrane-Nylon 0.20 µm/47mm. (Metrohm PN 62714020), or equivalent.
- 7.12 Conductivity meter to pre-determine dilutions for possible interferences. This screening step may be omitted if sample history is known, and or sample matrix appears to be relatively clean. The system will auto-dilute any over range samples, so pre-screening is not critical unless samples are suspected to be of an extreme nature (i.e.: brines, plating baths, etc.). If needed, samples can be pre-diluted prior to going on the instrument provided that manual dilution is recorded properly in the software to ensure correct sample concentration is reported. See Attachment B.

8.0 REAGENTS AND STANDARDS

All chemicals should be made from ACS grade reagents/standards unless otherwise noted. Deionized water must be used whenever water is required. Commercially purchased reagent and standards must be accompanied by Certificate of Analysis (CoA). CoA is examined for accuracy and completeness of the information, including verification of the reagent/standard concentration and expiration date. For further details on reagent/standard traceability refer to SOP QA017, current revision.

- 8.1 Individual Parent Stock Solutions: It is suggested that 1000mg/L individual anion standards be purchased commercially for Fluoride, Chloride, Nitrite (as N), Bromide, Nitrate (as N), Ortho-Phosphate (as P), and Sulfate. If needed, prepared stocks can be made using the appropriate amount of a respective ACS grade salt. Reference the available methods/literature for proper amounts. **Note that two sources are required for each anion standard. 1st Source is used for calibration, a 2nd Source for calibration verification.**
- 8.2 Combined Anion Working Stock Calibration Solution: 1st Source. A single Combined Anion Working Calibration Stock solution is used for the calibration of the instrument. The Combined Anion Working Stock is the same concentration as Standard 10 for the calibration curve. This standard can be made of commercially available individual parent anion standards, or solutions prepared from salts (Section 8.1). Prepare fresh for each calibration.
Appropriate expiration dates must be applied to all standards and reagents.

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Concentrated solutions greater than 100mg/L may be kept for 1 month, while working solutions (i.e.: CCV and BS) should be prepared fresh daily for solutions containing NO₂, NO₃ and OPO₄. Prepare as indicated below.

To prepare 50mL of Combined Anion Working Stock Calibration

Analyte	Final Concentration	Vol. of 1000 mg/L Parent Stock for 50 ml	Concentration of Parent Stock
Fluoride	10 mg/L	0.50 ml	1000 mg/l
Chloride	100 mg/L	5.0 ml	1000 mg/l
Nitrite-N	10 mg/L	5.0 ml	100 mg/l
Bromide	20 mg/L	1.00 ml	1000 mg/l
Nitrate-N	10 mg/L	5.0 ml	100 mg/l
Ortho-Phosphate-P	10 mg/L	0.50 ml	1000 mg/l
Sulfate	100 mg/L	5.0 ml	1000 mg/l

- 8.2.1 The Combined Anion Working Stock Calibration Standard (8.2) is loaded directly onto the instrument for calibration. Per the selected method, the instrument software will prepare the calibration curve by diluting the Working Stock solution (up to 100x). The suggested final concentrations and their corresponding dilutions for the method are listed in the table below, but alternate ranges can be used to meet various reporting requirements. **Standard 100 is the Calibration Blank and consists of DI Water.**

Standard ID	Std 100	Std 1	Std 2	Std 3	Std 4	Std 5	Std 6	Std 7	Std 8	Std 9	Std 10
Dilution Factor	1	100	50	40	20	10	5	2.5	2	1.25	1
Concentration mg/L											
Fluoride	0.0	0.10	0.20	0.25	0.5	1.0	2.0	4.0	5.0	8.0	10
Chloride	0.0	1.0	2.0	2.5	5.0	10	20	40	50	80	100
Nitrite-N	0.0	0.10	0.20	0.25	0.5	1.0	2.0	4.0	5.0	8.0	10
Bromide	0.0	0.20	0.40	0.50	1.0	2.0	4.0	8.0	10	16	20
Nitrate-N	0.0	0.10	0.20	0.25	0.5	1.0	2.0	4.0	5.0	8.0	10
Ortho-Phosphate-P	0.0	0.10	0.20	0.25	0.5	1.0	2.0	4.0	5.0	8.0	10
Sulfate	0.0	1.0	2.0	2.5	5.0	10	20	40	50	80	100

****Note that all calibration points may not be used for the final working calibration. The number of points used are based on the curve fit used and the corresponding method requirements. It is suggested that a minimum of six points with a quadratic curve fit and 1/x weighting be applied when possible. Use of this calibration model is dependent upon regulatory guidance from the state where the sample is collected. Note that WV and PA do not allow for Quadratic curve fit at the time of this SOP revision. All other states allow for this curve fit per 40 CFR Part 136, section 136.6 b.4.x.A which specifically calls out EPA 300.0 as a method in which the curve fit is one of a non-linear response.**

- 8.3 Continuing Calibration Verification (CCV) 1st Source. Continuing Calibration Verification is prepared from the Individual Parent Stock solutions (8.1). Suggested concentrations are as follows:

CCV	mg/L
Fluoride	2.5
Chloride	50
Nitrite-N	2.5
Bromide	10
Nitrate-N	2.5
Ortho-Phosphate-P	2.5
Sulfate	50

- 8.4 Initial Calibration Verification (ICV) and Blank Spike (BSP, LCS) 2nd Source. The ICV can be made at the same concentrations that the CCV is but MUST be from a different source than the CCV. It must be within the range of the curve. Alternatively, it can be purchased from an outside supplier.
- 8.5 Stock Eluent (100x Concentration-320mM Na₂CO₃, 100mM NaHCO₃): In a 1000mL flask, add approximately 300mL of DI H₂O. Using oven dried reagent, dried at 105°C, (temperature should not exceed 110 °C) weigh 33.916 +/- 0.0005 g of Na₂CO₃ and 8.401+/- 0.0005 g of NaHCO₃, and add to flask. Bring this solution to volume. Store tightly closed to eliminate CO₂ adsorption. Stable for at least 1 month at room temperature, and up to 6 months if refrigerated.
- 8.6 Working Eluent Solution (3.2mM Na₂CO₃, 1.0mM NaHCO₃): Dilute Stock Eluent –Sec. 8.5 using 20mL of stock in a 2000mL flask and bring up to volume. This solution is stable for several weeks if proper care is given to avoid CO₂ absorption.
- 8.7 Suppressor Regenerant Solution-500mM H₂SO₄: Pipet 28 mL of concentrated H₂SO₄ into 100 mL DI and dilute to final volume of 1000mL with DI. Solution can be augmented with up to 100mM Oxalic Acid (12.607g/L Oxalic Acid Dihydrate) if analyzing samples suspected to be high in heavy metals.

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.

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

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most interference problems connected with peak resolution.

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. 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 41.75 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 Mix the samples and QC for 10 minutes on the wrist action shaker.

10.1.6 Centrifuge samples and QC for 10 minutes at 2000 RPM. Decant supernatant of centrifugation procedure directly into sample tube if clear of suspended material. Samples still containing suspended matter or turbidity may be further filtered using 0.45µm syringe filters

For aqueous samples containing large amounts of particulate matter, or extreme turbidity, pre-filter samples through 0.45µm filters pouring into sample vials. 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 A general knowledge of MagIC Net software is needed for effective operation of the instrument. This document assumes the operator has had training on the software and has a general understanding of instrumental analysis and concepts as they relate to ion chromatography (separation theory, linear regression, calibration principles, etc.)

11.2 Instrument Calibration

11.2.1 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. Percent relative error for the mid-level and lowest calibration standards must be within laboratory-derived limits (See Table 1). If the correlation coefficient or the percent relative error criteria are not met, then the instrument must be recalibrated prior to the analysis of samples. Force to Origin (aka Force to Zero) is not permitted.

11.2.1.1 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. (see also section 8.2.1 for additional information regarding acceptable calibration models)*

11.2.2 The IC is calibrated using external standard quantitation.

11.2.3 Establish ion chromatographic operating parameters per instrument manufacturers suggestion.

11.2.4 Establish the linear calibration range semi-annually. This is done by examining a calibration curve made with standards below and above the expected range. Determine at what concentrations the calibration is no longer linear.

11.2.5 Load the calibration standards via the autosampler. All calibration standards must be scheduled as sample type "**Standard**".

11.2.6 The results are used to prepare a calibration curve for each analyte.

11.2.7 Immediately following calibration, a low-level standard at the reporting limit must be analyzed. This low check must have the levels in standard 1 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 a mid-level 2nd Source check standard (ICV) be analyzed prior to analysis of client samples. Recoveries must be within the range of 90-110%. (At a minimum, this check (ICV) must be analyzed immediately following each new calibration.) Continuing calibration checks (CCV) and continuing calibration blanks (CCB) must be ran every 10 samples as well to provide bracketing QC for all reportable 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.

11.2.8 After the run is completed, review all of the chromatograms and check for overlapping peaks, dilutions, etc.

11.2.9 If one or more calibration levels are responsible for the calibration curve *not* being linear, the offending level can be dropped if, and only if, the offender is the highest

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level or lowest level of calibration.

- 11.2.10 If linearity still cannot be achieved, new standards must be prepared and/or instrument operation must be examined.
- 11.2.11 Verify the working calibration curve on each working day by running a CCV standard before any samples. The calibration must also be verified whenever the eluent strength is changed
- 11.2.12 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.
- 11.2.13 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 a 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 known spike.
- 11.2.14 For large or overlapping peaks, make dilutions. If at all possible, make dilutions and reruns on the same run as the original sample.
- 11.2.15 Refer to section 14.7 for information on how to determine the appropriate retention time window.
- 11.3 Samples may be scheduled using the Determination Series found in the Workplace of the software. Special attention need be given to ensure proper sample table setup when using advanced techniques such as Metrohm in-Vial Dilution Technique (MIVDT). **With advanced methods, the various information fields found in the Sample Table drive the logic of the method. It is very important to adhere to the guidance indicated in Attachment A: Sample Table Control Guideline to ensure proper scheduling.**
- 11.4 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.
 - 11.4.1 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 If system pressure increases from nominal values, the suppressor may need to be cleaned. Refer to Metrohm document number 8.110.8010 for cleaning instructions.
- 12.2 The four in-line sample filters on the 930 Compact IC Flex and the one in-line filter on the 858 Professional Sample Processor need to be changed on a regular basis (Quarterly) or as needed.
- 12.3 Guard and analytical columns should be changed as dictated by instrument response and standard recoveries. An increase in nominal system pressure can be an indication of fouling from either the columns or the inline filters.
- 12.4 The instrument must be recalibrated whenever new guard or analytical columns are installed.
- 12.5 Samples high in metal concentration (especially aluminum and iron) can coat the MSM resin and affect both the baseline and the peak response.
- 12.6 A series of three 200 mM oxalic acid "samples", followed by three blanks, may be ran at the end of a batch to cleanse the entire system of metal contamination. If problems persist with suppressor, refer to section 12.1.
- 12.7 Augmenting the suppressor regenerant solution (8.7) to a total concentration of 1000 mM H_2SO_4 and 1-200 mM oxalic acid will prevent MSM contamination when running samples high in metal concentration.
- 12.8 **All maintenance performed on the instrument must be recorded in the maintenance logbook.**

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 completed following the procedure outlined in 40 CFR, Part 136, Appendix B, Rev. 2, 2016. Refer to SOP QA020, current revision. If instrument conditions (columns, etc.) are modified, then a new initial 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.

The method blank must contain $< \frac{1}{2}$ RL (absolute value) 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 absolute value of $< \frac{1}{2}$ RL, then all samples must be reanalyzed. If no sample volume remains to be reanalyzed, then the data must be flagged. Refer to SOP QA043, current revision. 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.

Note: West Virginia state specific requirement for method blank must contain analyte at $< \text{MDL}$

- 14.2.1 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. Refer to SOP QA043, current revision.
- 14.2.2 The matrix spike is spiked with all anions of interest. Method limits of 90 -110 % recovery must be applied. If the recoveries are outside of this range, and all other method quality control is within limits, then matrix interference should be suspected.
- 14.2.3 For matrix duplicates control limits of 15% 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 $\pm 10\%$, 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 required that a new calibration be run a minimum of 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. The percent relative error for the mid-point (See Table 1) and lowest calibration (See 14.5 below) standards must be within acceptable criteria.

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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 $\pm 10\%$ 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.

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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 qualifier. Refer to SOP QA043, current revision. *This must be approved by the department supervisor.* Samples with hits <10 times contamination are re-prepped 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, re-prepping and/or reanalyzing the samples, or qualifying the results as estimated. Refer to SOP QA043, current revision. *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 Metrohm Instrument and column manuals
- 17.2 SGS – Orlando SOPs: QA005, QA006, QA017, QA020, QA029, QA034, QA042, QA043, SAM108, current revisions.
- 17.3 TNI 2016 standards.
- 17.4 DoD QSM, 5-series, current revision
- 17.5 CFR 40 Part 136, Tables IB and II
- 17.6 Metrohm AG document number 8.110.8010 “*IC Anion Suppressors*”

ATTACHMENT A: Sample Table Control Guideline

Sample Table Control: Initial Commands (Info 1)



Info 1 field used to specify initial (pre-analysis) commands

- **(01) Reset to First Auto-Vial**
 - Resets the auto-vial position to the Common Variable (01) First Auto-Vial
 - Used after placing new, empty dilution vials on the autosampler
 - Also restarts the Sample Counter
- **(02) Restart sample prep**
 - Used if an error occurs during the previous sample run
 - Causes the sample dilution to be prepared again in new auto-vial
 - **Best practice is to run a blank rather than utilize this command!**
- **(03) Initial rinse**
 - Rinse of sample flow path prior to analysis
 - Use when contamination from a high sample is suspected



Troubleshooting Tip

- Be sure to avoid mistakenly using the "(01) Reset to First Auto-Vial" command.
- This could lead to dilutions being made in used auto-vials.

Sample Table Control: i-Dilution Commands (Info 2)

➡ Info 2 field used to specify if a sample will be evaluated for an intelligent dilution

- **Blank (no entry)**
 - Sample will be evaluated for an intelligent dilution
- **"No intelligent dilution"**
 - Sample will NOT be evaluated for an intelligent dilution

The screenshot shows the 'Edit line - Working sample table - Workplace IC Bootcamp' dialog box. The 'i-Dilution Commands' dropdown menu is highlighted with a green box and set to 'No intelligent dilution'. Other fields include Method (MVDI 4.0_AnCat 940_UF_AREA_EPM), Ident (Blank), Sample type (Sample), Position (149), Injections (1), Volume (20 µL), Dilution (1), Sample amount (1), Initial Commands ((01) Reset to First Auto-Vial), Injection Commands (AnCat), Calibration Commands (New Anion Calibration), Instrument Dilution (1), Auto-Vial (84), and Batch name.

Sample Table Controls: Calibration Reset (Info 4)

➡ Info 4 field used to specify when a new calibration is being performed

- **New Anion Calibration**
 - Resets Common Variable areas to zero for high standards



Troubleshooting Tip:

- Do not use calibration reset commands unless performing a new calibration.
 - Erroneous use will result in Common Variable areas being set to zero and will lead to incorrect intelligent dilutions.

The screenshot shows the 'Edit line - Working sample table - Workplace IC Bootcamp' dialog box. The 'Calibration Commands' dropdown menu is highlighted with a green box and set to 'New Anion Calibration'. Other fields include Method (MVDI 4.0_AnCat 940_UF_AREA_EPM), Ident (Blank), Sample type (Sample), Position (149), Injections (1), Volume (20 µL), Dilution (1), Sample amount (1), Initial Commands ((01) Reset to First Auto-Vial), i-Dilution Commands (No intelligent dilution), Injection Commands (AnCat), Instrument Dilution (1), Auto-Vial (84), and Batch name.

Sample Table Controls: Instrument Dilution (Value 1)

⇒ Value 1 field used to specify the dilution the instrument is to perform

- **1:100 is the maximum dilution!**

The screenshot shows a software interface for editing a sample table line. The 'Instrument Dilution' field is highlighted with a green box and contains the value '1'. Other fields include Method (MVDI 4.0_AnCat 940_UF_AREA_EPM), Ident (Blank), Sample type (Sample), Position (149), Injections (1), Volume (20 µL), Sample amount (1), Initial Commands ((01) Reset to First Auto-Vial), I-Dilution Commands (No intelligent dilution), Injection Commands (AnCat), Calibration Commands (New Anion Calibration), Auto-Vial (84), and Batch name. The bottom status bar shows 'Line 1 of 2'.

Sample Table Controls: Auto-Vial Position (Value 2)

⇒ Value 2 field used to serve as a reminder for which auto-vial positions to fill with clean, capped empty vials

- **This is not the actual position where dilutions will occur.**
- **It is a reminder to the user to load a sufficient number of empty vials on the sample processor.**
- **Actual current vial position can be found in the Configuration view under (03) Current Auto-Vial**
- **Numerical value must be between 84 – 148.**

The screenshot shows the same software interface as above, but the 'Auto-Vial' field is highlighted with a green box and contains the value '84'. All other fields and the status bar are identical to the previous screenshot.

ATTACHMENT B: CONDUCTIVITY SCREENING FOR UNKNOWN SAMPLES

Conductivity Screen	Dilution Factor
< 700 μ S	No dilution
700 – 1000 μ S	1:5
1001 – 3000 μ S	1:10
3001 – 5000 μ S	1:25
5001 – 8000 μ S	1:50
8 – 10 mS	1:100
10 – 15 mS	1:200
>15 mS	1:500

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 14.4
Percent Relative Error (%RE)	Each initial calibration	50 – 150% of the lowest cal. standard's true value. 90 – 110% of the calibration standard at or near the mid-point's true value	Rerun calibration standards, and/or prepare new calibration standards and recalibrate the instrument.
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)	After initial calibration, every tenth sample, and at end of run	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 (CCV2)	One per calibration	50-150% of the standard's true value	Rerun standards, and/or recalibrate instrument and reanalyze all samples associated with CCV2.
Continuing Calibration Blank (CCB)	After initial calibration, every tenth sample, and at the end of the run	$< \frac{1}{2}$ RL	Stop the analysis, determine the source of contamination, rerun CCB and all samples following CCB outside acceptance criteria, or document why the data are acceptable.
Method blank (MB)	One per batch	$< \frac{1}{2}$ RL; WV projects <MDL	Stop the analysis, determine the source of contamination, reanalyze, or document why the data are acceptable.
Retention time (RT)	Checked weekly	90-110% of the original calibration curve retention time window	Recondition column, if necessary, and/or recalibrate the instrument. If a sample peak has shifted significantly from the original RT and the ICV and CCV check samples are within the 10% RT window, verify the result with a spike on the sample. See 11.2.12 and 11.2.13.

Quality Control	Frequency	Acceptance Criteria	Corrective Action
Blank Spike (BS or LCS)	One per batch	90-110% of the standard's true value	Determine and correct the problem, reanalyze samples, if necessary, or document why data are acceptable.
MS/MSD	10% of matrix	90-110% of the standard's true value RPD ≤ 15	Determine and correct the problem, reanalyze samples and MS/MSD, or document why data are acceptable
Linear Calibration Range (LCR)	Semi-annually	$\pm 10\%$ of the standard's true value	Rerun and/or prepare new series of standard, and/or recalibrate instrument

APPENDIX OF SIGNIFICANT CHANGES

Revision Date	Revision Number	Affected Section(s)	Revision Description
09/04/2021	01	Entire Document	Added applicable SOP references
09/04/2021	01	Entire Document	Updated MDL determination procedure to 40 CFR, part 136, Appendix B, Revision 2
09/04/2021	01	Entire Document	Changed PO4 to OPO4 for Ortho Phosphate
09/04/2021	01	References	Added Revision for SW-846; Moved 40 CFR reference to Additional References section
09/04/2021	01	4.0	Updated MDL definition; Updated Reagent Water definition to match TNI 2016 Standards; Added Linear Calibration Range definition
09/04/2021	01	5.0	Added gloves for Health & Safety PPE
09/04/2021	01	6.0	Revised sample temperature preservation to “a temperature above the freezing point of water to 6°C”; removed H2SO4 preservation references
09/04/2021	01	07	Added balance calibration verification procedure
09/04/2021	01	8.0	Added additional requirements for reagents and standards to meet current regulations; Updated preparation of Combined Anion Working Stock Calibration and individual Anions; and CCV concentrations; Updated preparation of Stock Eluent
09/04/2021	01	10.0	Added use of wrist action shaker for sample and QC preparation
09/04/2021	01	11.0	Added Percent Relative Error; Added evaluation of absolute value for MB acceptance criteria; Removed MB QC acceptance criteria for WV
09/04/2021	01	14.0	Expanded Method Blank QC requirements; Revised calibration frequency from once per month to at least quarterly; Added Percent Relative Error
09/04/2021	01	17.0	Added CFR 40 Part 136 Table IB and II; Updated SOP references
09/04/2021	01	Appendix A	Changed title to Attachment A
09/04/2021	01	Attachment B	Conductivity Screening Table for sample dilution added
09/04/2021	01	Table 1	Added % Relative Error; Expanded frequency of CCV to include after initial calibration and at the end of the run; Revised corrective action for MB; Separated MB and CCB; Revised corrective actions for Retention Time

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			shifts
09/04/2021	01	Appendix of Significant Changes	Added
09/04/2021	01	SOP Acknowledgement Form	Added
01/05/2023	02	Table 1	Updated RPD limit for MS/MSD
04/21/2023	03	14.0	Updated RPD limit for MS/MSD

DETERMINATION OF INORGANIC ANIONS BY ION CHROMATOGRAPHY

SOP Acknowledgement Form

I have read and understand this SOP. I will not knowingly deviate from this approved SOP without approval of the Department Supervisor, QA Officer, or Technical Manager. If I notice any discrepancies between this SOP and the routine procedure, I will notify the Department Supervisor so that either the SOP or procedure can be changed. Furthermore, I understand that this SOP is property of SGS North America Inc. – Orlando and may not be **printed nor** duplicated in any manner.

