

SAP Worksheet #1—Title and Approval Page

Final

**Sampling and Analysis Plan
Basewide Site Inspection for Perfluorinated Compounds**

**Naval Air Station Oceana
Virginia Beach, Virginia**

Contract Task Order WE44

February 2017

Prepared for

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

Under the

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

Prepared by



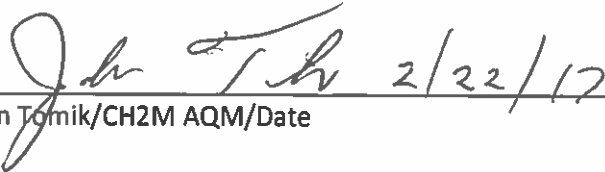
Virginia Beach, Virginia

This page intentionally left blank.

Approval Signatures

The following person(s) hereby state that they have reviewed this document and approved this document.

Review Signatures:

 2/22/17

John Tomik/CH2M AQM/Date

Approval Signatures:

 2/15/2017

Angela Jones/U.S. Navy Remedial Project Manager/ Date

 2/15/17

Rob Thomson/USEPA Project Manager/ Date

 2-15-17

Steve Mihalko/VDEQ Project Manager/ Date

 2-15-17

Laura Cook/CH2M Project Manager/ Date

This page intentionally left blank.

Executive Summary

This site-specific Sampling and Analysis Plan (SAP) is being submitted to provide a systematic data collection and analysis structure for the investigation of perfluorinated compounds (PFCs) at Naval Air Station (NAS) Oceana, in Virginia Beach, Virginia. In accordance with the Guidance for Uniform Federal Policy for Quality Assurance Project Plans (USEPA, 2005), this Department of the Navy (Navy)-specific SAP includes 37 worksheets that detail various aspects of the environmental investigation process and serve as guidelines for the fieldwork and data quality.

PFCs are constituents historically found in aqueous film-forming foam (AFFF) which is used in firefighting operations. PFCs are considered “emerging contaminants” and were not previously evaluated at Navy sites. In October 2014, the Assistant Secretary of the Navy, Energy, Installations and Environment issued a statement requiring evaluation of sites with the potential for PFC contamination under the Defense Environmental Restoration Program (Navy, 2014). Site 11 and Solid Waste Management Unit (SWMU) 26 at NAS Oceana were identified as sites requiring additional investigation for PFCs because firefighting activities involving the use of AFFF were previously conducted at those sites. Additionally, interviews with fire department personnel completed in November of 2015 (**Appendix A**) identified several other areas at NAS Oceana where AFFF was reportedly or potentially released. Potential release areas include:

- Site 11, Firefighting Training Area
- SWMU 26, Fire Station Burn Pit
- The area near the aircraft hangars, where several accidental releases of AFFF occurred
- 1986 Crash Site
- 1996 Crash Site
- 2007 Crash Site
- The area near the Hush House, where an accidental release of AFFF occurred

The objectives of the NAS Oceana Basewide Site Inspection for PFCs are to determine whether PFCs have migrated offsite and are present at levels exceeding screening criteria in private drinking water within 1 mile downgradient of suspected source areas; determine whether PFCs are present at levels posing potentially unacceptable risks in groundwater at NAS Oceana; and confirm suspected source areas. Because of uncertainties in the groundwater flow direction around the perimeter of the Base and the potential for other unknown AFFF releases, a water level survey of a network of new piezometers and existing wells will be completed to evaluate Basewide groundwater flow and assess the potential for offsite migration of PFCs. This SAP summarizes the proposed sampling approach (Phase I) to evaluate the possible presence of PFCs at offsite properties, at potential on-Base source areas and at perimeter wells within the Base boundary. A Phase II investigation, including additional groundwater sampling as necessary, is also discussed as a contingency in the event that PFCs exceed screening criteria in the Phase I investigation. The City of Virginia Beach GIS database indicates that while the majority of properties surrounding NAS Oceana are connected to city water supplies, there are some properties that do not have access to city water. It is also possible that some residences and businesses may have private wells in addition to city water access. As a result, and in accordance with Navy policy, drinking water samples will be collected from properties without access to city water within 1 mile downgradient of potential PFC source areas and analyzed for PFCs prior to the on-Base investigation.

This Site Investigation (SI) at NAS Oceana is being conducted under the Comprehensive Environmental Response Compensation, and Liability Act of 1980 (CERCLA). CERCLA work is currently being conducted with USEPA Region 3 as the lead regulatory agency. The Virginia Department of Environmental Quality is the State regulatory agency. Together, these three agencies form the NAS Oceana Partnering Team. As such, the CERCLA process will be adhered to during this and any subsequent investigations to evaluate PFCs at NAS Oceana.

This document will help ensure that environmental data collected or compiled are scientifically sound, of known and documented quality, and are suitable for intended uses. The laboratory information cited in this SAP is for the laboratory currently contracted to provide analytical services for this investigation. The analytical services for this investigation will be provided by Vista Analytical Laboratory, El Dorado Hills, California. Additionally, data

validation services will be provided by CH2M. The field standard operating procedures for this work are included in **Appendix B** and the laboratory Department of Defense Environmental Laboratory Accreditation Program documentation is included as **Appendix C**.

Per Partnering Team decisions, all samples will be analyzed for select PFCs (six PFCs identified in the Unregulated Contaminant Monitoring Rule 3) [USEPA, 2012] and screened against the USEPA Lifetime Drinking Water Health Advisory Limits and Regional Screening Levels. Project decisions will only be made based on PFCs with screening criteria (perfluorooctanesulfonic acid [PFOS], perfluorooctanoic acid [PFOA], and perfluorobutanesulfonic acid [PFBS]). The other PFC results will be used for informational purposes only and may be necessary for future evaluation, if screening criteria are established.

Based on the results of the Phase I event, Phase II sampling may be completed, to include additional monitoring well installation and groundwater sampling if further investigation is needed to determine potential release areas.

The Phase II investigation will follow the procedures described in this SAP, but locations will be identified based on the results of the Phase I sampling. Should PFCs be present at levels greater than available screening values after Phase II sampling, then additional investigation and risk assessment will be completed as part of a remedial investigation, which would be discussed in a separate SAP.