Internal SOPs referenced within this SOP: QA005, QA006, QA017, QA020, QA029, QA034, QA042, QA043, SAM108, current revisions

Print Name	Signature	Date

Print the SOP Acknowledgement Form, sign, and submit to the SGS Orlando QA department.

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SAMPLE RECEIPT AND STORAGE

Prepared by: Svetlana Izosimova Date: 07/15/2023

Approved by: Shayla Prince Date: 07/19/2023

Annual Review

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Document Control

Issued to: QA Department Date: 07/19/2023

Issued to: Sample Management Date: * 07/19/2023

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Effective 7 days after “*” date

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TITLE: SAMPLE RECEIPT AND STORAGE

REFERENCES: TNI Standards 2016; State of Florida DEP SOPs; 40 CFR Part 136; DoD QSM 5-series; SOP QA021, Subcontracting, current revision.

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 Forms are automatically emailed to the department supervisors and SGS - Orlando Project Manager (PM) team from the Receipt utility by the sample receiving technician. Laboratory personnel accept the samples, time of transfer is recorded (See Attachment I, Short Hold Notification Form, and Attachment IV, for container types and sizes, hold times and required preservatives.)

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. (See Attachment II, listing of tests associated with the requirement)

- 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 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 thermometer the following needs to be documented on Sample Receipt Confirmation Form:
 - 2.2.1.1 IR thermometer 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. 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. Receipt utility calculates corrected temperatures.
 - 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 2016 revision and DoD QSM 5 - series 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. **Note:** PFAS samples have higher upper tolerance up to 10°C.

- 2.2.4 Any discrepancies or non-compliant situations are documented on the Sample Receipt Confirmation Form (also referred to as p-note) which is automatically e-mailed to the entire 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, are but not limited to missing COC's, insufficient sample volume, bottles received not on COC, samples being out of hold or out of temperature range.
 - 2.2.4.1 Missing CoC requires the client to be contacted before the samples can be logged in. If resolution of the problem is not immediate, the samples remain in the original cooler until the problems are resolved.
 - 2.2.4.2 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. The CoC then stamped with both technicians' ID.
 - 2.2.7.1 Wherever samples are designated to be put on hold by the client, labels on these samples are marked with bright pink sticker.
- 2.2.8 Identify samples with subcontracted parameters and process according to SOP QA021, current revision. Most common, but not limited to, subcontracted parameters are listed in Attachment III.

- 2.2.9 **Cooler Drop-Off Procedure.** Upon return to the lab SGS - Orlando-employed couriers will visually inspect the coolers and take the original temperature. Sample Receiving technicians verify Short Holds, Rushes etc as per sec. 3.1.5 and 3.1.6. Coolers will then be placed into Refrigerated storage until Sample Receiving Technicians can process the coolers.
- 2.2.9.1 SGS – Orlando has installed an outside locker equipped with digital lock for clients' after-hours deliveries. Project Management staff shares lock combination with the clients as necessary and Sample Management staff checks the locker every morning and assumes the custody of the coolers.
- 2.3 When generating a job number, the following information is entered in the Access Receipt utility:
- 2.3.1 SGS - Orlando Job # (generated sequentially)
 - 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 and airbill # if available
 - 2.3.7 Technician ID
- 2.4 The sample custodian then checks the samples' preservation, except for the **VOA** samples, which are checked by the analyst after the sample is analyzed and **AQ Oil and Grease** due to method-specific way preservation is checked. 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 all samples with EPA 600-series methods indicated on CoC 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 Pesticides/PCB's/Semivolatile Organic aqueous samples with residual chlorine present: Immediately request an appropriate amount of 8% sodium thiosulfate solution to be prepared by WetChem department. Segregate affected samples on a cart in a walk-in cooler until solution is received. 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.
 - 2.4.3 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.

- 2.4.4 Cyanide is preserved to $\text{pH} \geq 12$ using 10N NaOH, prepared by WetChem personnel.
- 2.4.5 Sulfide is preserved to $\text{pH} \geq 9$ using 10N NaOH and Zn acetate, prepared by WetChem personnel.
- 2.4.6 Aqueous samples for metals are preserved to $\text{pH} \leq 2$ 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 ≤ 2 with H_2SO_4 , prepared by WetChem Personnel.
- 2.4.8 To avoid using expired preservatives Sample Receiving does not keep them in the department. Staff obtains necessary preservatives from Shipping department.
- 2.5 Upon confirmation to proceed from PM or client incorrectly preserved samples have the proper amount of preservative added. Volume added is recorded on the Sample Receipt Confirmation form. 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 also recorded on the Sample Receipt Confirmation form.

Full preservation adjustment record should contain Sample ID, Bottle Number, Parameter, Preservative Type, Preservative Lot, and Amount of Preservative Added, Date/Time Added and the technician's initials.
- 2.6 All bottles must be labeled. Each bottle will be labeled both on the cap and on the bottle. The labels are generated by the electronic sample receipt log. The following information is entered into the electronic log along with the information already captured in sec. 2.3:
 - 2.6.1 Job # automatically assigned by Receipt utility
 - 2.6.2 Client Name and Project
 - 2.6.3 Date and time samples were received.
 - 2.6.4 The number of coolers received
 - 2.6.5 The temperature of each cooler
 - 2.6.6 ID of custodian logging in the job
 - 2.6.7 Number of samples
 - 2.6.8 Number of bottles
 - 2.6.9 Bottle type
 - 2.6.10 Preservative by code. Choose from pull down menu in the Receipt utility app.
 - 2.6.11 Bottle storage location – cooler and shelf
 - 2.6.12 Department assigned to the analysis

The information is saved, and labels can be printed.

- 2.7 The following information is present on the bottle:
- 2.7.1 The sample number and bottle number
 - 2.7.2 Storage location
 - 2.7.3 The preservative used during sampling as indicated on the chain
- 2.8 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 HNO₃ for metals analyses are stored at room temperature. Access to the area is limited.
- 2.9 The original chain of custody and any additional documented information relative to the job is then placed in a bin in receiving for the Login personnel to pick up for entry into LIMS.
- 2.10 **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.
- 2.10.1 Foreign Samples shall be shipped in securely closed watertight containers and free of debris and macro organisms (insects, mollusks, worms, ticks and mites).
 - 2.10.2 Foreign samples are stored in lockable cooler #14 to prevent accidental disposal. This cooler is clearly marked *for foreign samples only*. Sample labels are marked with green sticker to stand out in the lab departments.
 - 2.10.3 Keep lids tightly closed while in storage.
 - 2.10.4 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 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 for unconsumed containers PFAS by EPA 1633 Draft should be kept below -20.0°C.
- 3.4 Sample storage area for volatile organics shall be monitored for cross contamination using refrigerator blanks. Refrigerator blanks shall be analyzed every other week.
 - 3.4.1 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.
 - 3.4.2 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.
 - 3.4.3 The source of the contamination must be located and removed.
 - 3.4.4 A new refrigerator blank is then placed in the refrigerator and analyzed after 24 hours.
 - 3.4.5 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 SAFETY and POLLUTION PREVENTION

4.1 Safety

The analyst should follow normal safety procedures as outlined in the SGS North America, Inc. Health and Safety Program and SGS Orlando SOP QA033 (Laboratory Safety Procedures), current revision. Safety glasses, a lab coat, and appropriate gloves should be worn when handling samples.

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.

Safety Data Sheets (SDS) are available for all standards and reagents used in the laboratory. Analysts should review the SDS prior to using any new standards or reagents.

4.2 Pollution Prevention

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.

Samples are archived and stored for 30 days after analysis. After the storage time has elapsed, the remaining aqueous samples are transferred to the appropriate drums for disposal.

5.0 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 # _____

<u>HOLD TIME</u>	<u>ANALYTE</u>	<u>CHECK COC</u>	<u>COMMENTS</u>
ASAP	RedOx		
	pH		
	Ferrous Iron		
	Total Coliform/Fecal Coliform (Subcontract)		
24 hrs	XCr / Hexachrome / Cr +6		
	Dissolved/Filtered Metals		
	Odor		
	Color		
48 hrs	BOD		
	CBOD		
	MBAS (Subcontract)		
	Turbidity		
	Nitrate (NO3)		
	Nitrite (NO2)		
	TN (NO2/NO3)		
	OPO4 / Orthophosphate		
	SS (Settleable Solids)		
	Chlorophyll A (Subcontract)		
72 hrs	Organochlorine Pesticides 608.3 (If no pH check and adjustment done)		
	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: _____

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Attachment II

SOIL SAMPLES

**Samples associated with tests listed below need to be brought to Volatile Soil Prep or Frozen within 48 hours from Date/Time of Sampling.
This requirement applies to soil Jars, 5035 Field Kits, Encores and Terracores**

8260

8021

Any GRO, including State-Specific TPH

VPH

OA1

VOA

VOC

VOH

PRE-BURN

8015

5035

5030

Attachment III

SUBCONTRACT ANALYSES

MOST COMMON – but not limited to - SUB PARAMETERS

TOX (Total Organic Halides)

TOC-SOILS

Oil and Grease SOILS

GROSS ALPHA, GROSS BETA (GR-A, GR-B)

Radium 226/228 (R-226/R-228)

ASBESTOS

CO₂ as Dissolved Gas (VIALS ONLY)

URANIUM (U)

B-BORON

LI-LITHIUM

Various Drinking Water tests

Microbiology

ORGANIC ANALYSIS

ANALYSIS	ANALYTICAL METHOD	MATRIX	MINIMUM VOLUME	CONTAINER TYPE	REQUIRED PRESERVATIVE	HOLDING TIME FROM DATE and TIME SAMPLED
SEMI-VOLATILE AND VOLATILE¹						
Volatile Organic Compounds	624 8260 SM 6200	Water	3 x 40 mL	Vials	HCl to pH<2 Cool 4°C	14 Days
	8260	Soil	3 x 40 mL ²	Field Kit ²	Freeze at -10°C	Freeze 48 hours, Analysis: 14 Days
	MA VPH	Water	3 x 40 mL	Vials	HCl to pH<2 Cool 4°C	14 Days
		Soil	2 x 40 mL ²	Field Kit ²	MeOH Cool to 4°C	28 Days
Methane, Ethane, Ethene	RSK 147	Water	3 x 40 mL	Vials	HCl to pH<2 Cool 4°C	14 Days
Gasoline Range Organics (GRO)	8015	Water	3 x 40 mL	Vials	HCl to pH<2 Cool 4°C	14 Days
		Soil	2 x 40 mL	Vials	MeOH Cool to 4°C	14 Days
Diesel Range Organics (DRO)	8015	Water	2 x 250 mL ³	Amber Glass	H ₂ SO ₄ to pH<2 Cool 4°C	7 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 Days
Acid Base Neutrals Extractable Organics (PAH and PAH SIM)	8270	Water	2 x 250 mL ³	Amber Glass	Cool, 4°C	7 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 Days Analysis: 40 Days
Acid Base Neutrals Extractable Organics full list	608 625 8270	Water	2 X 1L	Amber Glass	Cool, 4°C	7 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 Days Analysis: 40 Days
Organo Pesticides and PCBs by 608 Pesticides	8081	Water	2 x 250 mL ³	Amber Glass	Cool, 4°C	14 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 Days Analysis: 40 Days
	8141	Water	2 x 250 mL ³	Amber Glass	Cool, 4°C	7 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	7 Days Analysis: 40 Days
PCBs	8082	Water	2 x 250 mL ³	Amber Glass	Cool, 4°C	7 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 Days Analysis: 40 Days
Herbicides	8151	Water	2 x 250 mL ³	Amber Glass	Cool, 4°C	7 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 Days
Explosives	8330A/B	Water	2 x 1L	Amber Glass	Cool, 4°C	7 Days
	8330A	Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 Days Analysis: 40 Days
	8330B	Soil	Approximately 500 g	Clear Glass or Double Plastic Bags	Cool, 4°C	14 Days Analysis: 40 Days
EDB/DBCP	504.18011	Water	3 x 40 mL	Vials	Cool, 4°C 10 mg Na ₂ S ₂ O ₃ For Residual Cl ₂	14 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 Days
Acrylamide	8316	Water	2 x 40 mL	Vials	Cool, 4°C	7 days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	14 days
Perchlorate	6850	Water	1x 125 mL	Plastic 2/3 Full	Cool, 4°C	28 days
		Soil	1x 4 oz	Plastic 2/3 Full	Cool, 4°C	28 days
Extractable Petroleum Hydrocarbons (EPH)	MA EPH	Water	2 x 1L	Amber Glass	H ₂ SO ₄ to pH<2 Cool 4°C	7 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	Extraction: 14 Days Analysis: 40 Days
Total Recoverable Petroleum Hydrocarbons (TRPH)	FLPRO	Water	2 x 250 mL ³	Amber Glass	H ₂ SO ₄ to pH<2 Cool 4°C	7 Days
		Soil	1x 4 oz	Clear Glass	Cool, 4°C	Extraction: 14 Days
Perfluorinated Compounds	DoD 5-series Table B-15	Water	2 x 125 mL	HDPE, no Teflon liners	Cool 4°C	Extraction: 28 Days Analysis: 40 Days
		Soil	1x 4 oz			
	DoD 5-series Table B-24; EPA 1633 Draft	Water	2 x 500 mL + 1x 60 ml		Cool 4°C for up to 28 days, freeze <-20°C up to 90 days	Extraction: 28 Days Analysis: 28 Days
		Soil	1x 4 oz			
	EPA 537 MOD	Water	2 x 125 mL		Cool 4°C	Extraction: 14 Days
		Soil	1x 4 oz		Cool 4°C	Analysis: 28 Days
	EPA 533	DW	2 x 250 ml	HDPP / HDPE	Cool 4°C, Ammonium	Extraction: 28 Days; Analysis: 28 Days
	EPA 537.1	DW	2 x 250 ml	HDPP / HDPE	Cool 4°C, Tirzma	Extraction: 14 Days; Analysis: 28 Days
TCLP AND SPLP						
TCLP/SPLP Extractables	8270 8081 8151		2 x 1L	Amber Glass	Cool, 4°C	14 days for leaching, 7 days for extraction, 40 days for analysis
TCLP/SPLP Metals	6010		2 x 1L	Amber Glass	Cool, 4°C	Extract. & Analysis: 6 Months Aqueous and Solid; Hg Extract. & Analysis: 28 Days Aqueous and Solid
TCLP/SPLP Volatiles	8260		2 x 40 mL	Vials	Cool, 4°C	Extract. & Analysis: 14 Days to leaching, 14 days to analysis
Full Water TCLP/SPLP		Water	5 x 1L	Amber Glass	Cool, 4°C	See Above for Individual Analyses
			1x 1L	Plastic		
			2 x 40 mL	Glass Vials		
Full Soil TCLP/SPLP		Solid	2 x 8 oz + 1x 4	Glass Jars		
AIR						
Volatile Organics	TO3	Air	1x 1L	Tedlar Bag	None	72 Hours
Solids and soils may be analyzed for the above analytes with a general requirement of approximately 100 grams (60 ml) per analyte, or in combinations of analytes in 1-300 ml						
¹ Multiple analyses can be performed from a single container, please contact SGS Orlando for guidance. ² Pre-weighed methanol preserved and/or DI water vials are available upon request (Method 5035 preservation) for volatile analysis. ³ For South Carolina EPA 8000 Series, use 2 x 1L Amber Glass Bottles preserved as noted.						

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INORGANIC ANALYSIS

ANALYSIS	ANALYTICAL METHOD	MINIMUM VOLUME	CONTAINER TYPE	REQUIRED PRESERVATIVE	HOLDING TIME FROM DATE and TIME SAMPLED
IMMEDIATE TO 48 HOURS					
pH	SM 4500-H; EPA 9040C	100 mL	Plastic, Glass	Cool, 4°C	15 minutes, Field Parameter
Biochemical Oxygen Demand	SM 5210B	1L	Plastic, Glass	Cool, 4°C	48 Hours
Color	SM 2120B	100 mL	Plastic, Glass	Cool, 4°C	24 Hours
Ferrous Iron (Fe ²⁺)	SM 3500-Fe B	100 mL	Plastic	Cool, 4°C	15 minutes, Field Parameter
Hexavalent Chromium	EPA 716A/7199	500 mL	Plastic, Glass	Cool, 4°C	24 Hours
Nitrate Nitrogen; Nitrite Nitrogen	EPA 300/9056A	50 mL	Plastic, Glass	Cool, 4°C	48 Hours
Nitrate Nitrogen; Nitrite Nitrogen	EPA 9056A	4 oz	Glass	Cool, 4°C	48 Hours
Nitrite Nitrogen	EPA 353.2	50 mL	Plastic, Glass	Cool, 4°C	48 Hours
Orthophosphate	EPA 365.3	100 mL	Plastic, Glass	Cool, 4°C	Field Filtered 15 minutes, 48 Hours
Sulfite	SM 4500SO3	200 mL	Plastic, Glass	Cool, 4°C	15 minutes, Field Parameter
Total Residual Chlorine	SM 4500CL-F	200 mL	Plastic, Glass	Cool, 4°C	15 minutes, Field Parameter
Total Settleable Solids	SM 2540F	2 x 1L	Plastic, Glass	Cool, 4°C	48 Hours
Turbidity	EPA 80.1	100 mL	Plastic, Glass	Cool, 4°C	48 Hours
7 DAYS					
Sulfide	SM 4500S=F	3 x 250 mL	Plastic, Glass	NaOH to pH>=9 ZnAc/Cool, 4°C	7 Days
Total Dissolved Solids (TDS)	SM 2540C	250 mL	Plastic, Glass	Cool, 4°C	7 Days
Total Solids (TS)	SM 2540B	200 mL	Plastic, Glass	Cool, 4°C	7 Days
Total Suspended Solids (TSS)	SM 2540D	1L	Plastic, Glass	Cool, 4°C	7 Days
Total Volatile Solids (TVS)	SM 2540E/F	200 mL	Plastic, Glass	Cool, 4°C	7 Days
Total Volatile Suspended Solids (TVSS)	SM 2540E/F	1L	Plastic, Glass	Cool, 4°C	7 Days
GREATER THAN 7 DAYS					
Acidity/Alkalinity	SM 2310B	200 mL	Plastic, Glass	Cool, 4°C	14 Days
Amenable Cyanide	SW846 9012B	250 mL	Plastic, Glass	NaOH to pH>12/Cool, 4°C	14 Days
Ammonia Nitrogen	EPA 350.1	200 mL	Plastic, Glass	H ₂ SO ₄ to pH<2/Cool, 4°C	28 Days
Bulk Density	ASTM D2937-94	8 OZ	Glass	Cool, 4°C	Not Regulated
Carbonate, Bicarbonate, CO ₂ calculation	SM 2320B SM 4500-CO ₂	200 mL	Plastic, Glass	Cool, 4°C	14 Days
Chemical Oxygen Demand (COD)	SM 5220C	100 mL	Plastic, Glass	H ₂ SO ₄ to pH<2/Cool, 4°C	28 Days
Chloride, Sulfate, Bromide, Fluoride	EPA 300/9056A	100 mL	Plastic, Glass	Cool, 4°C	28 Days
Chloride, Sulfate, Bromide, Fluoride	EPA 9056A	4 oz	Glass	Cool, 4°C	28 Days
Cyanide AQ	EPA 335.4/9012B	100 mL	Plastic, Glass	NaOH to pH>12/Ascorbic Acid Cool, 4°C	14 Days
Cyanide SO	EPA 9012B	4 oz	Glass	Cool, 4°C	14 days
Hardness Calculation	SM 2340B	100 mL	Plastic, Glass	HNO ₃ to pH<2/Cool, 4°C	6 Months
Hexavalent Chromium	EPA 3060A/716A/7199	4 oz	Glass	Cool, 4°C	Digestion 30 days, Digestate 7 days
Hexavalent Chromium	EPA 218.6	100 mL	Plastic, Glass	Cool, 4°C, pH 9.3 - 9.7 with buffer	28 Days
Ignitability	SW846 1020B/C	100 mL	Plastic, Glass	Cool, 4°C	Not Regulated
Mercury	EPA 245.1/7470A	500 mL	Plastic, Glass	HNO ₃ to pH<2/Cool, 4°C	28 Days
Nitrate + Nitrite Nitrogen	EPA 353.2	100 mL	Plastic, Glass	H ₂ SO ₄ to pH<2/Cool, 4°C	28 Days
Nitrate Nitrogen	EPA 353.2	100 mL	Plastic, Glass	H ₂ SO ₄ to pH<2/Cool, 4°C	28 Days
Oil & Grease	EPA 1664A/B/9070A	2 x 1L	Glass	H ₂ SO ₄ to pH<2/Cool, 4°C	28 Days
Organic Nitrogen	TKN - AMN	500 mL	Plastic, Glass	H ₂ SO ₄ to pH<2/Cool, 4°C	28 Days
Oxidation Reduction Potential	ASTM D 1498-76	200 mL	Plastic, Glass	Cool, 4°C	Not Regulated
Paint Filter Test	EPA 9065	200 mL	Plastic, Glass	Cool, 4°C	Not Regulated
Percent Ash	ASTM D482-91/D2974-00	100 mL	Plastic, Glass	Cool, 4°C	Not Regulated
Phenols	EPA 420.4	250 mL	Glass	H ₂ SO ₄ to pH<2/Cool, 4°C	28 Days
Reactive Cyanide	SW846 Chapter 7	100 mL	Plastic, Glass	Cool, 4°C	Not Regulated
Reactive Sulfide	SW846 Chapter 7	100 mL	Plastic, Glass	Cool, 4°C	Not Regulated
Specific Conductance	EPA 120.1	200 mL	Plastic, Glass	Cool, 4°C	28 Days
Total Kjeldahl Nitrogen (TKN)	EPA 3512	100 mL	Plastic, Glass	H ₂ SO ₄ to pH<2/Cool, 4°C	28 Days
Total Metals	EPA 6010/6020/200.7/200.8	500 mL	Plastic, Glass	HNO ₃ to pH<2/Cool, 4°C	6 Months
Total Nitrogen	TKN +NO ₂ +NO ₃	500 mL	Plastic, Glass	H ₂ SO ₄ to pH<2/Cool, 4°C	28 Days
Total Phosphorus	EPA 365.3	200 mL	Plastic, Glass	H ₂ SO ₄ to pH<2/Cool, 4°C	28 Days
Total Organic Carbon SO	EPA 9060A	4 oz	Glass	Cool, 4°C	28 Days
Total, Dissolved Organic Carbon	SM 5310B/9060A	2 x 40 mL	Amber VOC Vials	HCl to pH<2/Cool, 4°C	28 Days

Solids and soils may be analyzed for the above analytes with a general requirement of approximately 100 grams (160 mL) per analyte, or in combinations of analytes in 1-300 mL bottle.