SAP Worksheets

| | |
|--|----------|
| Approval Signatures | 3 |
| Executive Summary | 5 |
| Abbreviations and Acronyms | 9 |
| SAP Worksheet #1—Title and Approval Page | 1 |
| SAP Worksheet #2—SAP Identifying Information | 11 |
| SAP Worksheet #3—Distribution List | 13 |
| SAP Worksheet #4—Project Personnel Sign-Off Sheet | 15 |
| SAP Worksheet #5—Project Organizational Chart | 17 |
| SAP Worksheet #6—Communication Pathways..... | 19 |
| SAP Worksheet #7—Personnel Responsibilities Table | 23 |
| SAP Worksheet #8—Special Personnel Training Requirements Table | 25 |
| SAP Worksheet #9-1—Project Scoping Session Participants Sheet Summary | 27 |
| SAP Worksheet #9-2—Project Scoping Session Participants Sheet Summary | 29 |
| SAP Worksheet #9-3—Project Scoping Session Participants Sheet Summary | 30 |
| SAP Worksheet #10—Conceptual Site Model | 31 |
| SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements | 35 |
| SAP Worksheet #12-1—Measurement Performance Criteria Table – Field QC Samples..... | 37 |
| SAP Worksheet #12-2—Measurement Performance Criteria Table – Field QC Samples..... | 38 |
| SAP Worksheet #13—Secondary Data Criteria and Limitations Table | 39 |
| SAP Worksheet #14—Summary of Project Tasks | 41 |
| SAP Worksheet #15—Reference Limits and Evaluation Table | 45 |
| SAP Worksheet #16—Project Schedule/Timeline Table..... | 47 |
| SAP Worksheet #17—Sampling Design and Rationale | 49 |
| SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table..... | 53 |
| SAP Worksheet #19—Analytical SOP Requirements Table | 57 |
| SAP Worksheet #20—Field Quality Control Sample Summary Table..... | 59 |
| SAP Worksheet #21—Project Sampling SOP References Table | 61 |
| SAP Worksheet #22—Field Equipment Calibration, Maintenance, Testing, and Inspection Table | 63 |
| SAP Worksheet #23—Analytical SOP References Table | 65 |
| SAP Worksheet #24—Analytical Instrument Calibration Table..... | 67 |
| SAP Worksheet #25—Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table | 69 |
| SAP Worksheet #26—Sample Handling System | 71 |
| SAP Worksheet #27—Sample Custody Requirements Table | 73 |
| SAP Worksheet #28-1—Laboratory QC Samples Table | 75 |
| SAP Worksheet #29—Project Documents and Records Table | 77 |
| SAP Worksheet #30—Analytical Services Table | 79 |
| SAP Worksheet #31—Planned Project Assessments Table..... | 81 |

SAP Worksheet #32—Assessment Findings and Corrective Action Responses 83
SAP Worksheet #32-1—Laboratory Corrective Action Form..... 85
SAP Worksheet #32-2—Field Performance Audit Checklist 87
SAP Worksheet #33—QA Management Reports Table 89
SAP Worksheet #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process Table..... 91
SAP Worksheet #37—Usability Assessment..... 93
References 95

Appendixes

- A Fire Department Interview Report
- B Field SOPs
- C DoD ELAP Letter
- D Vista Analytical Laboratory SOP 49

Tables

- 1 Previous Environmental Investigations at NAS Oceana Potential PFC Source Areas
- 2 Problem Definitions/Objectives, Environmental Questions, and Project Quality Objectives

Figures

- 1 Installation Location Map
- 2 Proposed Monitoring Well Locations – Basewide
- 3 Proposed Monitoring Well Locations – Site 11
- 4 Water Level Survey Locations
- 5 Decision Tree

Abbreviations and Acronyms

| | |
|--------|--|
| °C | degree Celsius |
| µg/kg | microgram per kilogram |
| µg/L | microgram per liter |
| AFFF | aqueous film-forming foam |
| AM | Activity Manager |
| amsl | above mean sea level |
| AQM | Activity Quality Manager |
| bgs | below ground surface |
| CA | corrective action |
| CCV | Continuing Calibration Verification |
| CERCLA | Comprehensive Environmental Response Compensation, and Liability Act |
| CH2M | CH2M HILL, Inc. |
| CLEAN | Comprehensive Long-term Environmental Action—Navy |
| DO | dissolved oxygen |
| DoD | Department of Defense |
| DQO | data quality objective |
| DV | Data Validator |
| EDD | electronic data deliverable |
| ELAP | Environmental Laboratory Accreditation Program |
| FB | field blank |
| FTL | Field Team Leader |
| H&S | health and safety |
| HHRA | human health risk assessment |
| HQ | hazard quotient |
| HSO | Health and Safety Officer |
| HSP | Health and Safety Plan |
| ICAL | initial calibration |
| IDW | investigation-derived waste |
| LCS | Laboratory Control Samples |
| MS | Matrix Spike |
| MSD | Matrix Spike Duplicate |
| N/A | not applicable |
| NAS | Naval Air Station |
| NAVFAC | Naval Facilities Engineering Command |
| Navy | Department of the Navy |
| NIRIS | Naval Installation Restoration Information System |
| ORP | oxidation-reduction potential |
| PAL | project action limits |
| PC | Project Chemist |
| PFC | perfluorinated compound |
| PFBS | perfluorobutanesulfonic acid |
| PFHpA | perfluoroheptanoic acid |

| | |
|-------|---|
| PFHxS | perfluorohexanesulfonic acid |
| PFNA | perfluorononanoic acid |
| PFOA | perfluorooctanoic acid |
| PFOS | perfluorooctanesulfonic acid |
| POL | petroleum-oil-lubricant |
| PM | Project Manager |
| POC | point of contact |
| PQL | project quantitation limit |
| PQO | project quality objectives |
| PVC | polyvinyl chloride |
| QA | quality assurance |
| QAO | Quality Assurance Officer |
| QC | quality control |
| QSM | Quality Systems Manual |
| RL | reporting limit |
| RPD | relative percent difference |
| RPM | Remedial Project Manager |
| RSD | relative standard deviation |
| RSL | regional screening level |
| SAP | Sampling and Analysis Plan |
| SI | site investigation |
| SME | Subject Matter Expert |
| SOP | standard operating procedure |
| SSC | Site Safety Coordinator |
| STC | Senior Technical Consultant |
| SWMU | solid waste management unit |
| SVOC | semivolatile organic compound |
| TBD | to be determined |
| UFP | Uniform Federal Policy |
| USEPA | United States Environmental Protection Agency |
| VDEQ | Virginia Department of Environmental Quality |

SAP Worksheet #2—SAP Identifying Information

Site Name/Number: Naval Air Station (NAS) Oceana, Site 11 (Firefighting Training Area), SWMU 26 (Fire Station Burn Pit), SWMUs 2B, 2C, and 2E (Line Shack SWMUs), and other identified potential release sites of aqueous film-forming foam (AFFF) (**Appendix A**)

Operable Unit: Not applicable (N/A)

Contractor Name: CH2M HILL, Inc. (CH2M)

Contract Number: N62470-11-D-8012, Contract Task Order WE44

Contract Title: Comprehensive Long-term Environmental Action—Navy (CLEAN) 8012

1. This Uniform Federal Policy (UFP)-Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the following documents:
 - *Uniform Federal Policy for Quality Assurance Plans* (USEPA, 2005)
 - *Guidance for Quality Assurance Project Plans*, EPA QA/G-5, QAMS (USEPA, 2002)
2. Identify regulatory program:
 - Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
3. This is a project-specific SAP.
4. List organizational partners (stakeholders) and connection with lead organization:

| Organization Partners/Stakeholders | Connection |
|--|-------------------------|
| United States Environmental Protection Agency (USEPA) | Lead Regulatory Agency |
| Virginia Department of Environmental Quality (VDEQ) | State Regulatory Agency |
| Department of Defense (DoD) | Land Owner |
| Naval Facilities Engineering Command (NAVFAC), Mid-Atlantic Division | Lead Organization |

5. If any required SAP elements or required information are not applicable to the project or are provided elsewhere, then note the omitted SAP elements and provide an explanation for their exclusion below:
 - All required UFP-SAP elements are included in this UFP-SAP; therefore, the crosswalk table is not necessary for this project.
6. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.
 - No previous SAPs have been completed that are relevant to the current investigation.

This page intentionally left blank.