PPENDIX OF SIGNIFICANT CHANGES

Revision Date	Revision Number	Affected Section(s)	Revision Description
07/2023	22	References	Updated to current references; removed TNI 2009 throughout the document
07/2023	22	2.1.5	Short Hold form process updated
07/2023	22	2.2 and subsections	Editorial updates
07/2023	22	2.2.10	Added outside locker for clients' after hours deliveries
07/2023	22	2.3	Editorial updates
07/2023	22	2.4	Added Oil and Grease preservation check discussion
07/2023	22	2.4.8	Updated location of preservatives
07/2023	22	2.5	Editorial updates
07/2023	22	2.6	Editorial updates
07/2023	22	3.3	PFAS freezer added
07/2023	22	4.0	Safety and Pollution prevention section added, documentation moved to 5.0
07/2023	22	Attachments I through IV	revised
07/2023	22	Appendix of Significant Changes	Added
07/2023	22	SOP Acknowledgement Form	Added

SAMPLE RECEIPT AND STORAGE

SOP Acknowledgement Form

I have read and understand this SOP. I will not knowingly deviate from this approved SOP without approval of the Department Supervisor, QA Officer, or Technical Manager. If I notice any discrepancies between this SOP and the routine procedure, I will notify the Department Supervisor so that either the SOP or procedure can be changed. Furthermore, I understand that this SOP is property of SGS North America Inc. – Orlando and may not be **printed nor** duplicated in any manner.

Internal SOPs referenced within this SOP: QA002, QA004, QA021, QA033, and SAM108, current revisions

Print Name	Signature	Date

Print the SOP Acknowledgement Form, sign, and submit to the SGS Orlando QA department.



SAMPLE AND LABORATORY WASTE DISPOSAL

Prepared by: Jonathan Miller Date: 08/21/2020

Approved by: Svetlana Izosimova Date: 08/24/2020

Annual Review

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Reviewed by: _____ Date: _____

Document Control

Issued to: QA Department Date: 08/24/2020

Issued to: Sample Management (Shipping) - digital Date: * 08/25/2020

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Issued to: _____ Date: _____

Effective 7 days after “*” date

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TITLE: SAMPLE AND LABORATORY WASTE DISPOSAL

REFERENCES: Florida DEP Hazardous Waste; 40 CFR, Part 261

REVISED SECTIONS: Multiple rewrites in Procedure – sec. 4.1, 4.2, 4.3; 4.5.2, Segregation of Foreign soils – see 4.2.5; Storage and Disposal of samples in “HOLD” status – sec. 4.7 (new), corrected facility name throughout the document; changed lab status to Large Quantity Generator, added detailed waste profiles to the back of 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 - 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 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 samples.
- 4.1.3 Non-hazardous samples are emptied into a drum. Once a series of satellite drums are full, they are pumped into a 500 gallon holding tank. Once the large holding tank is full, the tank is neutralized with sodium bicarbonate to pH 5-9. The

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contracted waste disposal company is then contacted to arrange for an on-site transfer. The contents are profiled as requested by the disposal firm 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 are disposed of separately. The liquid drum, when full, is then handled in the same way as described in section 4.1.3.
- 4.1.5 Hazardous waste is segregated into into multiple waste streams to be handled in the appropriate manner by the Contract Disposal Company used by SGS-Orlando.
- 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 as defined above.
 - 4.2.2 When the drums are full, they are labeled accordingly, and the vendor contacted for removal.
 - 4.2.3 Some samples, on a case by case basis, will be returned to the client for disposal, or may need specialized disposal such as LabPak. This would include samples of a proprietary nature, or those that contain excessive amounts of regulated or unregulated materials. (ie: Very high PFC content, PCBs in excess of 50ppm, elemental samples, etc.)
 - 4.2.4 Foreign soil samples (FSS) come in vials (volatile organic analysis) or jars. These soils are segregated in in lockable cage (see also SAM101 and SAM109, current revisions)
 - 4.2.5 After minimum 60-day hold period, but not to exceed 6 months, these FSS are disposed of in the following manner.
 - 4.2.5.1 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.

4.2.5.2 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 labeled accordingly, and the vendor contacted for removal. Drums have a 6 month expiration time. If the drum is not full by then it is picked up by our contract disposal company.

4.3.3 Samples may, 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 - Orlando direct use. A lock and key has been installed to keep the containers use limited to SGS - Orlando only.

4.4.2 Containers from samples deemed hazardous are disposed of into the Hazardous waste solids drum or other appropriate waste stream.

4.4.3 The contracted vendor 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. As of the date of this SOP, SGS-Orlando is separating wastes into several different waste streams. General descriptions of the primary stream types are below. A more descriptive list along with the corresponding profile numbers and primary generators within the labs can be found at the end of this document. If/when new profiles are needed, the contract vendor must be contacted and the appropriate information supplied.

Chlorinated Waste- Methylene Chloride

Non-Chlorinated Waste - Hexane, Methanol, and mixed solvents

Sodium Sulfate/Used Charcoal- Charcoal and paper filters used in the filtering of samples.

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Non Hazardous Aqueous Vials - Primarily Acid Vials.

Hazardous Flammable Vials - Methylene Chloride, Hexane.

Hazardous Aqueous waste - High Odor Samples, Lachat Waste.

Non Hazardous Soil - Soils.

Hazardous Solid Waste - .

Non-Aqueous/Oil Samples-

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 - Orlando is considered a "Large 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 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 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, personnel must first confirm with management (Sample Management Supervisor, Laboratory Manager or Operations Manager) that samples can indeed be disposed of.
 - 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.

WASTE PROFILES			
NAME (Dept.)	DESCRIPTION	PROFILE NUMBER	Primary Constituents
Recovered Methylene Chloride/Chlorinated Solvents (EXT)	Waste Methylene Chloride (aka: Dichloromethane, DCM, CH ₂ Cl ₂ , Me-Cl) generated through extraction and analysis process. May be from Buchi units and or wastes, or rinse products from Extractions or Semi-Volatiles labs. This waste stream should contain <1.0% material that is NOT Me-Cl.	D191839TPA	Should be >99% Me-Cl.
Solvent Contaminated Vials (SEMIS)	Glass Prep or Autosampler vials that may have residual solvent and/or sample in them. Solvents may be chlorinated or non-chlorinated in nature. Can be for Aq or solid samples.	D191838TPA	Could contain Acetone, Hexane, Acetonitrile, Me-Cl, Me-OH, Ether, etc.
Methanol Contaminated Plastic Vials (LCMS)	Plastic Prep or Autosampler vials that may have residual solvent and/or sample in them. Solvents may be chlorinated or non-chlorinated in nature. Can be for Aq or solid samples. Waste stream is primarily comprised of Sample vials used for LCMS prep and analysis.	F191708TPA	Waste contains mainly a mixture of Me-OH, water and spent samples.
Non-Chlorinated Solvent (EXT SEMIS LCMS)	Waste Solvent that is non-chlorinated. The bulk of this waste stream is generated as eluent for LCMS, but it can also include the flammable wastes generated in Semis and Extractions as well. FLAMMABLES.	D190752TPA	Typically >90% Me-OH, but can also contain up to 5% of other non-chlorinated solvents such as Acetone, Acetonitrile, Hexane, Ether, etc.
Sodium Sulphate contaminated with Methylene Chloride (EXT)	This is the product of the drying step in Extractions. It consists primarily of Na ₂ SO ₄ solids along with the accompanying filter paper and waste sample dregs that have been rinsed with Me-Cl. Waste stream is typically gathered in small 2gal pails with liners inside them. The liners and waste are collected, and the pails are then reused with fresh liners.	D191841TPA	Waste is comprised almost entirely of sodium sulphate. No other solvents should be in this stream except Me-Cl.
Mixed inorganic Acids (MET GEN)	Mixed inorganic acids (HCl, HNO ₃ , H ₂ SO ₄ , H ₃ PO ₄ , etc.) that have been primarily used in the Inorganics department for digestion and or sample dissolution. Waste is typically more concentrated than preserved samples, and is not neutralized before disposal.	F190687TPA	Metals digests and ICP waste.
Non-Regulated Soil (Non-APHIS)	All spent soil samples that are not foreign in nature.	ACCL 003	Samples. Soils samples.
3-Door Waste Samples	Samples from 3-Door storage. Samples mainly comprised of contaminated solids that have petroleum type products on them such as spill pads, soaked rags, wipes, filters, soils and papers in plastic bags/containers. The samples may/will have free liquids that may be petroleum in nature.	J191619TPA	Samples. 3-Door Material. Solids and liquids.
APHIS Soils	Foreign Soils. Spent samples and lab items that have come into contact with foreign soils during the process of analysis. All items are sequestered from other waste streams!	ACCL 004	Expired 10-24-19
Broken Glass	Labware that has broken during standard usage and/or disposable glassware within the laboratories. May include pipets, beakers, jars, etc.	ACCL 002	Broken glass from labs. Beakers, cylinders, glass jars, etc.
Used Oil	Spent oil from the labs. Oils used for production purposes (pumps and standards), as well as spent samples and their associated wastes that are oil based.	J190773TPA	Samples. Used Oils. Samples and lab oils used in pumps, for stds, etc.
Used Photo Developer Solution	Spent photo development solutions. Typically containing very high amounts of heavy metals (Ag) and basic (pH>10) in nature. Separated from all other metals waste streams.	J191664TPA	Samples. Spent photo development solutions. Typically from samples.
Pyridine	Waste Pyridine solvent. Diluted with H ₂ O. Waste is generated in Inorganics department via the Lachat instrumentation.	ACCL 007	Pyridine and H ₂ O

**CONTROLLED COPY
DO NOT DUPLICATE**

ATTACHMENT B

Field Documentation Forms

1. Example Field Daily Logbook
2. Water Level Field Data Worksheet
3. Passive Diffusion Bag (PDB) 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. Fort Ord Munitions and Explosives of Concern (MEC) Incident Reporting Form
8. Ahtna Chain of Custody (Water / Soil)
9. Example Sample Labels
10. Post-Treatment Parameter Monitoring Form

Former Ft. Ord, CA

3/1/2020

1Q 2020 Groundwater Monitoring
Project #Weather: (am) Clear, cool 48°
(pm) Overcast, 63°

Team #2

Ahtna Rep. - Shaelyn Hession

Blaine Tech Rep. - Ross Mikovich

0800 - Arrived at MW-002-18-A

W.L. = 78.40 T.D. = 110.6

0810 - Sample collected from station #2
#2010Y002100F

0815 - Duplicate sample #2010Y002101D

0820 - Labeled Trip Blank #2010Y002102A

Lid requires new paint & I.D.

0835 - Arrived at MW-BW-75-A

W.L. = 84.32 T.D. = 126.3

Required new lock - replaced.

0845 - Arrived at MW-BW-14-A

W.L. = 63.11 T.D. = 97.5

3/1/2020

1Q 2020 FO GLWM

Team #2

S. Hession

R. Mikovich

0900 - Arrived at MW-BW-07-180

W.L. = 121.63 T.D. = 194.6

0910 - Sample collected from station #1
#2010Y00BW103F

0915 - Station #2 sample #2010Y00BW104F

0920 - Station #3 sample #2010Y00BW105F

0925 - Station #4 sample #2010Y00BW106F

0930 - Station #5 sample #2010Y00BW107F

No PDB's installed.

1000 - Return to staging area.

Unload equipment

QC all samples, placed in refrigerator.

1030 - Team #2 offsite

~~Steve Holley~~

Water Level Measurements

Job #:

Event:

Site:

[illegible]

Ahtna

Task #: _____

Lab: SGS

Analysis: 8260 SIM

Sampled By: _____

Water Level Indicator Serial #: _____ **Correction:** _____

Quality Control Samples:		
Type	Date	Sample Number

General Comments:

**Groundwater Sampling
and Pressure Levels Form
for Westbay Wells**

Ahtna

Project Number: _____

Task Manager: _____

Technicians: _____

Recorded By: _____ / _____
(Signature) (Initials)

Reviewed By: _____ / _____
(Signature) (Initials)

Well Name: MP - BW -

Sample Date: / /

Barometric Pressure: _____

Sample Time: Start: _____
Finish: _____

Sample # First Port: _____

Client: USACE

Location: Former Fort Ord

Probe Type: West Bay

DTW: _____

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 #	
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>			
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>			
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>			
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>			
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>			
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>			
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>			
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>			

General Comments: _____ Cooler Temp: _____ °C

QC Sample # _____ Associated Sample: _____

Fort Ord Groundwater Monitoring Program
Water Level Indicator Calibration by Steel Tape

Event:	
Well #:	
Steel Tape DTW:	
Date:	

Serial #	Measured DTW	Calibration Correction

Reviewed By:	
Date:	



Site Safety Tailgate Meeting

Installation/Site Name		Project Number	
Event Name		Safety Representative	
Date		Field Team Leader	
Weather Forecast:			

Participants (attach loose-leaf sheet if additional space is needed)

Printed Name and Initials	Affiliation	Role	Signature

Scope of Today's Work

--

Health and Safety Topics Discussed (✓ applicable topics)

<input type="checkbox"/> Weather Factors	<input type="checkbox"/> Chem. of Concern	<input type="checkbox"/> Lifting Safety	<input type="checkbox"/> Sanitation
<input type="checkbox"/> AHA Review	<input type="checkbox"/> PPE Requirements	<input type="checkbox"/> Recent near miss/injuries/lessons	<input type="checkbox"/> _____
<input type="checkbox"/> Site emergency SOP, rally point, etc.	<input type="checkbox"/> Slip/Trip/Fall Hazards	<input type="checkbox"/> BBS Hazard Triggers ^[1]	<input type="checkbox"/> _____
<input type="checkbox"/> Changed Conditions	<input type="checkbox"/> Site Controls	<input type="checkbox"/> BBS Trigger Controls ^[2]	<input type="checkbox"/> _____
<input type="checkbox"/> Equipment Hazards	<input type="checkbox"/> Biological Hazards	<input type="checkbox"/> BBS Trigger Controls ^[2]	<input type="checkbox"/> _____
<input type="checkbox"/> Equipment Hazards	<input type="checkbox"/> COVID 19 SOPs	<input type="checkbox"/> Traffic Control	<input type="checkbox"/> _____

[1] Behavior-based Safety Hazard Triggers: Distractions, rushing, short-cuts, frustration, exhaustion, complacency, anger, multi-tasking, not focusing on task
[2] Behavior-based Safety Trigger Controls: Communicating, accountability, patience, relaxation techniques, healthy lifestyle, and adequate sleep

Comments:

The individual in the Safety Representative role acknowledges that the checked (✓) topics were discussed.

Name (Print) _____ Signature _____ Date _____

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:

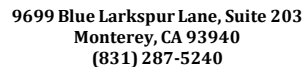
Initial when completed	Mon– Thu (6 a.m. – 5 p.m.) Contact and FAX Form to:	Contact Number	Date & Time Called
	USACE Ordnance Safety Specialist or MMRP Site Safety Manager	Ph: (831) 884-9925 ext.226 Cell: (831) 760-2571 Fax:(831) 884-9030 Ph: (831) 242-7919 Fax:(831) 242-7019 Cell: (831) 760-2575	
	Fri – Sun (24 Hours) 60 th Civ Engr Sqdn EOD	Phone: (707) 424-5517	
	Note: If 60 th 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):	



WATER / SOIL

Carbon Copies: White - Laboratory Yellow - Ahtna

[illegible]

Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: _____ Time: _____
Sample #:

Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: _____ Time: _____
Sample #:

Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: _____ Time: _____
Sample #:

Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: _____ Time: _____
Sample #:

Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: _____ Time: _____
Sample #:

Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: _____ Time: _____
Sample #:

Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: _____ Time: _____
Sample #:

Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: _____ Time: _____
Sample #:

Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: _____ Time: _____
Sample #:

Ahtna
Ft Ord GW Monitoring-
Samplers:
Date: _____ Time: _____
Sample #:



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:

[illegible]

NOTES:

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 C

Three Phase Quality Control Process and Documentation



Preparatory Inspections

Project Number		Field Team Leader	
Installation/Site		QC Lead	
Event Name		Project Lead	
Date		Safety Representative	

Meeting Attendees *(list additional attendees on second page)*

Name and Initials	Event Role/Position	Organization

Preparatory Steps

Planning Documents/Submittals Completed with Approvals	
Item	Comments
Planning Documents/Submittals Reviewed by Field Team (Ahtna and Subcontractors)	
Item	Comments
Preliminary Work Completed in Accordance with Plans	
Item	Comments



Preparatory Inspections

DFOW/Tasks Discussed, and Field Team to Implement Work According to Plans	
Item	Comments

Equipment/Supplies/Materials Procured, Available, in Working Order, and Conforming to Standards (list)	
Item	Comments

Action Items

--

Additional Meeting Attendees

Name and Initials	Event Role/Position	Organization

Approved By

Initial _____ Signature _____ Date _____
--



Initial/Follow-Up QC Inspections

Project Number		Field Team Leader	
Installation/Site		QC Lead	
Event Name		Project Lead	

List of Applicable Inspection Items

Item	Inspection	Spec. Document and/or Section	QC Category & Frequency ^[1]
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

[1] (W) Workmanship; (S) Safety; (M/E) Materials and Equipment; (P) Plan Compliance. Depending on the item, list one or more categories (W, S, M/E, or P) and specify the frequency of follow-up inspections.

Project Lead Approval

Initial _____	Signature _____	Date _____
---------------	-----------------	------------



Initial/Follow-Up QC Inspections

Project Number											
Installation/Site						QC Representative					
Event Name						Date of Inspection(s)					
Item Number and Inspection	Phase	Inspect. Type ^[2]				Basis ^[3]	Variance	Deficient	Inspector		
	(I/F) ^[1]	W	S	M/E	P	E/N/P/O	(Y/N) ^[4]	(Y/N) ^[5]	Initial/Time		
Details:											
Details:											
Details:											
Details:											
Details:											
Details:											

Notes:

[1] **Phase:** Initial (I); Follow-up (F)

[2] **Inspection Type:** (W) Workmanship; (S) Safety; (M/E) Materials/Equipment; (P) Plan Compliance

[3] **Basis:** (E) Existing DFOW or task; (N) New DFOW or task; (P) New personnel; (O) Other (specify) _____

[4] **Variance:** Contact FTL/PL for variance approval, document resolution. Complete field form SWE-FFRM-004, "Work Variance" as directed by FTL..

[5] **Deficiency:** Contact FTL/PL before proceeding with work, note resolution. Complete field form SWE-FFRM-102, "Corrective Action" as directed.