SAP Worksheet #3—Distribution List

| Name of SAP Recipients | Title/Role | Organization | Telephone Number | E-mail Address or Mailing Address | Document Control Number |
|------------------------|--|-----------------------------|------------------|-----------------------------------|-------------------------|
| Angela Jones | Remedial Project Manager (RPM) | NAVFAC Mid-Atlantic | (757) 341-0485 | angela.jones1@navy.mil | EN1125151022VBO |
| Rob Thomson | RPM | USEPA Region 3 | (215) 814-3357 | rob.thomson@epa.gov | |
| Steve Mihalko | RPM | VDEQ | (804) 698-4202 | stephen.mihalko@deq.virginia.gov | |
| Bonnie Capito | Librarian | NAVFAC Atlantic | (757) 322-4785 | bonnie.capito@navy.mil | |
| Laura Cook | Activity Manager (AM)/Project Manager (PM) | CH2M | (757) 671-6214 | laura.cook@ch2m.com | |
| Juliana Dean | Deputy AM | CH2M | (757) 671-6232 | juliana.dean@ch2m.com | |
| Anita Dodson | Program Chemist | CH2M | (757) 671-6218 | anita.dodson@ch2m.com | |
| Tiffany Hill | Project Chemist (PC) | CH2M | (541) 768-3109 | tiffany.hill@ch2m.com | |
| John Tomik | Activity Quality Manager (AQM)/Senior Technical Consultant (STC) | CH2M | (757) 671-6259 | john.tomik@ch2m.com | |
| Bill Diguisseppi | Emerging Contaminants Subject Matter Expert (SME) | CH2M | (720) 409-9271 | bill.diguisseppi@ch2m.com | |
| Mark Ost | Field Team Leader (FTL) | CH2M | Mark Ost | mark.ost@ch2m.com | |
| Martha Maier | Vista PM | Vista Analytical Laboratory | (916) 673-15200 | mmaier@vista-analytical.com | |
| Herb Kelly | Data Validator (DV) | CH2M | (352) 384-7100 | Herb.kelly@ch2m.com | |

This page intentionally left blank.

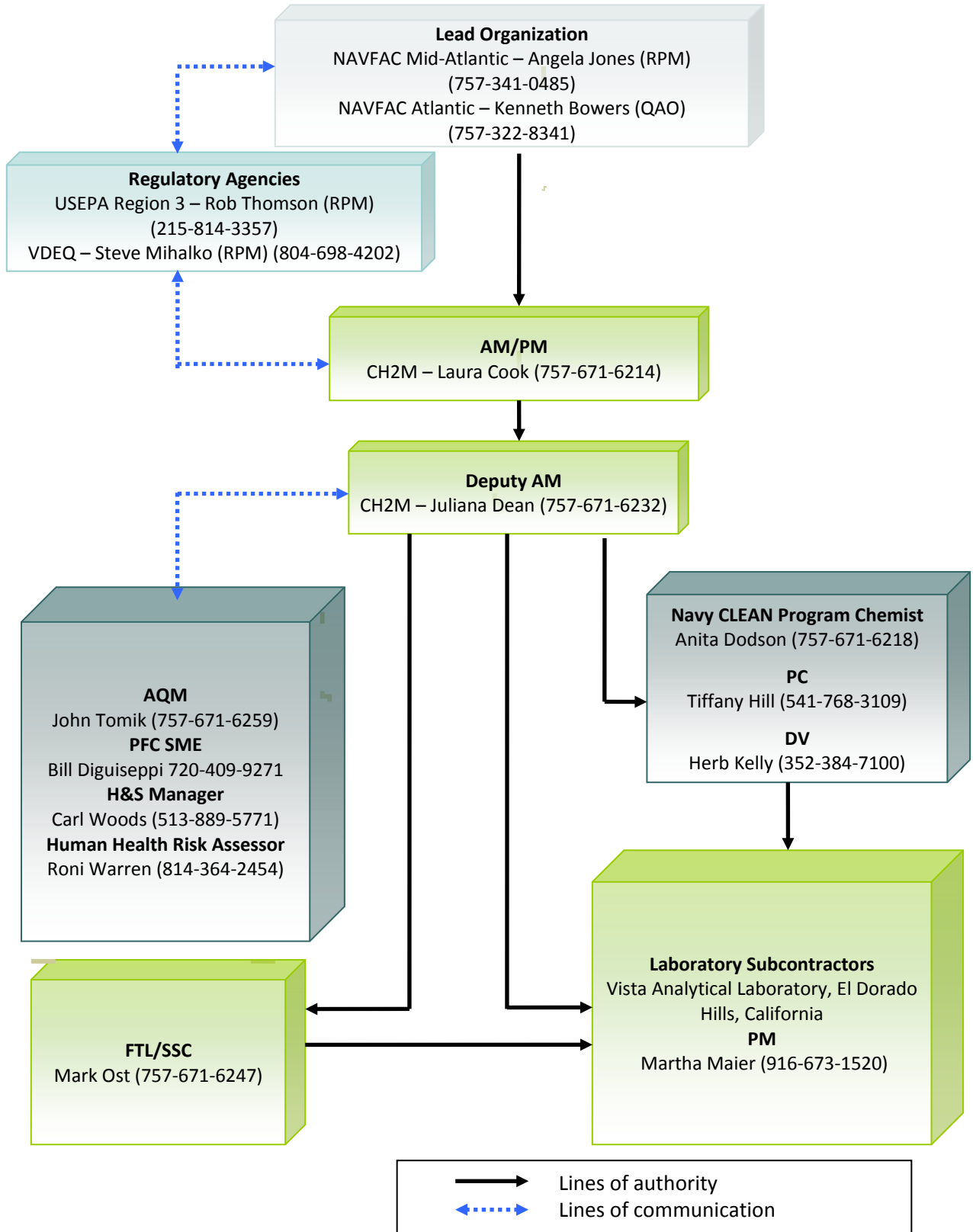
SAP Worksheet #4—Project Personnel Sign-Off Sheet

| Name | Organization/Title/Role | Telephone Number (optional) | Signature/E-mail Receipt | SAP Section Reviewed | Date SAP Read |
|----------------|--|-----------------------------|--------------------------|----------------------|---------------|
| Laura Cook | CH2M/AM | (757) 671-6214 | | | |
| John Tomik | CH2M AQM/STC | (757) 671-6259 | | | |
| Anita Dodson | CH2M/Program Chemist | (757) 671-6218 | | | |
| Angela Jones | NAVFAC Mid-Atlantic RPM | (757) 341-0485 | | | |
| Kenneth Bowers | NAVFAC Chemist/Quality Assurance Officer (QAO) | (757) 322-8341 | | | |
| Rob Thomson | USEPA Region 3 RPM | (215) 814-3357 | | | |
| Steve Mihalko | VDEQ RPM | (804) 698-4202 | | | |
| Martha Maier | Vista PM | (916) 673-1520 | | | |

Each organization will read the SAP and provide an original copy of the sign-off sheet to the PM for maintenance in the central project file.

This page intentionally left blank.

SAP Worksheet #5—Project Organizational Chart



This page intentionally left blank.