Approved By

Initial _____	Signature _____	Date _____
---------------	-----------------	------------

ATTACHMENT D

ADR Library and Qualifier Tables

Project Target Analyte Reporting Limit, Blank Contamination, and Lab & Field Duplicate RPD Criteria

eQapp Name: FtOrd_UFP_QAPP_Rev9_3
Description: Quality Assurance Project Plan
 Former Fort Ord, California
 Volume I Appendix A

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	25	2.0	ug/L	5.00	20.00	30.00
LEAD	7439-92-1	10	2.0	ug/L	5.00	20.00	30.00
Method: EPA6010D Matrix: AQ							
ANTIMONY	7440-36-0	6.0	5.0	ug/L	5.00	20.00	30.00
COPPER	7440-50-8	25	2.0	ug/L	5.00	20.00	30.00
LEAD	7439-92-1	10	2.0	ug/L	5.00	20.00	30.00
Method: EPA8260B Matrix: AQ							
1,1,1,2-TETRACHLOROETHANE	630-20-6	0.300	0.0380	ug/L	5.00	20.00	30.00
1,1,1-TRICHLOROETHANE	71-55-6	0.200	0.0250	ug/L	5.00	20.00	30.00
1,1,2,2-TETRACHLOROETHANE	79-34-5	0.200	0.0560	ug/L	5.00	20.00	30.00
1,1,2-TRICHLOROETHANE	79-00-5	0.200	0.0700	ug/L	5.00	20.00	30.00
1,1-DICHLOROETHANE	75-34-3	0.200	0.0250	ug/L	5.00	20.00	30.00
1,1-DICHLOROETHYLENE	75-35-4	0.200	0.0350	ug/L	5.00	20.00	30.00
1,1-DICHLOROPROPENE	563-58-6	0.200	0.0360	ug/L	5.00	20.00	30.00
1,2,3-TRICHLOROBENZENE	87-61-6	0.500	0.149	ug/L	5.00	20.00	30.00
1,2,3-TRICHLOROPROPANE	96-18-4	0.200	0.0500	ug/L	5.00	20.00	30.00
1,2,4-TRICHLOROBENZENE	120-82-1	0.500	0.172	ug/L	5.00	20.00	30.00
1,2,4-TRIMETHYLBENZENE	95-63-6	0.300	0.0720	ug/L	5.00	20.00	30.00
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	2.00	0.440	ug/L	5.00	20.00	30.00
1,2-DIBROMOETHANE	106-93-4	0.100	0.0250	ug/L	5.00	20.00	30.00
1,2-DICHLOROBENZENE	95-50-1	0.300	0.0380	ug/L	5.00	20.00	30.00
1,2-DICHLOROETHANE	107-06-2	0.200	0.0430	ug/L	5.00	20.00	30.00
1,2-DICHLOROPROPANE	78-87-5	0.200	0.0600	ug/L	5.00	20.00	30.00
1,3,5-TRIMETHYLBENZENE	108-67-8	0.500	0.152	ug/L	5.00	20.00	30.00
1,3-DICHLOROBENZENE	541-73-1	0.300	0.0500	ug/L	5.00	20.00	30.00
1,3-DICHLOROPROPANE	142-28-9	0.200	0.0250	ug/L	5.00	20.00	30.00

Target Analyte Name	Analyte Label (CAS)	Quantitation Limit	Detection Limit	Units	Blank Contamination Rule	LabDup RPD	FieldDup RPD
Method: EPA8260B		Matrix: AQ					
1,4-DICHLOROBENZENE	106-46-7	0.300	0.0500	ug/L	5.00	20.00	30.00
2,2-DICHLOROPROPANE	594-20-7	0.500	0.0600	ug/L	5.00	20.00	30.00
2-CHLOROTOLUENE	95-49-8	0.500	0.116	ug/L	5.00	20.00	30.00
4-CHLOROTOLUENE	106-43-4	0.300	0.0500	ug/L	5.00	20.00	30.00
4-ISOPROPYLTOLUENE	99-87-6	0.500	0.146	ug/L	5.00	20.00	30.00
BENZENE	71-43-2	0.200	0.0300	ug/L	5.00	20.00	30.00
BROMOBENZENE	108-86-1	0.200	0.0380	ug/L	5.00	20.00	30.00
BROMOFORM	75-25-2	0.500	0.157	ug/L	5.00	20.00	30.00
BROMOMETHANE	74-83-9	0.500	0.0620	ug/L	5.00	20.00	30.00
CARBON TETRACHLORIDE	56-23-5	0.200	0.0250	ug/L	5.00	20.00	30.00
CHLOROBENZENE	108-90-7	0.200	0.0250	ug/L	5.00	20.00	30.00
Chlorobromomethane	74-97-5	0.200	0.0250	ug/L	5.00	20.00	30.00
CHLORODIBROMOMETHANE	124-48-1	0.200	0.0550	ug/L	5.00	20.00	30.00
CHLOROETHANE	75-00-3	0.500	0.0960	ug/L	5.00	20.00	30.00
CHLOROFORM	67-66-3	0.200	0.0300	ug/L	5.00	20.00	30.00
CHLOROMETHANE	74-87-3	0.500	0.0680	ug/L	5.00	20.00	30.00
CIS-1,2-DICHLOROETHYLENE	156-59-2	0.200	0.0550	ug/L	5.00	20.00	30.00
CIS-1,3-DICHLOROPROPENE	10061-01-5	0.200	0.0900	ug/L	5.00	20.00	30.00
DIBROMOMETHANE	74-95-3	0.200	0.0620	ug/L	5.00	20.00	30.00
DICHLOROBROMOMETHANE	75-27-4	0.200	0.0600	ug/L	5.00	20.00	30.00
DICHLORODIFLUOROMETHANE	75-71-8	0.400	0.128	ug/L	5.00	20.00	30.00
ETHYLBENZENE	100-41-4	0.200	0.0300	ug/L	5.00	20.00	30.00
HEXACHLOROBUTADIENE	87-68-3	0.500	0.0670	ug/L	5.00	20.00	30.00
ISOPROPYLBENZENE	98-82-8	1.00	0.187	ug/L	5.00	20.00	30.00
METHYL TERT-BUTYL ETHER	1634-04-4	0.300	0.0700	ug/L	5.00	20.00	30.00
METHYLENE CHLORIDE	75-09-2	5.00	1.20	ug/L	10.00	20.00	30.00
m-Xylene & p-Xylene	179601-23-1	0.500	0.115	ug/L	5.00	20.00	30.00
NAPHTHALENE	91-20-3	1.00	0.221	ug/L	5.00	20.00	30.00
N-BUTYLBENZENE	104-51-8	1.00	0.225	ug/L	5.00	20.00	30.00
N-PROPYLBENZENE	103-65-1	0.300	0.0910	ug/L	5.00	20.00	30.00
O-XYLENE	95-47-6	0.500	0.147	ug/L	5.00	20.00	30.00
SEC-BUTYLBENZENE	135-98-8	1.00	0.168	ug/L	5.00	20.00	30.00
STYRENE	100-42-5	1.00	0.192	ug/L	5.00	20.00	30.00

Target Analyte Name	Analyte Label (CAS)	Quantitation Limit	Detection Limit	Units	Blank Contamination Rule	LabDup RPD	FieldDup RPD
Method: EPA8260B Matrix: AQ							
TERT-BUTYLBENZENE	98-06-6	0.500	0.257	ug/L	5.00	20.00	30.00
TETRACHLOROETHYLENE	127-18-4	0.500	0.0840	ug/L	5.00	20.00	30.00
TOLUENE	108-88-3	0.200	0.0500	ug/L	5.00	20.00	30.00
TRANS-1,2-DICHLOROETHENE	156-60-5	0.200	0.0330	ug/L	5.00	20.00	30.00
TRANS-1,3-DICHLOROPROPENE	10061-02-6	0.200	0.0920	ug/L	5.00	20.00	30.00
Trichloroethylene	79-01-6	0.200	0.0660	ug/L	5.00	20.00	30.00
TRICHLOROFLUOROMETHANE	75-69-4	0.500	0.0430	ug/L	5.00	20.00	30.00
VINYL CHLORIDE	75-01-4	0.0200	0.0130	ug/L	5.00	20.00	30.00
Method: EPA8260-SIM Matrix: AQ							
1,1,1,2-TETRACHLOROETHANE	630-20-6	0.300	0.0380	ug/L	5.00	20.00	30.00
1,1,1-TRICHLOROETHANE	71-55-6	0.200	0.0250	ug/L	5.00	20.00	30.00
1,1,2,2-TETRACHLOROETHANE	79-34-5	0.200	0.0560	ug/L	5.00	20.00	30.00
1,1,2-TRICHLOROETHANE	79-00-5	0.200	0.0700	ug/L	5.00	20.00	30.00
1,1-DICHLOROETHANE	75-34-3	0.200	0.0250	ug/L	5.00	20.00	30.00
1,1-DICHLOROETHYLENE	75-35-4	0.200	0.0350	ug/L	5.00	20.00	30.00
1,1-DICHLOROPROPENE	563-58-6	0.200	0.0360	ug/L	5.00	20.00	30.00
1,2,3-TRICHLOROBENZENE	87-61-6	0.500	0.149	ug/L	5.00	20.00	30.00
1,2,3-TRICHLOROPROPANE	96-18-4	0.200	0.0500	ug/L	5.00	20.00	30.00
1,2,4-TRICHLOROBENZENE	120-82-1	0.500	0.172	ug/L	5.00	20.00	30.00
1,2,4-TRIMETHYLBENZENE	95-63-6	0.300	0.0720	ug/L	5.00	20.00	30.00
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	2.00	0.440	ug/L	5.00	20.00	30.00
1,2-DIBROMOETHANE	106-93-4	0.100	0.0250	ug/L	5.00	20.00	30.00
1,2-DICHLOROBENZENE	95-50-1	0.300	0.0380	ug/L	5.00	20.00	30.00
1,2-DICHLOROETHANE	107-06-2	0.200	0.0430	ug/L	5.00	20.00	30.00
1,2-DICHLOROPROPANE	78-87-5	0.200	0.0600	ug/L	5.00	20.00	30.00
1,3,5-TRIMETHYLBENZENE	108-67-8	0.500	0.152	ug/L	5.00	20.00	30.00
1,3-DICHLOROBENZENE	541-73-1	0.300	0.0500	ug/L	5.00	20.00	30.00
1,3-DICHLOROPROPANE	142-28-9	0.200	0.0250	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
1,4-DICHLOROBENZENE	106-46-7	0.300	0.0500	ug/L	5.00	20.00	30.00
2,2-DICHLOROPROPANE	594-20-7	0.500	0.0600	ug/L	5.00	20.00	30.00
2-CHLOROTOLUENE	95-49-8	0.500	0.116	ug/L	5.00	20.00	30.00

Target Analyte Name	Analyte Label (CAS)	Quantitation Limit	Detection Limit	Units	Blank Contamination Rule	LabDup RPD	FieldDup RPD
Method: EPA8260-SIM		Matrix: AQ					
4-CHLOROTOLUENE	106-43-4	0.300	0.0500	ug/L	5.00	20.00	30.00
4-ISOPROPYLTOLUENE	99-87-6	0.500	0.146	ug/L	5.00	20.00	30.00
BENZENE	71-43-2	0.200	0.0300	ug/L	5.00	20.00	30.00
BROMOBENZENE	108-86-1	0.200	0.0380	ug/L	5.00	20.00	30.00
BROMOFORM	75-25-2	0.500	0.157	ug/L	5.00	20.00	30.00
BROMOMETHANE	74-83-9	0.500	0.0620	ug/L	5.00	20.00	30.00
CARBON TETRACHLORIDE	56-23-5	0.200	0.0250	ug/L	5.00	20.00	30.00
CHLOROBENZENE	108-90-7	0.200	0.0250	ug/L	5.00	20.00	30.00
Chlorobromomethane	74-97-5	0.200	0.0250	ug/L	5.00	20.00	30.00
CHLORODIBROMOMETHANE	124-48-1	0.200	0.0550	ug/L	5.00	20.00	30.00
CHLOROETHANE	75-00-3	0.500	0.0960	ug/L	5.00	20.00	30.00
CHLOROFORM	67-66-3	0.200	0.0300	ug/L	5.00	20.00	30.00
CHLOROMETHANE	74-87-3	0.500	0.0680	ug/L	5.00	20.00	30.00
CIS-1,2-DICHLOROETHYLENE	156-59-2	0.200	0.0550	ug/L	5.00	20.00	30.00
CIS-1,3-DICHLOROPROPENE	10061-01-5	0.200	0.0900	ug/L	5.00	20.00	30.00
DIBROMOMETHANE	74-95-3	0.200	0.0620	ug/L	5.00	20.00	30.00
DICHLOROBROMOMETHANE	75-27-4	0.200	0.0600	ug/L	5.00	20.00	30.00
DICHLORODIFLUOROMETHANE	75-71-8	0.400	0.128	ug/L	5.00	20.00	30.00
ETHYLBENZENE	100-41-4	0.200	0.0300	ug/L	5.00	20.00	30.00
HEXACHLOROBUTADIENE	87-68-3	0.500	0.0670	ug/L	5.00	20.00	30.00
ISOPROPYLBENZENE	98-82-8	1.00	0.187	ug/L	5.00	20.00	30.00
METHYL TERT-BUTYL ETHER	1634-04-4	0.300	0.0700	ug/L	5.00	20.00	30.00
METHYLENE CHLORIDE	75-09-2	5.00	1.20	ug/L	10.00	20.00	30.00
m-Xylene & p-Xylene	179601-23-1	0.500	0.115	ug/L	5.00	20.00	30.00
NAPHTHALENE	91-20-3	1.00	0.221	ug/L	5.00	20.00	30.00
N-BUTYLBENZENE	104-51-8	1.00	0.225	ug/L	5.00	20.00	30.00
N-PROPYLBENZENE	103-65-1	0.300	0.0910	ug/L	5.00	20.00	30.00
O-XYLENE	95-47-6	0.500	0.147	ug/L	5.00	20.00	30.00
SEC-BUTYLBENZENE	135-98-8	1.00	0.168	ug/L	5.00	20.00	30.00
STYRENE	100-42-5	1.00	0.192	ug/L	5.00	20.00	30.00
TERT-BUTYLBENZENE	98-06-6	0.500	0.257	ug/L	5.00	20.00	30.00
TETRACHLOROETHYLENE	127-18-4	0.500	0.0840	ug/L	5.00	20.00	30.00
TOLUENE	108-88-3	0.200	0.0500	ug/L	5.00	20.00	30.00

Target Analyte Name	Analyte Label (CAS)	Quantitation Limit	Detection Limit	Units	Blank Contamination Rule	LabDup RPD	FieldDup RPD
Method: EPA8260-SIM Matrix: AQ							
TRANS-1,2-DICHLOROETHENE	156-60-5	0.200	0.0330	ug/L	5.00	20.00	30.00
TRANS-1,3-DICHLOROPROPENE	10061-02-6	0.200	0.0920	ug/L	5.00	20.00	30.00
Trichloroethylene	79-01-6	0.200	0.0660	ug/L	5.00	20.00	30.00
TRICHLOROFLUOROMETHANE	75-69-4	0.500	0.0430	ug/L	5.00	20.00	30.00
VINYL CHLORIDE	75-01-4	0.0200	0.0130	ug/L	5.00	20.00	30.00
Method: EPA9056A Matrix: AQ							
CHLORIDE	16887-00-6	250	0.80	mg/L	5.00	20.00	30.00
Method: SW846 6010D Matrix: AQ							
ANTIMONY	7440-36-0	6.0	5.0	ug/L	5.00	20.00	30.00
COPPER	7440-50-8	25	2.0	ug/L	5.00	20.00	30.00
LEAD	7439-92-1	10	2.0	ug/L	5.00	20.00	30.00

Project Accuracy and Precision Report

eQapp Name: FtOrd_UFP_QAPP_Rev9_3
Description: Quality Assurance Project Plan
 Former Fort Ord, California
 Volume I Appendix A

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	50.00	88.00	113.00		20.00
COPPER	7440-50-8	50.00	86.00	114.00		20.00
LEAD	7439-92-1	50.00	86.00	113.00		20.00
QC Type: MS						
ANTIMONY	7440-36-0	30.00	88.00	113.00		20.00
COPPER	7440-50-8	30.00	86.00	114.00		20.00
LEAD	7439-92-1	30.00	86.00	113.00		20.00
Method: EPA6010D Matrix: AQ						
QC Type: LCS						
ANTIMONY	7440-36-0	50.00	88.00	113.00		20.00
COPPER	7440-50-8	50.00	86.00	114.00		20.00
LEAD	7439-92-1	50.00	86.00	113.00		20.00
QC Type: MS						
ANTIMONY	7440-36-0	30.00	88.00	113.00		20.00
COPPER	7440-50-8	30.00	86.00	114.00		20.00
LEAD	7439-92-1	30.00	86.00	113.00		20.00
Method: EPA8260B Matrix: AQ						
QC Type: LCS						
1,1,1,2-TETRACHLOROETHANE	630-20-6	10.00	78.00	124.00		20.00
1,1,1-TRICHLOROETHANE	71-55-6	10.00	74.00	131.00		20.00
1,1,2,2-TETRACHLOROETHANE	79-34-5	10.00	71.00	121.00		20.00

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: EPA8260B						
Matrix: AQ						
QC Type: LCS						
1,1,2-TRICHLOROETHANE	79-00-5	10.00	80.00	119.00		20.00
1,1-DICHLOROETHANE	75-34-3	10.00	77.00	125.00		20.00
1,1-DICHLOROETHYLENE	75-35-4	10.00	71.00	131.00		20.00
1,1-DICHLOROPROPENE	563-58-6	10.00	79.00	125.00		20.00
1,2,3-TRICHLOROBENZENE	87-61-6	10.00	69.00	129.00		20.00
1,2,3-TRICHLOROPROPANE	96-18-4	10.00	73.00	122.00		20.00
1,2,4-TRICHLOROBENZENE	120-82-1	10.00	69.00	130.00		20.00
1,2,4-TRIMETHYLBENZENE	95-63-6	10.00	76.00	124.00		20.00
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	10.00	62.00	128.00		20.00
1,2-DIBROMOETHANE	106-93-4	10.00	77.00	121.00		20.00
1,2-DICHLOROBENZENE	95-50-1	10.00	80.00	119.00		20.00
1,2-DICHLOROETHANE	107-06-2	10.00	73.00	128.00		20.00
1,2-DICHLOROPROPANE	78-87-5	10.00	78.00	122.00		20.00
1,3,5-TRIMETHYLBENZENE	108-67-8	10.00	75.00	124.00		20.00
1,3-DICHLOROBENZENE	541-73-1	10.00	80.00	119.00		20.00
1,3-DICHLOROPROPANE	142-28-9	10.00	80.00	119.00		20.00
1,4-DICHLOROBENZENE	106-46-7	10.00	79.00	118.00		20.00
2,2-DICHLOROPROPANE	594-20-7	10.00	60.00	139.00		20.00
2-CHLOROTOLUENE	95-49-8	10.00	79.00	122.00		20.00
4-CHLOROTOLUENE	106-43-4	10.00	78.00	122.00		20.00
4-ISOPROPYLTOLUENE	99-87-6	10.00	77.00	127.00		20.00
BENZENE	71-43-2	10.00	79.00	120.00		20.00
BROMOBENZENE	108-86-1	10.00	80.00	120.00		20.00
BROMOFORM	75-25-2	10.00	66.00	130.00		20.00
BROMOMETHANE	74-83-9	10.00	53.00	141.00		20.00
CARBON TETRACHLORIDE	56-23-5	10.00	72.00	136.00		20.00
CHLOROBENZENE	108-90-7	10.00	82.00	118.00		20.00
Chlorobromomethane	74-97-5	10.00	78.00	123.00		20.00
CHLORODIBROMOMETHANE	124-48-1	10.00	74.00	126.00		20.00
CHLOROETHANE	75-00-3	10.00	60.00	138.00		20.00
CHLOROFORM	67-66-3	10.00	79.00	124.00		20.00
CHLOROMETHANE	74-87-3	10.00	50.00	139.00		20.00

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: EPA8260B						
Matrix: AQ						
QC Type: LCS						
CIS-1,2-DICHLOROETHYLENE	156-59-2	10.00	78.00	123.00		20.00
CIS-1,3-DICHLOROPROPENE	10061-01-5	10.00	75.00	124.00		20.00
DIBROMOMETHANE	74-95-3	10.00	79.00	123.00		20.00
DICHLOROBROMOMETHANE	75-27-4	10.00	79.00	125.00		20.00
DICHLORODIFLUOROMETHANE	75-71-8	10.00	32.00	152.00		20.00
ETHYLBENZENE	100-41-4	10.00	79.00	121.00		20.00
HEXACHLOROBUTADIENE	87-68-3	10.00	66.00	134.00		20.00
ISOPROPYLBENZENE	98-82-8	10.00	72.00	131.00		20.00
METHYL TERT-BUTYL ETHER	1634-04-4	10.00	71.00	124.00		20.00
METHYLENE CHLORIDE	75-09-2	10.00	74.00	124.00		20.00
m-Xylene & p-Xylene	179601-23-1	10.00	80.00	121.00		20.00
NAPHTHALENE	91-20-3	10.00	61.00	128.00		20.00
N-BUTYLBENZENE	104-51-8	10.00	75.00	128.00		20.00
N-PROPYLBENZENE	103-65-1	10.00	76.00	126.00		20.00
O-XYLENE	95-47-6	10.00	78.00	122.00		20.00
SEC-BUTYLBENZENE	135-98-8	10.00	77.00	126.00		20.00
STYRENE	100-42-5	10.00	78.00	123.00		20.00
TERT-BUTYLBENZENE	98-06-6	10.00	78.00	124.00		20.00
TETRACHLOROETHYLENE	127-18-4	10.00	74.00	129.00		20.00
TOLUENE	108-88-3	10.00	80.00	121.00		20.00
TRANS-1,2-DICHLOROETHENE	156-60-5	10.00	75.00	124.00		20.00
TRANS-1,3-DICHLOROPROPENE	10061-02-6	10.00	73.00	127.00		20.00
Trichloroethylene	79-01-6	10.00	79.00	123.00		20.00
TRICHLOROFLUOROMETHANE	75-69-4	10.00	65.00	141.00		20.00
VINYL CHLORIDE	75-01-4	10.00	58.00	137.00		20.00
QC Type: MS						
1,1,1,2-TETRACHLOROETHANE	630-20-6	0.01	78.00	124.00		20.00
1,1,1-TRICHLOROETHANE	71-55-6	0.01	74.00	131.00		20.00
1,1,2,2-TETRACHLOROETHANE	79-34-5	0.01	71.00	121.00		20.00
1,1,2-TRICHLOROETHANE	79-00-5	0.01	80.00	119.00		20.00
1,1-DICHLOROETHANE	75-34-3	0.01	77.00	125.00		20.00