SAP Worksheet #6—Communication Pathways

| Communication Drivers | Responsible Affiliation | Name | Phone Number and/or e-mail | Procedure |
|--|---|----------------|----------------------------|---|
| Communication with NAVFAC (lead agency) | Navy RPM for NAS Oceana | Angela Jones | 757-341-0485 | Primary point of contact (POC) for Navy; communicates directly with VDEQ and USEPA as needed. Can delegate communication to other internal or external POCs. |
| Communication with VDEQ | VDEQ RPM | Steve Mihalko | 804-698-4202 | Primary POC for VDEQ; communicates directly with the Navy and USEPA as needed. Can delegate communication to other internal or external POCs. Upon notification of field changes, VDEQ will have 24 hours to approve or comment on the field changes. All data results will be presented and discussed during partnering meetings. |
| Communication with USEPA | USEPA RPM | Rob Thomson | 215-814-3357 | Primary POC for USEPA; communicates directly with the Navy and VDEQ as needed. Can delegate communication to other internal or external POCs. Upon notification of field changes, USEPA will have 24 hours to approve or comment on the field changes. All data results will be presented and discussed during partnering meetings. |
| Navy Quality Assurance (QA)/Quality Control (QC) input | NAVFAC Chemist/QAO | Kenneth Bowers | 757-322-8341 | Provides review comments to Navy contractor on Pre-draft SAP via Navy Installation Restoration Information System (NIRIS) submittal. Provides overall Navy guidance via direct communication with Navy contractor chemist, as warranted. |
| Program QC and Oversight | CH2M AQM/STC | John Tomik | 757-671-6259 | Provides quality and technical oversight to the project. |
| Communication to/from Navy contractor (e.g., submission of SAP for review; receipt of regulatory comments, updates on project progress, communication of stakeholder expectations) | CH2M Program SAP reviewer | Janna Staszak | 757-671-6256 | Provides senior technical oversight of the SAP. |
| Communication regarding overall project status and implementation and primary POC with Navy RPM, USEPA, and VDEQ | CH2M Naval Air Station (NAS) Oceana AM/PM | Laura Cook | 757-671-6214 | Primary POC for stakeholder agency managers; can delegate agency communication to other contract staff, as appropriate. All information and materials about the project will be forwarded to the Partnering Team by the AM. The AM oversees all NAS Oceana projects. If field changes occur during investigation activities, the AM/PM will work with the Navy RPM to communicate the field changes to the Partnering Team via email and/or phone within 24 hours. All data will be communicated to the Partnering Team via email and meetings. |

SAP Worksheet #6—Communication Pathways (continued)

| Communication Drivers | Responsible Affiliation | Name | Phone Number and/or e-mail | Procedure |
|---|--------------------------------------|-----------------|-------------------------------------|--|
| Communication regarding PFCs | CH2M PFC Technical Resource | Bill Diguiseppi | 720-409-9271 | Provide support on PFC aspects of project fieldwork and data analysis and reporting. |
| Health and Safety (H&S) expectations and procedures | CH2M Health and Safety Officer (HSO) | Mark Orman | 414-847-0597 414-712-4138 (cell) | Review of Health and Safety Plan (HSP). Direct communication (via email, telephone, hardcopy, or in person, will be notified within 24 hours of any H&S incident) to/from Navy contractor project staff to ensure implementation of appropriate H&S procedures. |
| Implementation of sampling activities; SAP changes in the field; field corrective actions (CAs); daily field progress reports. | CH2M FTL | Mark Ost | 757-671-6247 | Documentation of deviations from SAP in field logbooks and rationale for deviations, made within 24 hours of deviation; deviations made only with approval from contractor PM and/or environmental manager. See Worksheet #32 Assessment Findings and CA Responses and Worksheet #32-1 CA Form. The FTL will immediately notify the PM of any field issues that would negatively impact the ability to meet project data quality objectives (DQOs), or would negatively impact project schedule. The AM or PM may notify the Navy RPM. FTL will email or fax daily field progress reports to contractor PMs weekly; telephone communication with PMs on as-needed basis. |
| Ensure staff H&S in the field | CH2M Site Safety Coordinator (SSC) | Mark Ost | 757-671-6247 | Daily safety tailgates; daily observations; real-time discussions of observations and changes to be implemented with field staff. |
| Data tracking from collection through upload to database. Management of analytical lab and data validation subcontractors. Analytical CAs/release of analytical data. | CH2M PC | Tiffany Hill | 541-768-3109 | Tracks data from sample collection through upload to the database, ensuring SAP requirements are met by laboratory and field staff. Will act as main POC for laboratory QAO. The CH2M AM and PM are informed within 24 hours to pass on communications to Navy and regulators as required. Analytical laboratory CAs will be identified by, or brought to the attention of, the PC as soon as they are discovered. Facilitates resolution on a same-day basis after consulting with the PM and AQM and the Navy chemist (if changes in the SAP are warranted) to ensure SAP requirements are met by the laboratory. Communicates with subs by phone, followed up with e-mail to document decisions and actions Should analytical laboratory issues affect data usability by rendering a significant amount of rejectable or unusable data such that the project completeness goal cannot be obtained, the PC will notify the project team including the Navy RPM and Navy QAO. |

SAP Worksheet #6—Communication Pathways (continued)

| Communication Drivers | Responsible Affiliation | Name | Phone Number and/or e-mail | Procedure |
|--|---|--|--|---|
| Reporting Laboratory Data Quality Issues | Laboratory PM | Martha Maier | 916-673-1520 | All QA/QC issues with project filed samples will be reported by the laboratory to the PC within 1 business day. The second-tier subcontracted laboratory will report all data quality issues to the primary subcontracted laboratory PM as soon as the QA/QC issue is identified. |
| Field and Analytical CAs | CH2M Program Chemist CH2M PC CH2M FTL | Anita Dodson Tiffany Hill Mark Ost | 757-671-6218 541-768-3109 757-671-6247 | The need for CA for field and analytical issues will be determined by the FTL and or Contractor Chemist. |
| Stop Work Order | CH2M AM FTL/SSC Field Team Members | Laura Cook Mark Ost | 757-671-6214 757-671-6247 | Any field member can immediately stop work if an unsafe condition which is immediately threatening to human health is observed. The field staff, FTL, or SSC, should notify the CH2M AM/PM immediately along with the Navy RPM. Ultimately, the FTL or AM/PM can stop work for a period of time. NAVFAC Mid-Atlantic can stop work at any time. |
| Reporting data quality issues | DV | Herb Kelly | 352-384-7100 | The DV reviews and qualifies analytical data as necessary. The data along with a validation narrative are returned to the PC within 14 calendar days. |
| Risk Assessment Support | CH2M Human Health Risk Assessment (HHRA) Lead | Roni Warren | 814-364-2454 | Risk assessment lead will oversee the preparation of the risk screening. |

This page intentionally left blank.

SAP Worksheet #7—Personnel Responsibilities Table

| Name | Title/Role | Organizational Affiliation | Responsibilities |
|----------------|-----------------------------------|----------------------------|--|
| Angela Jones | RPM | NAVFAC | Coordinates all environmental activities at NAS Oceana. |
| Kenneth Bowers | NAVFAC Chemist/QAO | NAVFAC | Navy Review of SAP and QA input. |
| Laura Cook | AM/PM | CH2M | Responsible for Environmental Restoration Program at NAS Oceana. Responsible for administration; coordinates staffing; monitors project performance; directs and oversees project staff. |
| John Tomik | AQM/STC | | Provides activity-level quality review and guidance. Provides senior technical oversight. |
| Anita Dodson | Navy CLEAN Program Chemist | | Provides guidance during preparation of UFP-SAP. Provides program level review of UFP-SAP. |
| Janna Staszak | Program Level SAP Reviewer | | Provides guidance during preparation of UFP-SAP. Provides program level review of UFP-SAP. |
| Bill Diguseppi | PFC Technical Resource | | Provides support during PFC fieldwork and data analysis and reporting. |
| Tiffany Hill | PC | | Preparation of chemistry specific UFP-SAP worksheets. Ensure proper data tracking, reporting, and maintaining communication with contracted laboratory. Responsible for coordination of laboratory deliverables. Ensures that laboratory adheres to requirements in UFP-SAP. |
| Mark Ost | FTL | | Supervises and coordinates all field activities and responsible for overseeing subcontractors. |
| Mark Orman | HSO | | Oversees H&S for field activities. |
| Roni Warren | Senior Human Health Risk Assessor | | Conducts HHRA to identify possible impacts to receptors. |
| Martha Maier | Laboratory PM | Vista | Manages analytical projects from initiation to completion. |
| Herb Kelly | DV | CH2M | Responsible for validation of environmental data. |

This page intentionally left blank.

SAP Worksheet #8—Special Personnel Training Requirements Table

No specialized training beyond standard H&S training is required for this project.

This page intentionally left blank.

SAP Worksheet #9-1—Project Scoping Session Participants Sheet Summary

| Project Name: NAS Oceana Basewide Site Inspection for PFCs Projected Date(s) of Sampling: Fall 2016 PM: Laura Cook | | Site Name: NAS Oceana Site Location: NAS Oceana, Virginia Beach, Virginia | | |
|---|-------------------------------|--|--------------|----------------------------------|
| Date of Session: March 21, 2016 Scoping Sessions Purpose: Agree on Site Investigation (SI) Approach | | | | |
| Name | Project Role | Affiliation | Phone # | E-mail Address |
| Angela Jones | Navy Technical Representative | NAVFAC Mid-Atlantic | 757-341-0485 | angela.jones@navy.mil |
| Steve Mihalko | VDEQ RPM | VDEQ | 804-698-4202 | stephen.mihalko@deq.virginia.gov |
| Kathy Davies | Hydrogeologist | USEPA | 215-814-3315 | davies.kathy@epa.gov |
| Rob Thomson | USEPA RPM | USEPA | 215-814-3357 | thomson.bob@epa.gov |
| Laura Cook | AM/PM | CH2M | 757-671-6214 | laura.cook@ch2m.com |
| Juliana Dean | Deputy AM | CH2M | 757-671-6232 | juliana.dean@ch2m.com |

A scoping session was held to discuss the project background and objectives for the NAS Oceana Basewide Site Inspection for PFCs. The objectives for this investigation are to determine if PFCs are present in groundwater at or in the vicinity of potential source areas and, if present, determine the potential for PFCs to migrate off-Base.

The Team reviewed the historical investigations completed at the Firefighting Training Area (also known as Site 11, SWMU 11, SWMU 62, and SWMU 63) and SWMU 26 (also known as SWMU 65) at NAS Oceana, which are potential PFC source areas due to the use of AFFF during firefighter training activities at these sites. The Team also reviewed additional potential PFC sources that were identified based on Fire Department interviews. In addition to Site 11 and SWMU 26, AFFF releases may have occurred at the following locations (**Figure 2** and **Appendix A**):

- At the site of a 1986 plane crash off of Oceana Boulevard
- At the site of a 1996 plane crash in the woods southeast of the runway
- At the site of a 2007 civilian plane crash near runway 5L
- At the site of a 2012 off-Base crash near the Mayview Apartments in Virginia Beach
- Near the Hush House, where an accidental AFFF release occurred
- In Building 145 (near the aircraft hangars), Hangar 111, Building 139, and Hangar 122, where accidental AFFF releases and/or spills occurred
- In Hangar 500, where an AFFF activation used to occur monthly due to sensitive sensors causing releases

Proposed monitoring well locations in the vicinity of potential source areas listed above were discussed, as well as locations of existing petroleum-oil-lubricant (POL) program monitoring wells that could be sampled. The location of offsite crashes that could also be possible PFC source areas were discussed; however, this investigation will not include off-Base sampling. The Partnering Team agreed to the following proposed sampling strategy:

- Install and sample seven shallow wells at and north of Site 11 (one well upgradient of each former fire training ring, one well downgradient of each former fire training ring, one well in the land application area [downgradient of the former fire training rings], one well east of the fire training ring north of Site 11)
- Install and sample one shallow well downgradient of SWMU 26

SAP Worksheet #9-1—Project Scoping Session Participants Sheet Summary (continued)

- Sample one existing well or install and sample one shallow well in the vicinity of each potential AFFF release area (one well at the private plane crash on the runway, one well at the site of the 1995 crash, one well at the Hush House, and one well at the site of the 1986 crash near Oceana Boulevard)
- Sample three existing wells in the vicinity of the aircraft hangars and maintenance buildings, where accidental AFFF releases occurred, for PFCs
- Evaluate locations of existing background and POL wells near all potential source areas to minimize the number of new wells to be installed
- Evaluate Basewide groundwater flow direction, velocity, and gradient (both vertical and horizontal) using a water level survey and slug tests

The Partnering Team agreed to the following analyses (consistent with Unregulated Contaminant Monitoring Rule 3):

- Perfluorooctane sulfonate (PFOS)
- Perfluorooctanoic acid (PFOA)
- Perfluorononanoic acid (PFNA)
- Perfluorohexanesulfonic acid (PFHxS)
- Perfluoroheptanoic acid (PFHpA)
- Perfluorobutanesulfonic acid (PFBS)

The Team agreed that PFCs will be screened against the USEPA Provisional Health Advisory (the Provisional Health Advisory Limits were replaced by USEPA's Lifetime Health Advisory Limits in May 2016). The Team agreed that if PFCs exceed screening criteria in any of the samples, additional sampling (including additional monitoring wells) may be completed, based on the nature and extent of the initial detections. Any additional sampling approach will be agreed to by the Partnering Team prior to field mobilization.

SAP Worksheet #9-2—Project Scoping Session Participants Sheet Summary

| Project Name: NAS Oceana Basewide Site Inspection for PFCs Projected Date(s) of Sampling: Fall 2016 PM: Laura Cook | | Site Name: NAS Oceana Site Location: NAS Oceana, Virginia Beach, Virginia | | |
|--|-------------------------------|--|--------------|----------------------------------|
| Date of Session: June 15, 2016 Scoping Sessions Purpose: Provide status update on current UFP-SAPs (including that for the Basewide Site Inspection for PFCs) | | | | |
| Name | Project Role | Affiliation | Phone # | E-mail Address |
| Angela Jones | Navy Technical Representative | NAVFAC Mid-Atlantic | 757-341-0485 | angela.jones@navy.mil |
| Tom Kowalski | Navy Supervisor | NAVFAC Mid-Atlantic | 757-341-0483 | Tom.kowalski@navy.mil |
| Steve Mihalko | VDEQ RPM | VDEQ | 804-698-4202 | stephen.mihalko@deq.virginia.gov |
| Rob Thomson | USEPA RPM | USEPA | 215-814-3357 | thomson.bob@epa.gov |
| Laura Cook | AM/PM | CH2M | 757-671-6214 | laura.cook@ch2m.com |
| Juliana Dean | Deputy AM | CH2M | 757-671-6232 | juliana.dean@ch2m.com |

A scoping session was held to discuss the status of NAS Oceana Basewide Site Inspection for PFCs and address the proposed sampling approach. Following the first scoping session, existing monitoring well locations were field verified and the following revised sampling locations were proposed:

- Ten existing monitoring wells along the perimeter of the Base (previously used for background evaluation) and one new monitoring well near the northeast corner of the Base to assess the potential for offsite migration
- One existing monitoring well and six new monitoring wells at Site 11 to determine the presence of absence of PFCs in groundwater at Site 11
- Three existing monitoring wells in the vicinity of the aircraft hangars and maintenance buildings to determine the presence of absence of PFCs in groundwater at these potential release areas
- One new monitoring well at SWMU 26 to determine the presence or absence of PFCs in groundwater at SWMU 26
- One new monitoring well near the location of the 1986 crash to determine the presence or absence of PFCs in groundwater as a result of possible AFFF use at the crash site
- One existing monitoring well near the location of the 1996 crash to determine the presence of absence of PFCs in groundwater as a result of possible AFFF use at the crash site

The Team agreed on the proposed monitoring well network.