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: EPA8260B						
Matrix: AQ						
QC Type: MS						
1,1-DICHLOROETHYLENE	75-35-4	0.01	71.00	131.00		20.00
1,1-DICHLOROPROPENE	563-58-6	0.01	79.00	125.00		20.00
1,2,3-TRICHLOROBENZENE	87-61-6	0.01	69.00	129.00		20.00
1,2,3-TRICHLOROPROPANE	96-18-4	0.01	73.00	122.00		20.00
1,2,4-TRICHLOROBENZENE	120-82-1	0.01	69.00	130.00		20.00
1,2,4-TRIMETHYLBENZENE	95-63-6	0.01	76.00	124.00		20.00
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	0.01	62.00	128.00		20.00
1,2-DIBROMOETHANE	106-93-4	0.01	77.00	121.00		20.00
1,2-DICHLOROBENZENE	95-50-1	0.01	80.00	119.00		20.00
1,2-DICHLOROETHANE	107-06-2	0.01	73.00	128.00		20.00
1,2-DICHLOROPROPANE	78-87-5	0.01	78.00	122.00		20.00
1,3,5-TRIMETHYLBENZENE	108-67-8	0.01	75.00	124.00		20.00
1,3-DICHLOROBENZENE	541-73-1	0.01	80.00	119.00		20.00
1,3-DICHLOROPROPANE	142-28-9	0.01	80.00	119.00		20.00
1,4-DICHLOROBENZENE	106-46-7	0.01	79.00	118.00		20.00
2,2-DICHLOROPROPANE	594-20-7	0.01	60.00	139.00		20.00
2-CHLOROTOLUENE	95-49-8	0.01	79.00	122.00		20.00
4-CHLOROTOLUENE	106-43-4	0.01	78.00	122.00		20.00
4-ISOPROPYLTOLUENE	99-87-6	0.01	77.00	127.00		20.00
BENZENE	71-43-2	0.01	79.00	120.00		20.00
BROMOBENZENE	108-86-1	0.01	80.00	120.00		20.00
BROMOFORM	75-25-2	0.01	66.00	130.00		20.00
BROMOMETHANE	74-83-9	0.01	53.00	141.00		20.00
CARBON TETRACHLORIDE	56-23-5	0.01	72.00	136.00		20.00
CHLOROBENZENE	108-90-7	0.01	82.00	118.00		20.00
Chlorobromomethane	74-97-5	0.01	78.00	123.00		20.00
CHLORODIBROMOMETHANE	124-48-1	0.01	74.00	126.00		20.00
CHLOROETHANE	75-00-3	0.01	60.00	138.00		20.00
CHLOROFORM	67-66-3	0.01	79.00	124.00		20.00
CHLOROMETHANE	74-87-3	0.01	50.00	139.00		20.00
CIS-1,2-DICHLOROETHYLENE	156-59-2	0.01	78.00	123.00		20.00
CIS-1,3-DICHLOROPROPENE	10061-01-5	0.01	75.00	124.00		20.00

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: EPA8260B						
Matrix: AQ						
QC Type: MS						
DIBROMOMETHANE	74-95-3	0.01	79.00	123.00		20.00
DICHLOROBROMOMETHANE	75-27-4	0.01	79.00	125.00		20.00
DICHLORODIFLUOROMETHANE	75-71-8	0.01	32.00	152.00		20.00
ETHYLBENZENE	100-41-4	0.01	79.00	121.00		20.00
HEXACHLOROBUTADIENE	87-68-3	0.01	66.00	134.00		20.00
ISOPROPYLBENZENE	98-82-8	0.01	72.00	131.00		20.00
METHYL TERT-BUTYL ETHER	1634-04-4	0.01	71.00	124.00		20.00
METHYLENE CHLORIDE	75-09-2	0.01	74.00	124.00		20.00
m-Xylene & p-Xylene	179601-23-1	0.01	80.00	121.00		20.00
NAPHTHALENE	91-20-3	0.01	61.00	128.00		20.00
N-BUTYLBENZENE	104-51-8	0.01	75.00	128.00		20.00
N-PROPYLBENZENE	103-65-1	0.01	76.00	126.00		20.00
O-XYLENE	95-47-6	0.01	78.00	122.00		20.00
SEC-BUTYLBENZENE	135-98-8	0.01	77.00	126.00		20.00
STYRENE	100-42-5	0.01	78.00	123.00		20.00
TERT-BUTYLBENZENE	98-06-6	0.01	78.00	124.00		20.00
TETRACHLOROETHYLENE	127-18-4	0.01	74.00	129.00		20.00
TOLUENE	108-88-3	0.01	80.00	121.00		20.00
TRANS-1,2-DICHLOROETHENE	156-60-5	0.01	75.00	124.00		20.00
TRANS-1,3-DICHLOROPROPENE	10061-02-6	0.01	73.00	127.00		20.00
Trichloroethylene	79-01-6	0.01	79.00	123.00		20.00
TRICHLOROFLUOROMETHANE	75-69-4	0.01	65.00	141.00		20.00
VINYL CHLORIDE	75-01-4	0.01	58.00	137.00		20.00
QC Type: SURR						
1,2-Dichloroethane-d4 (Surr)	17060-07-0	10.00	81.00	118.00		
4-BROMOFLUOROBENZENE (SURR)	460-00-4	10.00	85.00	114.00		
Dibromofluoromethane (Surr)	1868-53-7	10.00	80.00	119.00		
Toluene-d8 (Surr)	2037-26-5	10.00	89.00	112.00		
Trifluorotoluene (Surr)	98-08-8	10.00	70.00	136.00		

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: EPA8260-SIM						
Matrix: AQ						
QC Type: LCS						
1,1,1,2-TETRACHLOROETHANE	630-20-6	10.00	78.00	124.00		20.00
1,1,1-TRICHLOROETHANE	71-55-6	10.00	74.00	131.00		20.00
1,1,2,2-TETRACHLOROETHANE	79-34-5	10.00	71.00	121.00		20.00
1,1,2-TRICHLOROETHANE	79-00-5	10.00	80.00	119.00		20.00
1,1-DICHLOROETHANE	75-34-3	10.00	77.00	125.00		20.00
1,1-DICHLOROETHYLENE	75-35-4	10.00	71.00	131.00		20.00
1,1-DICHLOROPROPENE	563-58-6	10.00	79.00	125.00		20.00
1,2,3-TRICHLOROBENZENE	87-61-6	10.00	69.00	129.00		20.00
1,2,3-TRICHLOROPROPANE	96-18-4	10.00	73.00	122.00		20.00
1,2,4-TRICHLOROBENZENE	120-82-1	10.00	69.00	130.00		20.00
1,2,4-TRIMETHYLBENZENE	95-63-6	10.00	76.00	124.00		20.00
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	10.00	62.00	128.00		20.00
1,2-DIBROMOETHANE	106-93-4	10.00	77.00	121.00		20.00
1,2-DICHLOROBENZENE	95-50-1	10.00	80.00	119.00		20.00
1,2-DICHLOROETHANE	107-06-2	10.00	73.00	128.00		20.00
1,2-DICHLOROPROPANE	78-87-5	10.00	78.00	122.00		20.00
1,3,5-TRIMETHYLBENZENE	108-67-8	10.00	75.00	124.00		20.00
1,3-DICHLOROBENZENE	541-73-1	10.00	80.00	119.00		20.00
1,3-DICHLOROPROPANE	142-28-9	10.00	80.00	119.00		20.00
1,3-Dichloropropene (total)	542-75-6	10.00	77.00	123.00		20.00
1,4-DICHLOROBENZENE	106-46-7	10.00	79.00	118.00		20.00
2,2-DICHLOROPROPANE	594-20-7	10.00	60.00	139.00		20.00
2-CHLOROTOLUENE	95-49-8	10.00	79.00	122.00		20.00
4-CHLOROTOLUENE	106-43-4	10.00	78.00	122.00		20.00
4-ISOPROPYLTOLUENE	99-87-6	10.00	77.00	127.00		20.00
BENZENE	71-43-2	10.00	79.00	120.00		20.00
BROMOBENZENE	108-86-1	10.00	80.00	120.00		20.00
BROMOFORM	75-25-2	10.00	66.00	130.00		20.00
BROMOMETHANE	74-83-9	10.00	53.00	141.00		20.00
CARBON TETRACHLORIDE	56-23-5	10.00	72.00	136.00		20.00
CHLOROBENZENE	108-90-7	10.00	82.00	118.00		20.00
Chlorobromomethane	74-97-5	10.00	78.00	123.00		20.00

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: EPA8260-SIM						
Matrix: AQ						
QC Type: LCS						
CHLORODIBROMOMETHANE	124-48-1	10.00	74.00	126.00		20.00
CHLOROETHANE	75-00-3	10.00	60.00	138.00		20.00
CHLOROFORM	67-66-3	10.00	79.00	124.00		20.00
CHLOROMETHANE	74-87-3	10.00	50.00	139.00		20.00
CIS-1,2-DICHLOROETHYLENE	156-59-2	10.00	78.00	123.00		20.00
CIS-1,3-DICHLOROPROPENE	10061-01-5	10.00	75.00	124.00		20.00
DIBROMOMETHANE	74-95-3	10.00	79.00	123.00		20.00
DICHLOROBROMOMETHANE	75-27-4	10.00	79.00	125.00		20.00
DICHLORODIFLUOROMETHANE	75-71-8	10.00	32.00	152.00		20.00
ETHYLBENZENE	100-41-4	10.00	79.00	121.00		20.00
HEXACHLOROBUTADIENE	87-68-3	10.00	66.00	134.00		20.00
ISOPROPYLBENZENE	98-82-8	10.00	72.00	131.00		20.00
METHYL TERT-BUTYL ETHER	1634-04-4	10.00	71.00	124.00		20.00
METHYLENE CHLORIDE	75-09-2	10.00	74.00	124.00		20.00
m-Xylene & p-Xylene	179601-23-1	10.00	80.00	121.00		20.00
NAPHTHALENE	91-20-3	10.00	61.00	128.00		20.00
N-BUTYLBENZENE	104-51-8	10.00	75.00	128.00		20.00
N-PROPYLBENZENE	103-65-1	10.00	76.00	126.00		20.00
O-XYLENE	95-47-6	10.00	78.00	122.00		20.00
SEC-BUTYLBENZENE	135-98-8	10.00	77.00	126.00		20.00
STYRENE	100-42-5	10.00	78.00	123.00		20.00
TERT-BUTYLBENZENE	98-06-6	10.00	78.00	124.00		20.00
TETRACHLOROETHYLENE	127-18-4	10.00	74.00	129.00		20.00
TOLUENE	108-88-3	10.00	80.00	121.00		20.00
TRANS-1,2-DICHLOROETHENE	156-60-5	10.00	75.00	124.00		20.00
TRANS-1,3-DICHLOROPROPENE	10061-02-6	10.00	73.00	127.00		20.00
Trichloroethylene	79-01-6	10.00	79.00	123.00		20.00
TRICHLOROFLUOROMETHANE	75-69-4	10.00	65.00	141.00		20.00
VINYL CHLORIDE	75-01-4	10.00	58.00	137.00		20.00
QC Type: MS						
1,1,1,2-TETRACHLOROETHANE	630-20-6	0.01	78.00	124.00		20.00

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: EPA8260-SIM						
Matrix: AQ						
QC Type: MS						
1,1,1-TRICHLOROETHANE	71-55-6	0.01	74.00	131.00		20.00
1,1,2,2-TETRACHLOROETHANE	79-34-5	0.01	71.00	121.00		20.00
1,1,2-TRICHLOROETHANE	79-00-5	0.01	80.00	119.00		20.00
1,1-DICHLOROETHANE	75-34-3	0.01	77.00	125.00		20.00
1,1-DICHLOROETHYLENE	75-35-4	0.01	71.00	131.00		20.00
1,1-DICHLOROPROPENE	563-58-6	0.01	79.00	125.00		20.00
1,2,3-TRICHLOROBENZENE	87-61-6	0.01	69.00	129.00		20.00
1,2,3-TRICHLOROPROPANE	96-18-4	0.01	73.00	122.00		20.00
1,2,4-TRICHLOROBENZENE	120-82-1	0.01	69.00	130.00		20.00
1,2,4-TRIMETHYLBENZENE	95-63-6	0.01	76.00	124.00		20.00
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	0.01	62.00	128.00		20.00
1,2-DIBROMOETHANE	106-93-4	0.01	77.00	121.00		20.00
1,2-DICHLOROBENZENE	95-50-1	0.01	80.00	119.00		20.00
1,2-DICHLOROETHANE	107-06-2	0.01	73.00	128.00		20.00
1,2-DICHLOROPROPANE	78-87-5	0.01	78.00	122.00		20.00
1,3,5-TRIMETHYLBENZENE	108-67-8	0.01	75.00	124.00		20.00
1,3-DICHLOROBENZENE	541-73-1	0.01	80.00	119.00		20.00
1,3-DICHLOROPROPANE	142-28-9	0.01	80.00	119.00		20.00
1,3-Dichloropropene (total)	542-75-6	0.01	77.00	123.00		20.00
1,4-DICHLOROBENZENE	106-46-7	0.01	79.00	118.00		20.00
2,2-DICHLOROPROPANE	594-20-7	0.01	60.00	139.00		20.00
2-CHLOROTOLUENE	95-49-8	0.01	79.00	122.00		20.00
4-CHLOROTOLUENE	106-43-4	0.01	78.00	122.00		20.00
4-ISOPROPYLTOLUENE	99-87-6	0.01	77.00	127.00		20.00
BENZENE	71-43-2	0.01	79.00	120.00		20.00
BROMOBENZENE	108-86-1	0.01	80.00	120.00		20.00
BROMOFORM	75-25-2	0.01	66.00	130.00		20.00
BROMOMETHANE	74-83-9	0.01	53.00	141.00		20.00
CARBON TETRACHLORIDE	56-23-5	0.01	72.00	136.00		20.00
CHLOROBENZENE	108-90-7	0.01	82.00	118.00		20.00
Chlorobromomethane	74-97-5	0.01	78.00	123.00		20.00
CHLORODIBROMOMETHANE	124-48-1	0.01	74.00	126.00		20.00

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: EPA8260-SIM						
Matrix: AQ						
QC Type: MS						
CHLOROETHANE	75-00-3	0.01	60.00	138.00		20.00
CHLOROFORM	67-66-3	0.01	79.00	124.00		20.00
CHLOROMETHANE	74-87-3	0.01	50.00	139.00		20.00
CIS-1,2-DICHLOROETHYLENE	156-59-2	0.01	78.00	123.00		20.00
CIS-1,3-DICHLOROPROPENE	10061-01-5	0.01	75.00	124.00		20.00
DIBROMOMETHANE	74-95-3	0.01	79.00	123.00		20.00
DICHLOROBROMOMETHANE	75-27-4	0.01	79.00	125.00		20.00
DICHLORODIFLUOROMETHANE	75-71-8	0.01	32.00	152.00		20.00
ETHYLBENZENE	100-41-4	0.01	79.00	121.00		20.00
HEXACHLOROBUTADIENE	87-68-3	0.01	66.00	134.00		20.00
ISOPROPYLBENZENE	98-82-8	0.01	72.00	131.00		20.00
METHYL TERT-BUTYL ETHER	1634-04-4	0.01	71.00	124.00		20.00
METHYLENE CHLORIDE	75-09-2	0.01	74.00	124.00		20.00
m-Xylene & p-Xylene	179601-23-1	0.01	80.00	121.00		20.00
NAPHTHALENE	91-20-3	0.01	61.00	128.00		20.00
N-BUTYLBENZENE	104-51-8	0.01	75.00	128.00		20.00
N-PROPYLBENZENE	103-65-1	0.01	76.00	126.00		20.00
O-XYLENE	95-47-6	0.01	78.00	122.00		20.00
SEC-BUTYLBENZENE	135-98-8	0.01	77.00	126.00		20.00
STYRENE	100-42-5	0.01	78.00	123.00		20.00
TERT-BUTYLBENZENE	98-06-6	0.01	78.00	124.00		20.00
TETRACHLOROETHYLENE	127-18-4	0.01	74.00	129.00		20.00
TOLUENE	108-88-3	0.01	80.00	121.00		20.00
TRANS-1,2-DICHLOROETHENE	156-60-5	0.01	75.00	124.00		20.00
TRANS-1,3-DICHLOROPROPENE	10061-02-6	0.01	73.00	127.00		20.00
Trichloroethylene	79-01-6	0.01	79.00	123.00		20.00
TRICHLOROFLUOROMETHANE	75-69-4	0.01	65.00	141.00		20.00
VINYL CHLORIDE	75-01-4	0.01	58.00	137.00		20.00
QC Type: SURR						
1,2-Dichloroethane-d4 (Surr)	17060-07-0	10.00	81.00	118.00		
4-BROMOFLUOROBENZENE (SURR)	460-00-4	10.00	85.00	114.00		

Analyte Name	Analyte Label (CAS)	Lower Rejection (%)	Lower Recovery (%)	Upper Recovery (%)	Upper Rejection (%)	RPD (%)
Method: EPA8260-SIM						
Matrix: AQ						
QC Type: SURR						
Dibromofluoromethane (Surr)	1868-53-7	10.00	80.00	119.00		
Toluene-d8 (Surr)	2037-26-5	10.00	89.00	112.00		
Trifluorotoluene (Surr)	98-08-8	10.00	70.00	136.00		
Method: EPA9056A						
Matrix: AQ						
QC Type: LCS						
CHLORIDE	16887-00-6	50.00	90.00	110.00		
QC Type: MS						
CHLORIDE	16887-00-6	30.00	90.00	110.00		20.00
Method: SW846 6010D						
Matrix: AQ						
QC Type: LCS						
ANTIMONY	7440-36-0	50.00	88.00	113.00		20.00
COPPER	7440-50-8	50.00	86.00	114.00		20.00
LEAD	7439-92-1	50.00	86.00	113.00		20.00
QC Type: MS						
ANTIMONY	7440-36-0	30.00	88.00	113.00		20.00
COPPER	7440-50-8	30.00	86.00	114.00		20.00
LEAD	7439-92-1	30.00	86.00	113.00		20.00

Project Holding Time Report

eQapp Name: FtOrd_UFP_QAPP_Rev9_3
Description: Quality Assurance Project Plan
 Former Fort Ord, California
 Volume I Appendix A

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:	EPA6010D	Matrix: AQ							
	Primary	180.00						Days	2.00
Method:	EPA8260B	Matrix: AQ							
	Primary	14.00						Days	2.00
Method:	EPA8260-SIM	Matrix: AQ							
	Primary	14.00						Days	2.00
Method:	EPA9056A	Matrix: AQ							
	Primary	28.00						Days	2.00
Method:	SW846 6010D	Matrix: AQ							
	Primary	180.00						Days	2.00

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-	X
Continuing Calibration Verification Percent Difference Upper Estimation	J+	
Continuing Calibration Verification Percent Difference Upper Rejection	J+	No qual
Continuing Calibration Verification Relative Response Factor	J	UJ
Continuing Tune	J	X
Equipment Blank Contamination	U	
Extraction to Analysis Estimation	J-	UJ
Extraction to Analysis Rejection	J-	X
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-	X
Initial Calibration Verification Percent Difference Upper Estimation	J+	
Initial Calibration Verification Percent Difference Upper Rejection	J+	No qual
Initial Calibration Verification Relative Response Factor	J	UJ
Initial Tune	J	X
Internal Standard Estimation	J	UJ
Internal Standard Rejection	J	X
Laboratory Control Precision	J	UJ
Laboratory Control Spike Lower Estimation	J-	UJ
Laboratory Control Spike Lower Rejection	J-	X
Laboratory Control Spike Upper Estimation	J+	
Laboratory Control Spike Upper Rejection	J+	No qual
Laboratory Duplicate Precision	J	UJ
Matrix Spike Lower Estimation	J-	UJ
Matrix Spike Lower Rejection	J-	X
Matrix Spike Precision	J	UJ
Matrix Spike Upper Estimation	J+	
Matrix Spike Upper Rejection	J+	No qual
Method Blank Contamination	U	
Preservation	J-	UJ
Sampling to Analysis Estimation	J-	UJ
Sampling to Analysis Rejection	J-	X
Sampling to Extraction Estimation	J-	UJ
Sampling to Extraction Rejection	J-	X
Sampling to Leaching Estimation	J-	UJ
Sampling to Leaching Rejection	J-	X
Surrogate Recovery Lower Estimation	J-	UJ
Surrogate Recovery Lower Rejection	J-	X
Surrogate Recovery Upper Estimation	J+	
Surrogate Recovery Upper Rejection	J+	No qual
Temperature Estimation	J-	UJ
Temperature Rejection	J-	X
Trip Blank Contamination	U	

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	J-	X
Continuing Calibration Verification Percent Recovery Upper Estimation	J+	
Continuing Calibration Verification Percent Recovery Upper Rejection	X	No qual
Equipment Blank Contamination	U	
Extraction to Analysis Estimation	J-	UJ
Extraction to Analysis Rejection	J-	X
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	J-	X
Initial Calibration Verification Percent Recovery Upper Estimation	J+	
Initial Calibration Verification Percent Recovery Upper Rejection	X	No qual
Laboratory Control Precision	J	UJ
Laboratory Control Spike Lower Estimation	J-	UJ
Laboratory Control Spike Lower Rejection	J-	X
Laboratory Control Spike Upper Estimation	J+	
Laboratory Control Spike Upper Rejection	J+	No qual
Laboratory Duplicate Precision	J	UJ
Matrix Spike Lower Estimation	J-	UJ
Matrix Spike Lower Rejection	J-	X
Matrix Spike Precision	J	UJ
Matrix Spike Upper Estimation	J+	
Matrix Spike Upper Rejection	J+	
Method Blank Contamination	U	
Sampling to Analysis Estimation	J-	UJ
Sampling to Analysis Rejection	J-	X
Sampling to Extraction Estimation	J-	UJ
Sampling to Extraction Rejection	J-	X
Sampling to Leaching Estimation	J-	UJ
Sampling to Leaching Rejection	J-	X
Trip Blank Contamination	U	

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	J-	X
Continuing Calibration Verification Percent Recovery Upper Estimation	J+	
Continuing Calibration Verification Percent Recovery Upper Rejection	X	
Equipment Blank Contamination	U	
Extraction to Analysis Estimation	J-	UJ
Extraction to Analysis Rejection	J-	X
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	X J-	X
Initial Calibration Verification Percent Recovery Upper Estimation	J+	
Initial Calibration Verification Percent Recovery Upper Rejection	X	
Laboratory Control Precision	J	UJ
Laboratory Control Spike Lower Estimation	J-	UJ
Laboratory Control Spike Lower Rejection	J-	X
Laboratory Control Spike Upper Estimation	J+	
Laboratory Control Spike Upper Rejection	J+	X
Laboratory Duplicate Precision	J	UJ
Matrix Spike Lower Estimation	J-	UJ
Matrix Spike Lower Rejection	J-	X
Matrix Spike Precision	J	UJ
Matrix Spike Upper Estimation	J+	
Matrix Spike Upper Rejection	J+	X
Method Blank Contamination	U	
Sampling to Analysis Estimation	J-	UJ
Sampling to Analysis Rejection	J-	X
Sampling to Extraction Estimation	J-	UJ
Sampling to Extraction Rejection	J-	X
Sampling to Leaching Estimation	J-	UJ
Sampling to Leaching Rejection	J-	X
Trip Blank Contamination	U	

ATTACHMENT E

Analytical Laboratory Certifications



CERTIFICATE OF ACCREDITATION

The ANSI National Accreditation Board

Hereby attests that

SGS North America Inc. - Orlando
4405 Vineland Road, Suite C-15
Orlando, FL 32811

Fulfills the requirements of

ISO/IEC 17025:2017

and

U.S. Department of Defense (DoD) Quality Systems Manual
for Environmental Laboratories (DoD QSM V 5.4)

In the field of

TESTING

This certificate is valid only when accompanied by a current scope of accreditation document.
The current scope of accreditation can be verified at www.anab.org.