Follow-up decisions: One well on the west side of the existing Fuel Farm POL site was identified for inclusion in the perimeter assessment and an existing well in the FITWING POL area was added to assess conditions in the vicinity of the 2007 crash location. Proposed sampling locations were emailed to the Partnering Team and the entire team agreed on the field approach in August 2016.

SAP Worksheet #9-3—Project Scoping Session Participants Sheet Summary

| Project Name: NAS Oceana Basewide Site Inspection for PFCs | | Site Name: NAS Oceana | | |
|---|-------------------------------|--|--------------|----------------------------------|
| Projected Date(s) of Sampling: Fall 2016 | | Site Location: NAS Oceana, Virginia Beach, Virginia | | |
| PM: Laura Cook | | | | |
| Date of Session: September 15, 2016 | | | | |
| Scoping Sessions Purpose: Provide update on proposed sampling approach for Basewide PFC SI | | | | |
| Name | Project Role | Affiliation | Phone # | E-mail Address |
| Angela Jones | Navy Technical Representative | NAVFAC Mid-Atlantic | 757-341-0485 | angela.jones@navy.mil |
| Steve Mihalko | VDEQ RPM | VDEQ | 804-698-4202 | stephen.mihalko@deq.virginia.gov |
| Rob Thomson | USEPA RPM | USEPA | 215-814-3357 | thomson.bob@epa.gov |
| Kathy Davies | USEPA Hydrogeologist | USEPA | 215-814-3315 | davies.kathy@epa.gov |
| Laura Cook | AM/PM | CH2M | 757-671-6214 | laura.cook@ch2m.com |
| Juliana Dean | Deputy AM | CH2M | 757-671-6232 | juliana.dean@ch2m.com |

A scoping session was held to discuss the revised proposed sampling procedure of NAS Oceana Basewide Site Inspection for PFCs, following a reinterpretation of the 2015 PFC Interim Guidance issued by the Navy (Navy, 2015). Following the previous scoping session, the policy was reinterpreted, requiring off-Base drinking water sources within 1 mile downgradient of potential PFC source areas to be sampled for PFCs if groundwater is used as a drinking water source, prior to initiating any on-Base investigation. The following updates to the sampling approach were proposed:

- Prior to on-Base investigation, private residences within 1 mile downgradient of potential PFC source areas will be evaluated to determine whether any properties use groundwater as a drinking water source.
- In order to determine Basewide groundwater flow, piezometers will be installed prior to SAP finalization and water level surveys will be completed on a network on existing wells, in addition to the newly installed piezometers.
- One golf course irrigation well will be added to the proposed monitoring well network to assess conditions in the southeast area of the Base.
- In order to achieve lower reporting limits, all samples (including drinking water) will be analyzed for PFCs via Modified USEPA Method 537.

The Team agreed on the above changes to the sampling approach and the following additions to the proposed monitoring well network:

- Proposed monitoring well OC-MW01 (in the vicinity of the 1986 Crash Site) will be moved to the southeast, to ensure the sample is representative of groundwater downgradient of the crash site.
- Two additional wells will be added to the proposed sampling approach: OC-MW03 (downgradient of the 1996 Crash Site) and OC-MW04 (downgradient of the Hush House Reported AFFF Release).

The Partnering Team agreed that, prior to SAP finalization, piezometers can be installed and, pending the results of the water level survey, drinking water samples may be collected from downgradient drinking water sources

SAP Worksheet #10—Conceptual Site Model

Installation Background

NAS Oceana (**Figure 1**) is located in Virginia Beach, Virginia and was established in 1940 as a small auxiliary airfield. Since 1940, NAS Oceana has grown to more than 16 times its original size and is now a 6,000-acre master jet base supporting a community of more than 9,100 Navy personnel and 11,000 dependents. The primary mission of NAS Oceana is to provide the personnel, operations, maintenance, and training facilities to ensure that fighter and attack squadrons on aircraft carriers of the U.S. Atlantic Fleet are ready for deployment.

NAS Oceana Physical Characteristics

Topography at NAS Oceana is relatively flat, with the elevation ranging from 5 feet above mean sea level (amsl) to 25 feet amsl with a gradual easterly slope. Surface runoff from the Base is directed to a system of drainage ditches and surface canals, which flow west to West Neck creek, north to London Bridge and Great Neck Creeks, and east to Owls Creek and Lake Rudee (CH2M, 2001).

NAS Oceana is on the outer edge of the Atlantic Coastal Plain physiographic province. The Atlantic Coastal Plain is a broad wedge of unconsolidated sediments that dip and thicken to the east. In the vicinity of NAS Oceana, the sediments consist of several thousand feet of unconsolidated sand, clay, silt, and gravel, and are underlain by granite basement rock. The sediments range in age from early Cretaceous to Recent. From oldest to youngest, the four geologic units underlying NAS Oceana are (1) the Potomac Formation, (2) the Pamunkey Group, (3) the Chesapeake Group, and (4) the Columbia Group (Meng and Harsh, 1984). The geologic units of concern in the environmental investigations at the NAS Oceana are in the Chesapeake Group (only the youngest unit, the Yorktown Formation) and the Columbia Group. The Chesapeake Group has been differentiated into several units, which are, from oldest to youngest, the Calvert, Choptank, St. Mary's, Eastover, and Yorktown Formations. The subsurface at NAS Oceana consists of three stratigraphic units. The uppermost unit is a 4- to 8-foot-thick unit of fine sediments, mainly silty clays and silty sands, which is underlain by a 15- to 20-foot layer of poorly graded fine to medium sand with some silty lenses. The two units correspond to the Columbia Group sediments. The Columbia Group is underlain by the Yorktown formation, which consists of silty sand interbedded with zones of cleaner sand. Shells and shell hash indicative of the top of the Yorktown formation have been typically encountered at approximately 25 feet below ground surface (bgs).

Groundwater at NAS Oceana is generally within 4 to 10 feet of the ground surface. The surficial hydrogeologic unit consists of the Columbia aquifer, which extends to a depth of approximately 17 to 30 feet bgs at the installation. This unit is underlain by the Yorktown-Eastover aquifer. The Yorktown confining unit has not been encountered during drilling activities at NAS Oceana. No monitoring wells or water supply wells at the Base have been installed to the total depth of the Yorktown-Eastover aquifer, but the approximate thickness of the unit is 100 feet based on *The Virginia Coastal Plain Hydrogeologic Framework* (USGS, 2006).

Basewide groundwater flow at NAS Oceana is generally south to southeast, but flow direction in the Columbia aquifer is toward surface water bodies and drainage ditches. Therefore, the flow direction is highly variable due to complex drainage patterns.

PFC Source Areas Background and Investigation History

The background and investigation history for areas identified as having been potentially impacted by discharges of AFFF are presented in **Table 1**. Potential source areas are also depicted on **Figure 2**.