R. Douglas Leonard Jr., VP, PILR SBU

Expiry Date: 15 December 2024
Certificate Number: L2229



This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017.
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).

SCOPE OF ACCREDITATION TO ISO/IEC 17025:2017

AND

U.S. Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (DoD QSM V 5.4)

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, 2024**

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

Drinking Water		
Technology	Method	Analyte
LC/MS/MS	EPA 537.1	Perfluorohexanoic Acid
LC/MS/MS	EPA 537.1	Perfluoroheptanoic Acid
LC/MS/MS	EPA 537.1	Perfluorooctanoic Acid
LC/MS/MS	EPA 537.1	Perfluorononanoic Acid
LC/MS/MS	EPA 537.1	Perfluorodecanoic Acid
LC/MS/MS	EPA 537.1	Perfluoroundecanoic Acid
LC/MS/MS	EPA 537.1	Perfluorododecanoic Acid
LC/MS/MS	EPA 537.1	Perfluorotridecanoic Acid
LC/MS/MS	EPA 537.1	Perfluorotetradecanoic Acid
LC/MS/MS	EPA 537.1	Perfluorobutanesulfonic Acid
LC/MS/MS	EPA 537.1	Perfluorohexanesulfonic Acid
LC/MS/MS	EPA 537.1	Perfluorooctanesulfonic Acid
LC/MS/MS	EPA 537.1	N-Methyl perfluorooctanesulfonamidoacetic acid
LC/MS/MS	EPA 537.1	N-Ethyl perfluorooctanesulfonamidoacetic acid
LC/MS/MS	EPA 537.1	ADONA
LC/MS/MS	EPA 537.1	2,3,3,3-Tetrafluoro-2-(heptafluoropropoxy)propanoic acid (HFPO-DA; GenX)
LC/MS/MS	EPA 537.1	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS; F53B minor)
LC/MS/MS	EPA 537.1	9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS; F53B major)
LC/MS/MS	EPA 533	Perfluorobutanoic acid
LC/MS/MS	EPA 533	Perfluoropentanoic acid
LC/MS/MS	EPA 533	Perfluorohexanoic acid
LC/MS/MS	EPA 533	Perfluoroheptanoic acid
LC/MS/MS	EPA 533	Perfluorooctanoic acid
LC/MS/MS	EPA 533	Perfluorononanoic acid

Drinking Water		
Technology	Method	Analyte
LC/MS/MS	EPA 533	Perfluorodecanoic acid
LC/MS/MS	EPA 533	Perfluoroundecanoic acid
LC/MS/MS	EPA 533	Perfluorododecanoic acid
LC/MS/MS	EPA 533	Perfluorobutanesulfonic acid
LC/MS/MS	EPA 533	Perfluoropentanesulfonic acid
LC/MS/MS	EPA 533	Perfluorohexanesulfonic acid
LC/MS/MS	EPA 533	Perfluoroheptanesulfonic acid
LC/MS/MS	EPA 533	Perfluorooctanesulfonic acid
LC/MS/MS	EPA 533	4:2 Fluorotelomer sulfonate
LC/MS/MS	EPA 533	6:2 Fluorotelomer sulfonate
LC/MS/MS	EPA 533	8:2 Fluorotelomer sulfonate
LC/MS/MS	EPA 533	Perfluoro-3-methoxypropanoic acid
LC/MS/MS	EPA 533	Perfluoro-4-methoxybutanoic acid
LC/MS/MS	EPA 533	Nonafluoro-3,6-dioxahheptanoic acid
LC/MS/MS	EPA 533	Perfluoro(2-ethoxyethane)sulfonic acid
LC/MS/MS	EPA 533	Hexafluoropropylene oxide dimer acid
LC/MS/MS	EPA 533	4,8-Dioxa-3H-perfluorononanoic acid
LC/MS/MS	EPA 533	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid
LC/MS/MS	EPA 533	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic 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)

Non-Potable Water		
Technology	Method	Analyte
GC/FID	EPA 8015C/D	Oil Range Organics (ORO)
GC/FID	EPA 8015C/D	Gasoline range organics (GRO)
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
GC/ECD	EPA 608.3; EPA 8081B	Methoxychlor
GC/ECD	EPA 608.3; EPA 8081B	Toxaphene (Chlorinated camphene)
GC/ECD	EPA 608.3; EPA 8082A	Aroclor-1016 (PCB-1016)
GC/ECD	EPA 608.3; EPA 8082A	Aroclor-1221 (PCB-1221)
GC/ECD	EPA 608.3; EPA 8082A	Aroclor-1232 (PCB-1232)
GC/ECD	EPA 608.3; EPA 8082A	Aroclor-1242 (PCB-1242)
GC/ECD	EPA 608.3; EPA 8082A	Aroclor-1248 (PCB-1248)
GC/ECD	EPA 608.3; EPA 8082A	Aroclor-1254 (PCB-1254)
GC/ECD	EPA 608.3; EPA 8082A	Aroclor-1260 (PCB-1260)
GC/ECD	EPA 8082A	Aroclor-1262 (PCB-1262)
GC/ECD	EPA 8082A	Aroclor-1268 (PCB-1268)
GC/ECD	EPA 8082A	Total PCB

Non-Potable Water		
Technology	Method	Analyte
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	Demeton
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
GC/ECD	EPA 8151A	2,4-D

Non-Potable Water		
Technology	Method	Analyte
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	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 8260C/D	1,1,1,2-Tetrachloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,1,1-Trichloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,1,2,2-Tetrachloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,1,2-Trichloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,1-Dichloroethane

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,1-Dichloroethylene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,1-Dichloropropene
GC/MS	EPA 624.1; EPA 8260C/D	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,2,3-Trichlorobenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,2,3-Trichloropropane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,2,4-Trichlorobenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,2,4-Trimethylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,2-Dibromoethane (EDB Ethylene dibromide)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,2-Dichlorobenzene (o-Dichlorobenzene)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,2-Dichloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,2-Dichloroethene (total)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,2-Dichloropropane
GC/MS	EPA 8260C/D	1,2-Dichlorotrifluoroethane (Freon 123)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,3,5-Trimethylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,3-Dichlorobenzene (m-Dichlorobenzene)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,3-Dichloropropane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	1,4-Dichlorobenzene (p-Dichlorobenzene)
GC/MS	EPA 8260C	1-Chlorohexane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	2,2-Dichloropropane

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	2-Butanone (Methyl ethyl ketone MEK)
GC/MS	EPA 624.1; EPA 8260C/D	2-Chloroethyl vinyl ether
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	2-Chlorotoluene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	2-Hexanone
GC/MS	EPA 8260C	2-Nitropropane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	4-Chlorotoluene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	4-Methyl-2-pentanone (MIBK)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Acetone
GC/MS	EPA 8260C/D	Acetonitrile
GC/MS	EPA 624.1; EPA 8260C/D	Acrolein (Propenal)
GC/MS	EPA 624.1; EPA 8260C/D	Acrylonitrile
GC/MS	EPA 8260C/D	Allyl chloride (3-Chloropropene)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Benzene
GC/MS	EPA 8260C/D	Benzyl Chloride
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Bromobenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Bromochloromethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Bromodichloromethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Bromoform
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	n-Butylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	sec-Butylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	tert-Butylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Carbon disulfide
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Carbon tetrachloride

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Chlorobenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Chloroethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Chloroform
GC/MS	EPA 8260C/D	Chloroprene
GC/MS	EPA 624.1; EPA 8260C/D	Cyclohexane
GC/MS	EPA 8260C/D	Cyclohexanone
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	cis-1,2-Dichloroethylene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	trans-1,2-Dichloroethylene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	cis-1,3-Dichloropropene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	trans-1,3-Dichloropropylene
GC/MS	EPA 8260C/D	cis-1,4-Dichloro-2-butene
GC/MS	EPA 8260C/D	trans-1,4-Dichloro-2-butene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Di-isopropylether (DIPE)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Dibromochloromethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Dibromomethane (Methylene Bromide)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Dichlorodifluoromethane
GC/MS	EPA 8260C/D	Diethyl ether
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D; EPA 8260C/D SIM	p-Dioxane (1,4-Dioxane)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Ethanol (Ethyl Alcohol)
GC/MS	EPA 8260C/D	Ethyl acetate
GC/MS	EPA 8260C/D	Ethyl methacrylate
GC/MS	EPA 8260C	Ethyl tert-butyl alcohol (ETBA)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Ethyl tert-butyl ether (ETBE)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Ethylbenzene

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Hexachlorobutadiene
GC/MS	EPA 8260C/D	Hexane
GC/MS	EPA 8260C/D	Iodomethane (Methyl iodide)
GC/MS	EPA 8260C/D	Isobutyl alcohol (2-Methyl-1-propanol)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	p-Isopropyltoluene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Isopropylbenzene
GC/MS	EPA 8260C/D	Methacrylonitrile
GC/MS	EPA 624.1; EPA 8260C/D	Methyl Acetate
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Methyl bromide (Bromomethane)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Methyl chloride (Chloromethane)
GC/MS	EPA 624.1; EPA 8260C/D	Methylcyclohexane
GC/MS	EPA 8260C/D	Methyl methacrylate
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Methyl tert-butyl ether (MTBE)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Methylene chloride
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Naphthalene
GC/MS	EPA 8260C/D	Pentachloroethane
GC/MS	EPA 8260C/D	Propionitrile (Ethyl cyanide)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	n-Propylbenzene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Styrene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	tert-Amyl alcohol (TAA)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	tert-Amyl methyl ether (TAME)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	tert-Butyl alcohol (TBA)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	tert-Butyl formate (TBF)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Tetrachloroethylene (Perchloroethylene)

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8260C/D	Tetrahydrofuran
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Toluene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Trichloroethene (Trichloroethylene)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Trichlorofluoromethane
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Vinyl acetate
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Vinyl chloride
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	Xylene (total)
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	m,p-Xylene
GC/MS	EPA 624.1; SM 6200B-11; EPA 8260C/D	o-Xylene
GC/MS	EPA 625.1; EPA 8270D/E	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 625.1; EPA 8270D/E	1,2,4-Trichlorobenzene
GC/MS	EPA 625.1; EPA 8270D/E	1,2-Dichlorobenzene (o-Dichlorobenzene)
GC/MS	EPA 625.1; EPA 8270D/E	1,2-Diphenylhydrazine
GC/MS	EPA 8270D/E	1,3,5-Trinitrobenzene (1,3,5-TNB)
GC/MS	EPA 625.1; EPA 8270D/E	1,3-Dichlorobenzene (m-Dichlorobenzene)
GC/MS	EPA 8270D/E	1,3-Dinitrobenzene (1,3-DNB)
GC/MS	EPA 625.1; EPA 8270D/E	1,4-Dichlorobenzene (p-Dichlorobenzene)
GC/MS	EPA 8270D/E	1,4-Naphthoquinone
GC/MS	EPA 8270D/E	1,4-Phenylenediamine
GC/MS	EPA 8270D/E	1-Chloronaphthalene
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	1-Methylnaphthalene
GC/MS	EPA 8270D/E	1-Naphthylamine
GC/MS	EPA 625.1; EPA 8270D/E	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 625.1; EPA 8270D/E	2,4,5-Trichlorophenol
GC/MS	EPA 625.1; EPA 8270D/E	2,4,6-Trichlorophenol
GC/MS	EPA 625.1; EPA 8270D/E	2,4-Dichlorophenol
GC/MS	EPA 625.1; EPA 8270D/E	2,4-Dimethylphenol
GC/MS	EPA 625.1; EPA 8270D/E	2,4-Dinitrophenol
GC/MS	EPA 625.1; EPA 8270D/E	2,4-Dinitrotoluene (2,4-DNT)

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8270D/E	2,6-Dichlorophenol
GC/MS	EPA 625.1; EPA 8270D/E	2,6-Dinitrotoluene (2,6-DNT)
GC/MS	EPA 8270D/E	2-Acetylaminofluorene
GC/MS	EPA 625.1; EPA 8270D/E	2-Chloronaphthalene
GC/MS	EPA 625.1; EPA 8270D/E	2-Chlorophenol
GC/MS	EPA 625.1; EPA 8270D/E	2-Methyl-4,6-dinitrophenol (4,6-Dinitro-o-cresol)
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	2-Methylnaphthalene
GC/MS	EPA 625.1; EPA 8270D/E	2-Methylphenol (o-Cresol)
GC/MS	EPA 8270D/E	2-Naphthylamine
GC/MS	EPA 625.1; EPA 8270D/E	2-Nitroaniline
GC/MS	EPA 625.1; EPA 8270D/E	2-Nitrophenol
GC/MS	EPA 8270D/E	2-Picoline (2-Methylpyridine)
GC/MS	EPA 625.1; EPA 8270D/E	3,3'-Dichlorobenzidine
GC/MS	EPA 8270D/E	3,3'-Dimethylbenzidine
GC/MS	EPA 8270D/E	3-Methylcholanthrene
GC/MS	EPA 625.1; EPA 8270D/E	3&4-Methylphenol (m,p-Cresol)
GC/MS	EPA 625.1; EPA 8270D/E	3-Nitroaniline
GC/MS	EPA 8270D/E	4-Aminobiphenyl
GC/MS	EPA 625.1; EPA 8270D/E	4-Bromophenyl phenyl ether
GC/MS	EPA 625.1; EPA 8270D/E	4-Chloro-3-methylphenol
GC/MS	EPA 625.1; EPA 8270D/E	4-Chloroaniline
GC/MS	EPA 625.1; EPA 8270D/E	4-Chlorophenyl phenylether
GC/MS	EPA 8270D/E	4-Dimethyl aminoazobenzene
GC/MS	EPA 625.1; EPA 8270D/E	4-Nitroaniline
GC/MS	EPA 625.1; EPA 8270D/E	4-Nitrophenol
GC/MS	EPA 8270D/E	5-Nitro-o-toluidine
GC/MS	EPA 8270D/E	7,12-Dimethylbenz(a) anthracene
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Acenaphthene
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Acenaphthylene
GC/MS	EPA 625.1; EPA 8270D/E	Acetophenone
GC/MS	EPA 625.1; EPA 8270D/E	Aniline
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Anthracene

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8270D/E	Aramite
GC/MS	EPA 625.1; EPA 8270D/E	Atrazine
GC/MS	EPA 625.1; EPA 8270D/E	Benzaldehyde
GC/MS	EPA 625.1; EPA 8270D/E	Benzidine
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Benzo(a)anthracene
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Benzo(a)pyrene
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Benzo(b)fluoranthene
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Benzo(g,h,i)perylene
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Benzo(k)fluoranthene
GC/MS	EPA 625.1; EPA 8270D/E	Benzoic acid
GC/MS	EPA 625.1; EPA 8270D/E	Benzyl alcohol
GC/MS	EPA 625.1; EPA 8270D/E	Biphenyl(1,1'-Biphenyl)
GC/MS	EPA 625.1; EPA 8270D/E	bis(2-Chloroethoxy)methane
GC/MS	EPA 625.1; EPA 8270D/E	bis(2-Chloroethyl) ether
GC/MS	EPA 625.1; EPA 8270D/E	bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane))
GC/MS	EPA 625.1; EPA 8270D/E	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	EPA 625.1; EPA 8270D/E	Butyl benzyl phthalate
GC/MS	EPA 625.1; EPA 8270D/E	Carbazole
GC/MS	EPA 625.1; EPA 8270D/E	Caprolactam
GC/MS	EPA 8270D/E	Chlorobenzilate
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Chrysene
GC/MS	EPA 8270D/E	Diallate
GC/MS	EPA 625.1; EPA 8270D/E	Di-n-butyl phthalate
GC/MS	EPA 625.1; EPA 8270D/E	Di-n-octyl phthalate
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Dibenz(a,h)anthracene
GC/MS	EPA 8270D/E	Dibenz(a,j)acridine
GC/MS	EPA 625.1; EPA 8270D/E	Dibenzofuran
GC/MS	EPA 625.1; EPA 8270D/E	Diethyl phthalate
GC/MS	EPA 625.1; EPA 8270D/E	Dimethyl phthalate

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8270D/E	a,a-Dimethylphenethylamine
GC/MS	EPA 8270D/E	Diphenyl Ether
GC/MS	EPA 8270D/E EPA 8270D/E SIM	p-Dioxane (1,4-Dioxane)
GC/MS	EPA 8270D/E	Ethyl methanesulfonate
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Fluoranthene
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Fluorene
GC/MS	EPA 625.1; EPA 8270D/E	Hexachlorobenzene
GC/MS	EPA 625.1; EPA 8270D/E	Hexachlorobutadiene
GC/MS	EPA 625.1; EPA 8270D/E	Hexachlorocyclopentadiene
GC/MS	EPA 625.1; EPA 8270D/E	Hexachloroethane
GC/MS	EPA 8270D/E	Hexachlorophene
GC/MS	EPA 8270D/E	Hexachloropropene
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270D	Isodrin
GC/MS	EPA 625.1; EPA 8270D/E	Isophorone
GC/MS	EPA 8270D/E	Isosafrole
GC/MS	EPA 8270D/E	Kepone
GC/MS	EPA 8270D/E	Methapyrilene
GC/MS	EPA 8270D/E	Methyl methanesulfonate
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Naphthalene
GC/MS	EPA 625.1; EPA 8270D/E	Nitrobenzene
GC/MS	EPA 8270D/E	Nitroquinoline-1-oxide
GC/MS	EPA 8270D/E	n-Nitroso-di-n-butylamine
GC/MS	EPA 625.1; EPA 8270D/E	n-Nitrosodi-n-propylamine
GC/MS	EPA 8270D/E	n-Nitrosodiethylamine
GC/MS	EPA 625.1; EPA 8270D/E	n-Nitrosodimethylamine
GC/MS	EPA 625.1; EPA 8270D/E	n-Nitrosodiphenylamine
GC/MS	EPA 8270D/E	n-Nitrosodiphenylamine/Diphenylamine (analyte pair)
GC/MS	EPA 8270D/E	n-Nitrosomethylethylamine
GC/MS	EPA 8270D/E	n-Nitrosomorpholine
GC/MS	EPA 8270D/E	n-Nitrosopiperidine

Non-Potable Water		
Technology	Method	Analyte
GC/MS	EPA 8270D/E	n-Nitrosopyrrolidine
GC/MS	EPA 8270D/E	Pentachlorobenzene
GC/MS	EPA 8270D/E	Pentachloroethane
GC/MS	EPA 8270D/E	Pentachloronitrobenzene
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Pentachlorophenol
GC/MS	EPA 8270D/E	Phenacetin
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Phenanthrene
GC/MS	EPA 625.1; EPA 8270D/E	Phenol
GC/MS	EPA 8270D/E	Pronamide (Kerb)
GC/MS	EPA 625.1; EPA 8270D/E; EPA 8270D/E SIM	Pyrene
GC/MS	EPA 625.1; EPA 8270D/E	Pyridine
GC/MS	EPA 8270D/E	Safrole
GC/MS	EPA 8270D/E	Simazine
GC/MS	EPA 8270D/E	Thionazin (Zinophos)
GC/MS	EPA 8270D/E	o-Toluidine
GC/MS	EPA 8270D/E	Dimethoate
GC/MS	EPA 8270D/E	Disulfoton
GC/MS	EPA 8270D/E	Famphur
GC/MS	EPA 8270D/E	Methyl parathion (Parathion methyl)
GC/MS	EPA 8270D/E	Parathion ethyl
GC/MS	EPA 8270D/E	Phorate
GC/MS	EPA 8270D/E	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

Non-Potable Water		
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/B	2,4-diamino-6-Nitrotoluene
HPLC	EPA 8330A/B	2,6-diamino-4-Nitrotoluene
HPLC	EPA 8330A/B	DNX
HPLC	EPA 8330A/B	MXN
HPLC	EPA 8330A/B	TNX
LC/MS/MS	EPA 6850	Perchlorate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorobutanoic Acid (PFBA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoropentanoic Acid (PFPeA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorohexanoic Acid (PFHxA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoroheptanoic Acid (PFHpA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctanoic Acid (PFOA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorononanoic Acid (PFNA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorodecanoic Acid (PFDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoroundecanoic Acid (PFUnA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorododecanoic Acid (PFDoA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorotridecanoic Acid (PFTTrDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorotetradecanoic Acid (PFTA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorobutanesulfonic Acid (PFBS)