SAP Worksheet #10—Conceptual Site Model (continued)

TABLE 1

Background and Previous Environmental Investigations at NAS Oceana Potential PFC Source Areas

| Potential AFFF Release Area | Details |
|--|--|
| Site 11, Fire Training Area | Site 11 was used for firefighting training twice per week from the 1960s to the 1980s. Initially, training exercises were performed on the abandoned runway. Waste fuel and oil were dumped onto the runway, ignited, and extinguished with AFFF. In 1969, the annual usage of AFFF was estimated to be 2,000 gallons. In the mid-1970s, the first fire training ring (SWMU 62, the Old Burn Pit) was installed with an earthen berm to contain runoff. After construction of the first ring, training exercises were performed within the earthen berm and runoff would occasionally flow onto surrounding soils. In the early 1980s, a second fire training ring (SWMU 63, the New Burn Pit) was installed on a concrete pad with a concrete berm and an oil/water separator to contain POL. In the 1990s, a third training ring was built to the north as a jet mock-up on a concrete pad with runoff collection devices. Historical use does not indicate that AFFF was used at the jet mock-up, but trucks are currently tested quarterly near this area by spraying AFFF onto the grass near the ring. In 2001, Site 11 (referred to as SWMU 11 in that report) was closed with no further action (CH2M, 2001). Site 11 is being evaluated for PFCs due to firefighting training activities historically conducted at the site. Areas identified at Site 11 for potential AFFF use include the firefighting training rings and the land application area to the southwest, where burned residues from the training area were potentially disposed (Figure 3). |
| SWMU 26, Fire Station Burn Pit | SWMU 26, southeast of Building 220 (Fire Station), was used for firefighting training activities from the 1960s to the 1980s and consisted of a partially buried tank that was filled with waste fuel and oil, ignited, and extinguished with AFFF. SWMU 26 was used for fire extinguisher training exercises from the 1960s to the 1980s. The tank was removed from the ground by 1990. In 2001, SWMU 26 was closed with no further action (CH2M, 2001b). |
| Aircraft Hangars and Maintenance Buildings | Several aircraft hangars and maintenance buildings were identified as potential AFFF release areas during NAS Oceana Fire Department interviews (Appendix A). In Building 145, AFFF was accidentally released into the parking lot. Personnel were advised to cover the storm drains and spray water to wash the AFFF onto the grass. A contractor was brought in to vacuum up any remaining foam. The date of this release is unknown. In Hangar 111, a release occurred during retrofit of the floor nozzles. The date of this release is unknown. In Hangar 500, an “activation” (which is technically not considered a “spill”) used to occur monthly due to sensitive sensors. The sensors have been adjusted and there have been no additional activations. The date range of the monthly activations is unknown. In Building 139, there was a spill at the corrosion control facility in 2010. There are no drains in that area and the foam was pushed outside to the grass swale on the southeast side of the building, and then cleaned up with a vacuum truck. In Building 139, there have been multiple releases, but the dates of these releases are unknown. In Hangar 122, a very large storm caused stormwater to back up and fill the overflow tanks in July 2011, releasing AFFF to the environment, including the storm drain and storm ditch. The Hampton Roads Sanitation District was notified of this release. |
| 1986 Crash Site | In 1986, a plane crashed off Oceana Boulevard near the Base boundary. Interviewees indicated that AFFF was probably used for this crash. |
| 1996 Crash Site | Interviewees indicated that a plane crashed in the woods on the installation in 1995. However, a local newspaper article indicated that the crash was in 1996 (Sizemore, 2012). This UFP-SAP will refer to this crash as the 1996 crash. Interviewees could not recall whether there was an associated fire and there is uncertainty associated with whether AFFF was used for this crash. |
| 2007 Crash Site | In 2007, a civilian plane crashed during an air show practice, right off runway 5L. Interviewees were not sure whether AFFF was used. |
| Hush House Reported AFFF Release | The Hush House (referred to as the Jet Test Cell) was first investigated in December 2003 as a result of a fuel release on November 24, 2003 (VDEQ, 2004). The Hush House is being evaluated for PFCs due to an accidental AFFF release in that area. During training in the 1100 area, an accidental AFFF release occurred. Personnel called Oceana Base Environmental personnel and were told to spray down the concrete area into the grass. |

SAP Worksheet #10—Conceptual Site Model (continued)

Potential Transport Pathways and Receptors

PFCs are associated with the use of AFFF. When AFFF is released into the environment due to intentional or inadvertent discharge, it may be released to groundwater as a result of infiltration from the soil. PFCs are frequently found in groundwater as they do not readily adsorb to soils. There is no known dermal or inhalation hazard associated with PFCs; therefore, the potential receptors of PFC contamination are current and future users of groundwater as a potable water source.

Groundwater is not currently used as a potable water supply on NAS Oceana. The Base and most properties surrounding the Base are connected to city water. However, based on property records, some properties are not connected to the municipal water supply and may use groundwater as a drinking water source. Non-potable wells are also located southeast of the Base boundary at a local campground and on the east side of the Base at the Natural Resources building. The possibility exists that people will accidentally use the water from these wells for potable purposes or incidentally ingest it during non-potable use. Irrigation wells are present at the Base golf course, but, based on conversations with NAS Oceana personnel, only one well extracts groundwater and could affect Basewide groundwater flow. Other wells are suspected to pump from irrigation ponds. At least two supply wells are located at fast food restaurants in the vicinity of the Base. No ecological risks will be assessed at this time.

This page intentionally left blank.

SAP Worksheet #11—Project Quality Objectives/Systematic Planning Process Statements

Problem Statement and Objectives

The investigation objectives for the SI are to:

- Determine whether PFCs have migrated offsite and are present at levels exceeding screening criteria in offsite drinking water.
- Determine whether PFCs are present at levels posing potentially unacceptable risks in groundwater in likely source areas and confirm suspected source areas at NAS Oceana.

Table 2 lists the environmental questions to be answered, the investigation approach, and the project quality objectives (PQOs). The decision tree for this investigation is presented on **Figure 5**.

TABLE 2
Problem Definitions, Environmental Questions, and Project Quality Objectives

| Problem Definition | Environmental Question | General Investigation Approach | Project Quality Objectives |
|--|---|--|---|
| Better refine understanding of hydraulic characteristics of the sites. | What are the groundwater flow direction, gradient, and velocity at the sites? | A network of new piezometers and existing monitoring wells will be gauged and groundwater contour maps will be generated to determine Basewide groundwater flow direction (Figure 4) prior to any off-Base or on-Base sampling. Slug tests will be completed at six wells (three Site 11 wells and three wells near the aircraft hangars) to determine hydraulic conductivity to allow for velocity calculations. | This information will be used to support planning for off-Base private drinking water sampling, and will be used to design a remedy if needed for PFCs in NAS Oceana groundwater. |
| Determine if PFCs have migrated offsite and are present at levels exceeding screening criteria in off-Base drinking water. | Do PFCs exceed screening criteria in off-Base drinking water? | Prior to on-Base investigation, downgradient off-Base properties with unknown water supply source, or with known potable wells, will be identified. Property owners will be surveyed to determine the use of the wells on their property. Any groundwater wells that are used as a drinking water source, will be sampled for PFCs. | If PFCs exceed screening criteria in any of the offsite drinking water samples, additional investigation and actions will be taken, following the decision logic presented on Figure 5 . |
| Determine if PFCs are present at levels posing potentially unacceptable risk in groundwater. | Do PFC concentrations exceed screening criteria in groundwater in the most likely source areas at the site and in the vicinity of the source areas? | Sample eight new shallow wells and six existing shallow wells at and in the vicinity of potential source areas (Figures 2 and 3). | If PFCs exceed screening criteria in any wells, additional investigation may be considered as part of a Phase II investigation, following the decision logic presented on Figure 5 . Phase II sampling procedures are outlined in this SAP, but numbers of samples and locations will be determined based on team agreements after the Phase I results are received. |