Non-Potable Water		
Technology	Method	Analyte
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorohexanesulfonic Acid (PFHxS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctanesulfonic Acid (PFOS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorononanesulfonic Acid (PFNS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorodecanesulfonic Acid (PFDS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoroheptanesulfonic Acid (PFHpS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoropentanesulfonic Acid (PFPeS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctane sulfonamide (PFOSA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Methyl perfluorooctanesulfonamidoacetic acid (MeFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Ethyl perfluorooctanesulfonamidoacetic acid (EtFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	4:2 Fluorotelomer Sulfonate (FTS 4:2)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	6:2 Fluorotelomer Sulfonate (FTS 6:2)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	8:2 Fluorotelomer Sulfonate (FTS 8:2)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	ADONA
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	2,3,3,3-Tetrafluoro-2-(heptafluoropropoxy)propanoic acid (HFPO-DA; GenX)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS; F53B minor)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS; F53B major)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	3:3 Fluorotelomer carboxylate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	5:3 Fluorotelomer carboxylate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	7:3 Fluorotelomer carboxylate

Non-Potable Water		
Technology	Method	Analyte
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	10:2 Fluorotelomer sulfonate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorododecanesulfonic acid
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-3-methoxypropanoic acid (PFMPA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-4-methoxybutanoic acid (PFMBA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro (2-ethoxyethane) sulfonic acid (PFEESA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorohexadecanoic acid (PFHxDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctadecanoic acid (PFOcDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	4-PFecHS (Perfluoro-4-ethylcyclohexanesulfonate)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Methyl perfluorooctane sulfonamide
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Ethyl perfluorooctane sulfonamide
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Methyl perfluorooctane sulfonamidoethanol
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Ethyl perfluorooctane sulfonamidoethanol
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorobutanoic Acid (PFBA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluoropentanoic Acid (PFPeA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorohexanoic Acid (PFHxA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluoroheptanoic Acid (PFHpA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorooctanoic Acid (PFOA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorononanoic Acid (PFNA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorodecanoic Acid (PFDA)

Non-Potable Water		
Technology	Method	Analyte
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluoroundecanoic Acid (PFUnA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorododecanoic Acid (PFDaA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorotridecanoic Acid (PFTTrDA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorotetradecanoic Acid (PFTA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorobutanesulfonic Acid (PFBS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorohexanesulfonic Acid (PFHxS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorooctanesulfonic Acid (PFOS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorononanesulfonic Acid (PFNS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorodecanesulfonic Acid (PFDS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluoroheptanesulfonic acid (PFHpS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluoropentanesulfonic Acid (PFPeS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorododecanesulfonic Acid (PFDoS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	1H,1H, 2H, 2H-Perfluorohexane sulfonic acid (FTS 4:2)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	1H,1H, 2H, 2H-Perfluorooctane sulfonic acid (FTS 6:2)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	1H,1H, 2H, 2H-Perfluorodecane sulfonic acid (FTS 8:2)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	3-Perfluoropropyl propanoic acid (3:3 FTCA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	3-Perfluoroheptyl propanoic acid (7:3 FTCA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorooctanesulfonamide (PFOSA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	N-Methyl perfluorooctanesulfonamide (NMeFOSA)

Non-Potable Water		
Technology	Method	Analyte
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	N-Ethyl perfluorooctanesulfonamide (NEtFOSA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	N-Methyl perfluorooctanesulfonamidoacetic acid (MeFOSAA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	N-Ethyl perfluorooctanesulfonamidoacetic acid (EtFOSAA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	N-Methyl perfluorooctane sulfonamidoethanol (NMeFOSE)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	N-Ethyl perfluorooctane sulfonamidoethanol (NEtFOSE)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	4,8-Dioxa-3H-perfluorononanoic acid (ADONA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Hexafluoropropylene oxide dimer acid (HFPO-DA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluoro-3-methoxypropanoic acid (PFMPA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluoro-4-methoxybutanoic acid (PFMBA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluoro (2-ethoxyethane) sulfonic acid (PFEESA)
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
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

Non-Potable Water		
Technology	Method	Analyte
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
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

Non-Potable Water		
Technology	Method	Analyte
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
IC	EPA 300; EPA 9056A	Orthophosphate
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 353.2	Nitrate
Automated Colorimetry	EPA 353.2	Nitrite
Automated Colorimetry	EPA 353.2	Nitrate + Nitrite
Manual Colorimetry	EPA 365.4	Orthophosphate
Automated Colorimetry	EPA 365.1	Orthophosphate
Automated Colorimetry	EPA 365.1	Total Phosphorus
Manual Colorimetry	EPA 365.4	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)
Electrometric Methods	SM 4500H+B-11; EPA 9040C	Hydrogen Ion (Ph)

Non-Potable Water		
Technology	Method	Analyte
Electrometric Methods	EPA 120.1	Specific conductivity
Combustion	EPA 9060A	Total Organic Carbon
Combustion	SM 5310B-11	Total Organic Carbon
Ignitability	EPA 1020B/ASTM D3278-78	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 8151A	Chlorinated Herbicides, Liquid-Liquid Extraction
Organic Preparation	EPA 608; 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)
GC/ECD	EPA 8081B	4,4'-DDD

Solid and Chemical Materials		
Technology	Method	Analyte
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)
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/ECD	EPA 8082A	Total PCB
GC/FPD	EPA 8141B	Azinphos-methyl (Guthion)
GC/FPD	EPA 8141B	Bolstar (Sulprofos)
GC/FPD	EPA 8141B	Carbophenothion

Solid and Chemical Materials		
Technology	Method	Analyte
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	Demeton
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
GC/ECD	EPA 8151A	2,4-D
GC/ECD	EPA 8151A	2,4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba

Solid and Chemical Materials		
Technology	Method	Analyte
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	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 8260C/D	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260C/D	1,1,1-Trichloroethane
GC/MS	EPA 8260C/D	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260C/D	1,1,2-Trichloroethane
GC/MS	EPA 8260C/D	1,1-Dichloroethane
GC/MS	EPA 8260C/D	1,1-Dichloroethylene
GC/MS	EPA 8260C/D	1,1-Dichloropropene
GC/MS	EPA 8260C/D	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)
GC/MS	EPA 8260C/D	1,2,3-Trichlorobenzene
GC/MS	EPA 8260C/D	1,2,3-Trichloropropane
GC/MS	EPA 8260C/D	1,2,4-Trichlorobenzene
GC/MS	EPA 8260C/D	1,2,4-Trimethylbenzene
GC/MS	EPA 8260C/D	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 8260C/D	1,2-Dibromoethane (EDB Ethylene dibromide)
GC/MS	EPA 8260C/D	1,2-Dichlorobenzene (o-Dichlorobenzene)
GC/MS	EPA 8260C/D	1,2-Dichloroethane

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8260C/D	1,2-Dichloroethene (total)
GC/MS	EPA 8260C/D	1,2-Dichloropropane
GC/MS	EPA 8260C/D	1,2-Dichlorotrifluoroethane (Freon 123)
GC/MS	EPA 8260C/D	1,3,5-Trimethylbenzene
GC/MS	EPA 8260C/D	1,3-Dichlorobenzene (m-Dichlorobenzene)
GC/MS	EPA 8260C/D	1,3-Dichloropropane
GC/MS	EPA 8260C/D	1,4-Dichlorobenzene (p-Dichlorobenzene)
GC/MS	EPA 8260C/D	1-Chlorohexane
GC/MS	EPA 8260C/D	2,2-Dichloropropane
GC/MS	EPA 8260C/D	2-Butanone (Methyl ethyl ketone MEK)
GC/MS	EPA 8260C/D	2-Chloroethyl vinyl ether
GC/MS	EPA 8260C/D	2-Chlorotoluene
GC/MS	EPA 8260C/D	2-Hexanone
GC/MS	EPA 8260C/D	2-Nitropropane
GC/MS	EPA 8260C/D	4-Chlorotoluene
GC/MS	EPA 8260C/D	4-Methyl-2-pentanone (MBK)
GC/MS	EPA 8260C/D	Acetone
GC/MS	EPA 8260C/D	Acetonitrile
GC/MS	EPA 8260C/D	Acrolein (Propenal)
GC/MS	EPA 8260C/D	Acrylonitrile
GC/MS	EPA 8260C/D	Allyl chloride (3-Chloropropene)
GC/MS	EPA 8260C/D	Benzene
GC/MS	EPA 8260C/D	Benzyl Chloride
GC/MS	EPA 8260C/D	Bromobenzene
GC/MS	EPA 8260C/D	Bromochloromethane
GC/MS	EPA 8260C/D	Bromodichloromethane
GC/MS	EPA 8260C/D	Bromoform
GC/MS	EPA 8260C/D	n-Butylbenzene
GC/MS	EPA 8260C/D	sec-Butylbenzene
GC/MS	EPA 8260C/D	tert-Butylbenzene
GC/MS	EPA 8260C/D	Carbon disulfide
GC/MS	EPA 8260C/D	Carbon tetrachloride
GC/MS	EPA 8260C/D	Chlorobenzene
GC/MS	EPA 8260C/D	Chloroethane
GC/MS	EPA 8260C/D	Chloroform
GC/MS	EPA 8260C/D	Chloroprene

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8260C/D	Cyclohexane
GC/MS	EPA 8260C/D	Cyclohexanone
GC/MS	EPA 8260C/D	cis-1,2-Dichloroethylene
GC/MS	EPA 8260C/D	trans-1,2-Dichloroethylene
GC/MS	EPA 8260C/D	cis-1,3-Dichloropropene
GC/MS	EPA 8260C/D	trans-1,3-Dichloropropylene
GC/MS	EPA 8260C/D	cis-1,4-Dichloro-2-butene
GC/MS	EPA 8260C/D	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260C/D	Di-isopropylether (DIPE)
GC/MS	EPA 8260C/D	Dibromochloromethane
GC/MS	EPA 8260C/D	Dibromomethane (Methylene Bromide)
GC/MS	EPA 8260C/D	Dichlorodifluoromethane
GC/MS	EPA 8260C/D	Diethyl ether
GC/MS	EPA 8260C/D; EPA 8260C/D SIM	p-Dioxane (1,4-Dioxane)
GC/MS	EPA 8260C/D	Ethanol (Ethyl Alcohol)
GC/MS	EPA 8260C/D	Ethyl acetate
GC/MS	EPA 8260C/D	Ethyl methacrylate
GC/MS	EPA 8260C/D	Ethyl tert-butyl alcohol (ETBA)
GC/MS	EPA 8260C/D	Ethyl tert-butyl ether (ETBE)
GC/MS	PA 8260C/D	Ethylbenzene
GC/MS	EPA 8260C/D	Ethylene Oxide
GC/MS	EPA 8260C/D	Hexachlorobutadiene
GC/MS	EPA 8260C/D	Hexane
GC/MS	EPA 8260C/D	Iodomethane (Methyl iodide)
GC/MS	EPA 8260C/D	Isobutyl alcohol (2-Methyl-1-propanol)
GC/MS	EPA 8260C/D	p-Isopropyltoluene
GC/MS	EPA 8260C/D	Isopropylbenzene
GC/MS	EPA 8260C/D	Methacrylonitrile
GC/MS	EPA 8260C/D	Methyl Acetate
GC/MS	EPA 8260C/D	Methyl bromide (Bromomethane)
GC/MS	EPA 8260C/D	Methyl chloride (Chloromethane)
GC/MS	EPA 8260C/D	Methylcyclohexane
GC/MS	EPA 8260C/D	Methyl methacrylate
GC/MS	EPA 8260C/D	Methyl tert-butyl ether (MTBE)
GC/MS	EPA 8260C/D	Methylene chloride
GC/MS	EPA 8260C/D	Naphthalene

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8260C/D	Pentachloroethane
GC/MS	EPA 8260C/D	Propionitrile (Ethyl cyanide)
GC/MS	EPA 8260C/D	n-Propylbenzene
GC/MS	EPA 8260C/D	Styrene
GC/MS	EPA 8260C/D	tert-Amyl alcohol (TAA)
GC/MS	EPA 8260C/D	tert-Amyl methyl ether (TAME)
GC/MS	EPA 8260C/D	tert-Butyl alcohol (TBA)
GC/MS	EPA 8260C/D	tert-Butyl formate (TBF)
GC/MS	EPA 8260C/D	Tetrachloroethylene (Perchloroethylene)
GC/MS	EPA 8260C/D	Tetrahydrofuran
GC/MS	EPA 8260C/D	Toluene
GC/MS	EPA 8260C/D	Trichloroethene (Trichloroethylene)
GC/MS	EPA 8260C/D	Trichlorofluoromethane
GC/MS	EPA 8260C/D	Vinyl acetate
GC/MS	EPA 8260C/D	Vinyl chloride
GC/MS	EPA 8260C/D	Xylene (total)
GC/MS	EPA 8260C/D	m,p-Xylene
GC/MS	EPA 8260C/D	o-Xylene
GC/MS	EPA 8270D/E	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270D/E	1,2,4-Trichlorobenzene
GC/MS	EPA 8270D/E	1,2-Dichlorobenzene (o-Dichlorobenzene)
GC/MS	EPA 8270D/E	1,2-Diphenylhydrazine
GC/MS	EPA 8270D/E	1,3,5-Trinitrobenzene (1,3,5-TNB)
GC/MS	EPA 8270D/E	1,3-Dichlorobenzene (m-Dichlorobenzene)
GC/MS	EPA 8270D/E	1,3-Dinitrobenzene (1,3-DNB)
GC/MS	EPA 8270D/E	1,4-Dichlorobenzene (p-Dichlorobenzene)
GC/MS	EPA 8270D/E	1,4-Naphthoquinone
GC/MS	EPA 8270D/E	1,4-Phenylenediamine
GC/MS	EPA 8270D/E	1-Chloronaphthalene
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	1-Methylnaphthalene
GC/MS	EPA 8270D/E	1-Naphthylamine
GC/MS	EPA 8270D/E	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270D/E	2,4,5-Trichlorophenol
GC/MS	EPA 8270D/E	2,4,6-Trichlorophenol
GC/MS	EPA 8270D/E	2,4-Dichlorophenol
GC/MS	EPA 8270D/E	2,4-Dimethylphenol

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8270D/E	2,4-Dinitrophenol
GC/MS	EPA 8270D/E	2,4-Dinitrotoluene (2,4-DNT)
GC/MS	EPA 8270D/E	2,6-Dichlorophenol
GC/MS	EPA 8270D/E	2,6-Dinitrotoluene (2,6-DNT)
GC/MS	EPA 8270D/E	2-Acetylaminofluorene
GC/MS	EPA 8270D/E	2-Chloronaphthalene
GC/MS	EPA 8270D/E	2-Chlorophenol
GC/MS	EPA 8270D/E	2-Methyl-4,6-dinitrophenol (4,6-Dinitro-o-cresol)
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	2-Methylnaphthalene
GC/MS	EPA 8270D/E	2-Methylphenol (o-Cresol)
GC/MS	EPA 8270D/E	2-Naphthylamine
GC/MS	EPA 8270D/E	2-Nitroaniline
GC/MS	EPA 8270D/E	2-Nitrophenol
GC/MS	EPA 8270D/E	2-Picoline (2-Methylpyridine)
GC/MS	EPA 8270D/E	3,3'-Dichlorobenzidine
GC/MS	EPA 8270D/E	3,3'-Dimethylbenzidine
GC/MS	EPA 8270D/E	3-Methylcholanthrene
GC/MS	EPA 8270D/E	3&4-Methylphenol (m,p-Cresol)
GC/MS	EPA 8270D/E	3-Nitroaniline
GC/MS	EPA 8270D/E	4-Aminobiphenyl
GC/MS	EPA 8270D/E	4-Bromophenyl phenyl ether
GC/MS	EPA 8270D/E	4-Chloro-3-methylphenol
GC/MS	EPA 8270D/E	4-Chloroaniline
GC/MS	EPA 8270D/E	4-Chlorophenyl phenylether
GC/MS	EPA 8270D/E	4-Dimethyl aminoazobenzene
GC/MS	EPA 8270D/E	4-Nitroaniline
GC/MS	EPA 8270D/E	4-Nitrophenol
GC/MS	EPA 8270D/E	5-Nitro-o-toluidine
GC/MS	EPA 8270D/E	7,12-Dimethylbenz(a) anthracene
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	Acenaphthene
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	Acenaphthylene
GC/MS	EPA 8270D/E	Acetophenone
GC/MS	EPA 8270D/E	Aniline
GC/MS	EPA 8270D; EPA 8270D SIM	Anthracene
GC/MS	EPA 8270D/E	Aramite

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8270D/E	Atrazine
GC/MS	EPA 8270D/E	Benzaldehyde
GC/MS	EPA 8270D/E	Benzydine
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	Benzo(a)anthracene
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	Benzo(a)pyrene
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270D/E	Benzoic acid
GC/MS	EPA 8270D/E	Benzyl alcohol
GC/MS	EPA 8270D/E	Biphenyl (1,1'-Biphenyl)
GC/MS	EPA 8270D/E	bis(2-Chloroethoxy) methane
GC/MS	EPA 8270D/E	bis(2-Chloroethyl) ether
GC/MS	EPA 8270D/E	bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane))
GC/MS	EPA 8270D/E	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	EPA 8270D/E	Butyl benzyl phthalate
GC/MS	EPA 8270D/E	Carbazole
GC/MS	EPA 8270D/E	Caprolactam
GC/MS	EPA 8270D/E	Chlorobenzilate
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	Chrysene
GC/MS	EPA 8270D/E	Diallate
GC/MS	EPA 8270D/E	Di-n-butyl phthalate
GC/MS	EPA 8270D/E	Di-n-octyl phthalate
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	Dibenz(a,h)anthracene
GC/MS	EPA 8270D/E	Dibenz(a,j)acridine
GC/MS	EPA 8270D/E	Dibenzofuran
GC/MS	EPA 8270D/E	Diethyl phthalate
GC/MS	EPA 8270D/E	Dimethyl phthalate
GC/MS	EPA 8270D/E	a,a-Dimethylphenethylamine
GC/MS	EPA 8270D/E	Diphenyl Ether
GC/MS	EPA 8270D/E EPA 8270D/E SIM	p-Dioxane (1,4-Dioxane)
GC/MS	EPA 8270D/E	Ethyl methanesulfonate
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	Fluoranthene
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	Fluorene

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8270D/E	Hexachlorobenzene
GC/MS	EPA 8270D/E	Hexachlorobutadiene
GC/MS	EPA 8270D/E	Hexachlorocyclopentadiene
GC/MS	EPA 8270D/E	Hexachloroethane
GC/MS	EPA 8270D/E	Hexachlorophene
GC/MS	EPA 8270D/E	Hexachloropropene
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270D/E	Isodrin
GC/MS	EPA 8270D/E	Isophorone
GC/MS	EPA 8270D/E	Isosafrole
GC/MS	EPA 8270D/E	Kepone
GC/MS	EPA 8270D/E	Methapyrilene
GC/MS	EPA 8270D/E	Methyl methanesulfonate
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	Naphthalene
GC/MS	EPA 8270D/E	Nitrobenzene
GC/MS	EPA 8270D/E	Nitroquinoline-1-oxide
GC/MS	EPA 8270D/E	n-Nitroso-di-n-butylamine
GC/MS	EPA 8270D/E	n-Nitrosodi-n-propylamine
GC/MS	EPA 8270D/E	n-Nitrosodiethylamine
GC/MS	EPA 8270D/E	n-Nitrosodimethylamine
GC/MS	EPA 8270D/E	n-Nitrosodiphenylamine
GC/MS	EPA 8270D/E	n-Nitrosodiphenylamine/Diphenylamine (analyte pair)
GC/MS	EPA 8270D/E	n-Nitrosomethylethylamine
GC/MS	EPA 8270D/E	n-Nitrosomorpholine
GC/MS	EPA 8270D/E	n-Nitrosopiperidine
GC/MS	EPA 8270D/E	n-Nitrosopyrrolidine
GC/MS	EPA 8270D/E	Pentachlorobenzene
GC/MS	EPA 8270D/E	Pentachloroethane
GC/MS	EPA 8270D/E	Pentachloronitrobenzene
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	Pentachlorophenol
GC/MS	EPA 8270D/E	Phenacetin
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	Phenanthrene
GC/MS	EPA 8270D/E	Phenol
GC/MS	EPA 8270D/E	Pronamide (Kerb)
GC/MS	EPA 8270D/E; EPA 8270D/E SIM	Pyrene

Solid and Chemical Materials		
Technology	Method	Analyte
GC/MS	EPA 8270D/E	Pyridine
GC/MS	EPA 8270D/E	Safrole
GC/MS	EPA 8270D/E	Simazine
GC/MS	EPA 8270D/E	o-Toluidine
GC/MS	EPA 8270D/E	Dimethoate
GC/MS	EPA 8270D/E	Disulfoton
GC/MS	EPA 8270D/E	Famphur
GC/MS	EPA 8270D/E	Methyl parathion (Parathion methyl)
GC/MS	EPA 8270D/E	Parathion ethyl
GC/MS	EPA 8270D/E	Phorate
GC/MS	EPA 8270D/E	Sulfotepp
GC/MS	EPA 8270D/E	Thionazin (Zinophos)
GC/MS	EPA 8270D/E	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
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/B	DNX
HPLC	EPA 8330A/B	MNX
HPLC	EPA 8330A/B	TNX

Solid and Chemical Materials		
Technology	Method	Analyte
LC/MS/MS	EPA 6850	Perchlorate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorobutanoic Acid (PFBA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoropentanoic Acid (PFPeA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorohexanoic Acid (PFHxA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoroheptanoic Acid (PFHpA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctanoic Acid (PFOA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorononanoic Acid (PFNA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorodecanoic Acid (PFDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoroundecanoic Acid (PFUnA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorododecanoic Acid (PFDoA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorotridecanoic Acid (PFTTrDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorotetradecanoic Acid (PFTA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorobutanesulfonic Acid (PFBS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorohexanesulfonic Acid (PFHxS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctanesulfonic Acid (PFOS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorononanesulfonic Acid (PFNS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorodecanesulfonic Acid (PFDS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoroheptanesulfonic Acid (PFHpS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoropentanesulfonic Acid (PFPeS)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctane sulfonamide (PFOSA)

Solid and Chemical Materials		
Technology	Method	Analyte
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Methyl perfluorooctanesulfonamidoacetic acid (MeFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Ethyl perfluorooctanesulfonamidoacetic acid (EtFOSAA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	4:2 Fluorotelomer Sulfonate (FTS 4:2)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	6:2 Fluorotelomer Sulfonate (FTS 6:2)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	8:2 Fluorotelomer Sulfonate (FTS 8:2)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	ADONA
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	2,3,3,3-Tetrafluoro-2-(heptafluoropropoxy)propanoic acid (HFPO-DA; GenX)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	11-Chloroeicosafuoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS; F53B minor)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	9-Chlorohexadecafluoro-3-oxanone-1-sulfonic acid (9Cl-PF3ONS; F53B major)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	3:3 Fluorotelomer carboxylate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	5:3 Fluorotelomer carboxylate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	7:3 Fluorotelomer carboxylate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	10:2 Fluorotelomer sulfonate
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorododecanesulfonic acid
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-3-methoxypropanoic acid (PFMPA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro-4-methoxybutanoic acid (PFMBA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluoro (2-ethoxyethane) sulfonic acid (PFEESA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorohexadecanoic acid (PFHxDA)

Solid and Chemical Materials		
Technology	Method	Analyte
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	Perfluorooctadecanoic acid (PFOcDA)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	4-PFecHS (Perfluoro-4-ethylcyclohexanesulfonate)
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Methyl perfluorooctane sulfonamide
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Ethyl perfluorooctane sulfonamide
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Methyl perfluorooctane sulfonamidoethanol
LC/MS/MS	PFAS by LCMSMS Compliant with QSM 5.4 Table B-15	N-Ethyl perfluorooctane sulfonamidoethanol
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorobutanoic Acid (PFBA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluoropentanoic Acid (PFPeA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorohexanoic Acid (PFHxA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluoroheptanoic Acid (PFHpA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorooctanoic Acid (PFOA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorononanoic Acid (PFNA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorodecanoic Acid (PFDA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluoroundecanoic Acid (PFUnA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorododecanoic Acid (PFDoA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorotridecanoic Acid (PFTTrDA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorotetradecanoic Acid (PFTA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorobutanesulfonic Acid (PFBS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorohexanesulfonic Acid (PFHxS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorooctanesulfonic Acid (PFOS)

Solid and Chemical Materials		
Technology	Method	Analyte
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorononanesulfonic Acid (PFNS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorodecanesulfonic Acid (PFDS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluoroheptanesulfonic acid (PFHpS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluoropentanesulfonic Acid (PFPeS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorododecanesulfonic Acid (PFDoS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	1H,1H, 2H, 2H-Perfluorohexane sulfonic acid (FTS 4:2)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	1H,1H, 2H, 2H-Perfluorooctane sulfonic acid (FTS 6:2)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	1H,1H, 2H, 2H-Perfluorodecane sulfonic acid (FTS 8:2)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	3-Perfluoropropyl propanoic acid (3:3 FTCA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	2H,2H,3H,3H-Perfluorooctanoic acid (5:3 FTCA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	3-Perfluoroheptyl propanoic acid (7:3 FTCA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluorooctanesulfonamide (PFOSA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	N-Methyl perfluorooctanesulfonamide (NMeFOSA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	N-Ethyl perfluorooctanesulfonamide (NEtFOSA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	N-Methyl perfluorooctanesulfonamidoacetic acid (MeFOSAA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	N-Ethyl perfluorooctanesulfonamidoacetic acid (EtFOSAA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	N-Methyl perfluorooctane sulfonamidoethanol (NMeFOSE)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	N-Ethyl perfluorooctane sulfonamidoethanol (NEtFOSE)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	11-Chloroeicosafluoro-3-oxaundecane-1-sulfonic acid (11Cl-PF3OUdS)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	9-Chlorohexadecafluoro-3-oxanonane-1-sulfonic acid (9Cl-PF3ONS)

Solid and Chemical Materials		
Technology	Method	Analyte
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	4,8-Dioxa-3H-perfluorononanoic acid (ADONA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Hexafluoropropylene oxide dimer acid (HFPO-DA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluoro-3-methoxypropanoic acid (PFMPA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluoro-4-methoxybutanoic acid (PFMBA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Nonafluoro-3,6-dioxaheptanoic acid (NFDHA)
LC/MS/MS	EPA Draft Method 1633 Compliant with QSM 5.4 Table B-24	Perfluoro (2-ethoxyethane) sulfonic acid (PFEESA)
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
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

Solid and Chemical Materials		
Technology	Method	Analyte
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
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

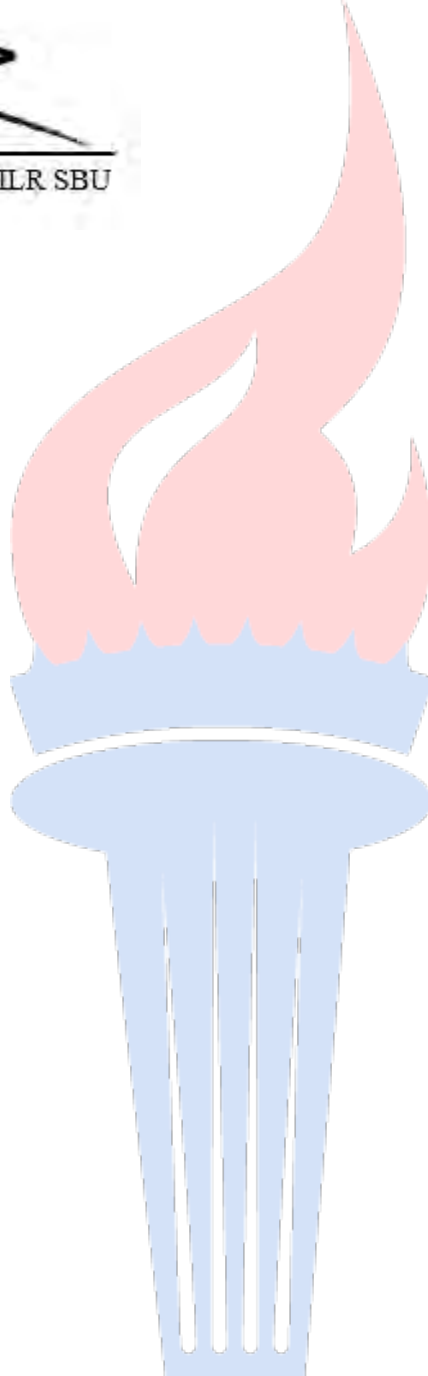
Solid and Chemical Materials		
Technology	Method	Analyte
IC	EPA 9056A	Nitrite
IC	EPA 9056A	Sulfate
IC	EPA 9056A	Total nitrate-nitrite
Gravimetric Methods	SM 2540G	% solids
Electrometric Methods	EPA 9045D	Hydrogen Ion (pH)
Ignitability	EPA 1020B MOD	Flash Point
Waste Characterization	EPA Ch.7	Reactive 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
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.



R. Douglas Leonard Jr., VP, PILR SBU



ATTACHMENT F

Responses to USEPA Comments on the Draft QAPP

Responses to Comments submitted by the Environmental Protection Agency (USEPA)¹

GENERAL COMMENTS

GENERAL COMMENT 1: It is unclear how geospatial data will be collected and whether global positioning system (GPS) units will be used for this project. For example, Section 3.5.10 (Geographic Information System Description) describes how geospatial data will be managed; however, Section 5.3 (Worksheet #21, Field SOPs/Methods) does not include a standard operating procedure (SOP) for collecting geospatial data, and Section 5.4 (Worksheet #22, Field Equipment Calibration, Maintenance, Testing, and Inspection) does not include calibration, maintenance, testing, and inspection requirements for GPS units. Please revise the QAPP to clarify how geospatial data will be collected and whether GPS units will be used during this project and revise the applicable QAPP worksheets.

RESPONSE TO GENERAL COMMENT 1: *All existing groundwater wells have been installed and surveyed. In the event that geospatial data are collected in the future, Field Work Documentation SOP (FSOP-001) was added to the QAPP, which references the manufacturer's handbook for the instrument that is used for collecting geospatial data at the former Fort Ord. Worksheets #21 and #22 were revised per the comment.*

SPECIFIC COMMENTS

SPECIFIC COMMENT 1: Section 2.1, Worksheet #1 and 2, Title and Approval Page, Page 2: It is unclear why Ahtna's Project Chemist is approving the QAPP, rather than the Quality Control (QC) Manager. According to Section 2.1 (Title and Approval Page) of the Uniform Federal Policy for Quality Assurance Project Plans Manual, dated March 2005 (the UFP-QAPP Manual), the QAPP should include the investigative organization's QA Officer's approval signature. Please revise Worksheet #1 and 2 to include space for the approval signature of the investigative organization's QC Manager.

RESPONSE TO SPECIFIC COMMENT 1: *Worksheet #1 & 2 was revised per the comment.*

SPECIFIC COMMENT 2: Section 2.2, Worksheet #3 and 5, Project Organization and QAPP Distribution, Page 5, and Section 2.3, Worksheet #4, 7, and 8, Personnel Qualifications and Sign-Off Sheet, Page 6: Worksheet #3 and 5 identifies Kelly O'Meara as Ahtna's Program Manager; however, Worksheet #4, 7, and 8 identifies Chuck Holman as Ahtna's Program Manager. Please revise the QAPP to resolve this discrepancy.

RESPONSE TO SPECIFIC COMMENT 2: *The QAPP was revised per the comment.*

SPECIFIC COMMENT 3: Section 3.2.2, Step 2: Identify the Goals of the Study, Page 23, and Section 3.6.1, Worksheet #15a, VOCs by EPA Method 8260-SIM, Pages 46 and 47: Section 3.2.2 indicates that data collected from the Fort Ord groundwater monitoring program (GWMP) will be evaluated to determine if concentrations of trichloroethene (TCE) in the Lower 180-Foot Aquifer are above the

¹ In a letter dated June 28, 2023 (see Administrative Record No. [BW-2785R.4](#)). The comments are reproduced here as provided to the U.S. Department of the Army (Army) and there have been no changes to spelling, grammar, or punctuation.

maximum contaminant level (MCL); however, the MCL for TCE is not included in Worksheet #15a, and as such, it is unclear how this study goal will be met. Please revise Worksheet #15a to include the MCL for TCE.

RESPONSE TO SPECIFIC COMMENT 3: *The MCL for TCE for the Lower 180 Aquifer at Operable Unit Carbon Tetrachloride Plume (OUCTP) was added to Worksheet #15a.*

SPECIFIC COMMENT 4: Section 3.3.3, Worksheet #12c, Wet Chemistry – Sites 2/12 GWTS and Sites 2/12 GWMP, Page 40, and Section 6.5.3, Worksheet #28c, Wet Chemistry, Page 90: Worksheets #12c and #28c both list the relative percent difference (RPD) limit for laboratory duplicate and matrix spike (MS)/matrix spike duplicate (MSD) samples as $\leq 20\%$, which is consistent with Table 1 (QC Criteria) in laboratory standard operating procedure (SOP) GN237.01 (see PDF Page 357). However, this RPD limit is less stringent than Section 9.3.3.4 of EPA Method 9056A and Table B-12 (Common Anions Analysis by Ion Chromatography) in Department of Defense (DoD) Quality Systems Manual (QSM) Version 5.4, which both indicate an RPD limit of 15%. Please revise Worksheets #12c and #28c to list the RPD limit as 15%. Alternatively, please revise these worksheets to clarify that less stringent QC criteria will be used for samples analyzed by Method 9056A.

RESPONSE TO SPECIFIC COMMENT 4: *Worksheets #12c and #28c were revised per the comment. The laboratory SOP was also updated.*

SPECIFIC COMMENT 5: Section 3.5, Worksheet #14 and 16, Project Tasks and Schedule, Section 3.5.16, Project Schedule, Page 45: The project schedule is insufficiently detailed. For example, the project schedule does not include start and end dates for project activities. In addition, the project schedule should include activities such as sample analysis, verification and validation, and usability assessment. Please revise Section 3.5.16 to include a detailed project schedule in accordance with Section 2.8.2 (Project Schedule) of the UFP-QAPP Manual.

RESPONSE TO SPECIFIC COMMENT 5: *It is acknowledged that the project schedule format presented in Section 3.5.16 is not consistent with Optimized UFP-QAPP Worksheet #14/16; however, the project schedule format required modification because the groundwater monitoring program is ongoing and there are not specified start and end dates. This format is also consistent with other Fort Ord QAPPs that describe ongoing quarterly monitoring programs. Conversely, the Optimized UFP-QAPP Worksheet #14/16 project schedule format is designed for a single investigation event.*

SPECIFIC COMMENT 6: Section 3.6.2, Worksheet #15b, Ion Chromatography by EPA Method 9056A, Page 48: It is unclear why this worksheet includes two different laboratory detection limits (DLs) (i.e., 0.02 milligrams per liter [mg/L] and 0.80 mg/L). This is of particular concern because Footnote 2 indicates that results above the DL and less than the limit of quantitation (LOQ) will be qualified as estimated. Please revise Worksheet #15b to resolve this discrepancy.

RESPONSE TO SPECIFIC COMMENT 6: *Worksheet #15b was revised per the comment.*

SPECIFIC COMMENT 7: Section 5.4, Worksheet #22, Field Equipment Calibration, Maintenance, Testing, and Inspection) , Page 75: This worksheet appears to be incomplete. For example, Section 5.3 (Worksheet #21, Field SOPs/Method) lists SOP #6 for collecting low flow groundwater quality

parameters, but Worksheet #22 is missing calibration, maintenance, testing, and inspection requirements for the Horiba Multi-Meter water quality meter used with low flow sampling. Please revise Worksheet #22 to include calibration, maintenance, testing, and inspection requirements for all field equipment that may be used during this project.

RESPONSE TO SPECIFIC COMMENT 7: *Worksheet #22 was revised per the comment and the Horiba U-50 series instruction manual was added to Attachment A (Sampling SOPs).*

SPECIFIC COMMENT 8: Section 7.2, Worksheet #31, 32, and 33, Assessments and Corrective Action, Pages 92 to 97: The table in Section 7.2.1 (Assessments and Corrective Action) does not include the number and frequency of each assessment type, and it is unclear when the assessments will be conducted. For example, it is recommended that, at a minimum, a field audit is conducted at the beginning of sampling activities to ensure procedures are properly implemented throughout the field effort, but this worksheet does not specify when field audits will occur.

Please revise Section 7.2.1 to include the number and frequency of each assessment type and to clarify when each assessment will be conducted.

RESPONSE TO SPECIFIC COMMENT 8: *It is acknowledged that the format presented in Section 7.2.1 is not consistent with Optimized UFP-QAPP Worksheet #31, 32, & 33; however; the worksheet required modification for consistency with the U.S. Army Corps of Engineers Three-Phase Control System (preparatory, initial, and follow-up) to assure adequate preparation for each definable feature of work and the work complies with the requirements of the contract plans and specifications. This format is also consistent with other Fort Ord QAPPs that describe ongoing quarterly monitoring programs. Field audits specifically are intended to be unscheduled, with field personnel understanding an unannounced audit may occur at any time. This approach is more effective at ensuring procedures are properly implemented throughout the field effort and having scheduled audits would undermine this.*

ATTACHMENT G

Responses to DTSC Comments on the Draft QAPP

Responses to Comments submitted by the California Department of Toxic Substances Control (DTSC)¹

GENERAL RECOMMENDATION: DTSC has found that Manuals for Westbay MOSDAX Sampler Probe and Hydrasleeve field manual was included. DTSC recommends including the field manual/ included manual for the Horiba Multi-meter Water Quality meter.

RESPONSE TO GENERAL RECOMMENDATION: *The Horiba Multi Water Quality Checker U-50 Series Instruction Manual was added to Attachment A per the comment.*

GEOLOGICAL SERVICES UNIT (GSU) COMMENT 1: Revision to Figure 9. Figure 9 should be revised to state that monitoring wells MW-BW-96-A and MW-BW-97-A are sampled quarterly for volatile organic compounds (VOCs). Worksheet #17c3 states that MW-BW-96-A and MW-BW-97-A are scheduled for quarterly sampling for VOCs; however, Figure 9 states MW-BW-96-A and MW-BW-97-A are for monitoring water levels only. Figure 9 should be revised accordingly.

RESPONSE TO GSU COMMENT 1: *Figure 9 was revised for consistency with Worksheet #17c3 per the comment.*

¹ In a letter dated August 22, 2023 (see Administrative Record No. [BW-2785R.5](#)). The comments are reproduced here as provided to the Army and there have been no changes to spelling, grammar, or punctuation.

ATTACHMENT H

Responses to CCRWQCB Comments on the Draft QAPP

Responses to Comments submitted by the Central Coast Regional Water Quality Control Board¹

COMMENT 1: Figure 2, Sites 2 and 12 Groundwater Monitoring Locations – It appears that one of the recommended groundwater sample schedule modifications provided in Table 28 of the *May 2023 Draft Final Sites 2/12 Fourth Quarter 2021 through Third Quarter 2022 Groundwater and Soil Gas Monitoring and Treatment System Report*² (Sites 2/12 Annual Report) has not been incorporated into the Draft QAPP. Please confirm whether groundwater monitoring well MW-12-01-180 should be shown on Figure 2 as depth to water only based on the recommendations provided in the Sites 2/12 Annual Report.

RESPONSE TO COMMENT 1: *Figure 2 was revised per the comment to show MW-12-01-180 is a water level only monitoring well. Figure 2 was also revised to indicate a quarterly sampling schedule for monitoring well MW-12-29-180U per the Sites 2/12 Annual Report.*

COMMENT 2: Figure 12, OUCTP Lower 180-Foot Aquifer Groundwater Monitoring Program Sampling Locations – It appears that one of the recommended groundwater sample schedule modifications provided in Table 13 of the *May 2023 Draft Final OUCTP Fourth Quarter 2021 through Third Quarter 2022 Groundwater Monitoring Report*³ (OUCTP Annual Report) has not been incorporated into the Draft QAPP. Please confirm whether multi-port monitoring well MP-BW-41-318 should be shown on Figure 12 as sampled annually based on the recommendations provided in the OUCTP Annual Report.

RESPONSE TO COMMENT 2: *Figure 12 was revised per the comment to show MP-BW-41-318 requires annual volatile organic compound (VOC) sampling and to note that co-located MP-BW-41-353 requires quarterly VOC sampling.*

¹ In a letter dated June 28, 2023 (see Administrative Record No. [BW-2785R.3](#)). The comments are reproduced here as provided to the U.S. Department of the Army (Army) and there have been no changes to spelling, grammar, or punctuation.

² https://documents.geotracker.waterboards.ca.gov/esi/uploads/geo_report/3060714364/DOD100204800.PDF

³ https://documents.geotracker.waterboards.ca.gov/esi/uploads/geo_report/2279875576/DOD100196800.PDF

ATTACHMENT I

Responses to FOCAG Comments on the Draft QAPP

Responses to Comments submitted by Fort Ord Community Advisory Group (FOCAG)¹

COMMENT: Locations of Extraction Wells and Monitoring Wells is again difficult to pinpoint because of the poor backgrounds on the Figures. We note on the small print below the Figure, Service Layer Credits: Source:, Esri, Mazar, Earthstar Geographies, and the GIS User Community.

You must be able to do better than this. The importance, especially on Figure 13, the OU2 A Aquifer Hydraulic Zone Map depicting the plumes (locations) of these serious carcinogenic toxics;

Trichloroethene (TCE)

Tetrachloroethene (PCE)

1,1 -Dichloroethane

1,2 Dichloroethane

Vinyl Chloride (VC)

and,

Carbon Tetrachloride (CT)

Looking forward to better.

RESPONSE TO COMMENT: *The background images provided on the figures are not poor quality; they are intentionally set at 40 percent transparency so that the data presented (chemical of concern [COC] plumes, wells, hydraulic zones) are not obscured and will be apparent to the reader. The purpose of the background imagery is to give the reader a frame of reference with respect to the locations of the COC plumes, wells, and hydraulic zones. If the transparency of the image is set to less than 40 percent, the COC plumes and other important map features would not be clearly visible on the figure. However, to provide the reader with additional context with respect to the locations of extraction wells and monitoring wells, figures have been updated to show street names where feasible.*

Please note that there are also limitations to map resolution when viewing paper copies; however, viewing the maps and figures in portable document format (PDF) on a computer will allow the reader to zoom in on or zoom out from specific map features at potentially higher resolutions. PDF versions of Fort Ord documents are available in the online Administrative Record at www.fortordcleanup.com and on the compact discs typically included with paper copies of the documents.

¹ In a letter dated June 19, 2023 (see Administrative Record No. [BW-2785R.2](#)). The comments are reproduced here as provided to the Army and there have been no changes to spelling, grammar, or punctuation.