SAP Worksheet #11—Project Quality Objectives/ Systematic Planning Process Statements (continued)

TABLE 2
Problem Definitions, Environmental Questions, and Project Quality Objectives

| Problem Definition | Environmental Question | General Investigation Approach | Project Quality Objectives |
|---|-------------------------------------|---|---|
| Determine if source areas are adequately defined. | Have all source areas been defined? | Sample 10 existing shallow background monitoring wells, 1 existing POL area well, and 1 new well around the perimeter of the Base (Figure 2) to assess PFC concentrations. | If additional source areas are suspected based on results of perimeter well sampling, additional investigation may be considered as part of a Phase II investigation, following the decision logic presented on Figure 5 . Phase II sampling procedures are outlined in this SAP, but numbers of samples and locations will be determined based on team agreements after the Phase I results are received. |

What are the Project Action Limits?

Worksheet #15 provides a list of the project action limits (PALs) for each constituent in each media. Groundwater data will be screened against the USEPA Lifetime Health Advisory Limits and the USEPA Tapwater Regional Screening Levels (RSL) based on a hazard quotient (HQ) of 1. The USEPA Lifetime Health Advisory Limits are 0.070 ug/L each for PFOA and PFOS. If both PFOA and PFOS are detected, the combined concentration must be less than 0.070 ug/L. PFCs without screening criteria are being evaluated for presence/absence only. Data will be archived for future use in case screening values are released.

For what will the data be used?

The data will be used to determine whether a release of PFCs has occurred at NAS Oceana, and if it has occurred, whether additional investigation or actions are required to characterize the nature and extent of the release.

What types of data are needed (matrix, target analytes, analytical groups, field screening, onsite analytical or offsite laboratory techniques, sampling techniques)?

The types of data needed include:

- A Basewide water-level survey and collection of slug test data.
- Drinking water and groundwater samples will be submitted to an offsite laboratory (Vista Analytical) for PFC analysis.
- Field measurements of groundwater quality (pH, dissolved oxygen [DO], temperature, conductivity, oxidation-reduction potential [ORP], and turbidity) will be completed during groundwater sampling.

Samples to be collected and analyzed to meet each of the project objectives are described in **Table 2**. Sampling and well installation methodology is included in **Worksheet #14**. Justification for individual sample locations is provided in **Worksheets #17** and **#18**. The specific target analytes and PALs are included in **Worksheet #15**.

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

No special data quality needs are necessary to support environmental decisions.

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

Detailed information on data collection is provided on **Worksheets #14, #16, and #17**.

SAP Worksheet #12-1—Measurement Performance Criteria Table – Field QC Samples

Matrix: Groundwater

Analytical Group: PFCs

Analytical Method / Standard Operating Procedures (SOP) Reference: EPA 537 Mod

| QC Sample | Analytical Group | Frequency | Data Quality Indicators | Measurement Performance Criteria |
|-------------------------------------|------------------|---|-------------------------|---|
| Field Duplicates | PFCs | One per 10 normal field samples | Precision | Relative percent difference (RPD) ≤ 25 percent |
| Matrix Spike/Matrix Spike Duplicate | | One per 20 normal field samples | Accuracy/Precision | See below. |
| Equipment Rinseate Blank | | One per day for decontaminated equipment. One per event for disposable equipment. | Contamination | No target analytes above the reporting limit (RL). |
| Field Reagent Blank | | One per week | Contamination | No target analytes above the RL. |
| Temperature Blank | | One per cooler | Representativeness | ≤10°C for up to 48 hours after sampling, upon sample receipt, then stored at lab ≤ 6°C, but not frozen. |

SAP Worksheet #12-2—Measurement Performance Criteria Table – Field QC Samples

Matrix: Drinking Water

Analytical Group: PFCs

Analytical Method/Standard Operating Procedures (SOP) Reference: EPA 537 Mod

| QC Sample | Analytical Group | Frequency | Data Quality Indicators | Measurement Performance Criteria |
|-------------------------------------|------------------|---------------------------------|-------------------------|---|
| Field Duplicates | PFCs | One per 10 normal field samples | Precision | RPD ≤ 25 percent |
| Matrix Spike/Matrix Spike Duplicate | | One per 20 normal field samples | Accuracy/Precision | See Worksheet 28 . |
| Field Reagent Blank | | One per residence | Contamination | No target analytes above the RL. |
| Temperature Blank | | One per cooler | Representativeness | ≤10°C for up to 48 hours after sampling, upon sample receipt, then stored at lab ≤ 6°C, but not frozen. |

SAP Worksheet #13—Secondary Data Criteria and Limitations Table

No secondary data will be used in support of this SI fieldwork.

This page intentionally left blank.

SAP Worksheet #14—Summary of Project Tasks

The technical approach for the proposed field activities at NAS Oceana is detailed below. The SOPs tabulated on **Worksheet #21** and provided in **Appendix B** address the protocols to be used for the SI.

Mobilization

Prior to mobilization, NAVFAC Mid-Atlantic, USEPA, and VDEQ will be notified to allow for appropriate oversight and coordination.

As part of the field mobilization, to will procure the following subcontractors to support investigation activities:

- Utility Locator
- Driller
- Surveyor
- Investigation-derived waste (IDW) subcontractor

Vista has already been procured to provide laboratory analytical services. Mobilization for the field effort includes procurement of necessary field equipment and initial transport to the site. Equipment and supplies will be brought to the site when the CH2M field team mobilizes for field activities.

Prior to beginning any phase of work, CH2M and its subcontractors will have field meetings to discuss the work items and worker responsibilities, and to familiarize workers with the HSP.

Prior to beginning any intrusive activities, CH2M will coordinate utility clearance with Miss Utility of Virginia and the Base's approving authority. Additionally, a separate utilities subcontractor will be procured to ensure the accuracy of the utility markings.

Drinking Water Sampling

Finished drinking water samples will be collected in accordance with the potable water sampling SOP (**Appendix B**). Water will be sampled by first purging the water supply for 3 to 5 minutes. The sampling port is usually the port at the bottom of a pressure tank. In instances where there is no port or the valve cannot be used without damage or leaking, the next closest pretreatment location will be selected. Samples will be collected directly into laboratory-provided containers. A field reagent blank is collected at the site of collection for the water sample. The field reagent blank is collected by transferring deionized water (prepared at the laboratory) from one bottle to another sampling bottle. This blank is used to determine if PFCs are in the air at the sampling location; if any contamination was introduced during the sample management and shipment process; and if there were any laboratory errors.

Cross-contamination of PFCs in accordance with the SOP (**Appendix B**) will be considered during sampling.

Monitoring Well Installation

Nine permanent shallow monitoring wells will be installed at NAS Oceana in locations described in **Worksheets #11, #17, and #18** and shown on **Figures 2 and 3**. Wells will be installed in accordance with the SOPs included in **Appendix B**. Shallow wells will be installed using 4.25-inch inner diameter hollow-stem auger and will be drilled to 9 feet below first encountered groundwater.

During well installation, lithology data will be collected using 4-foot direct push technology cores, collected continuously. Soil descriptions, including grain size, color, moisture content, relative density, consistency, soil structure, mineralogy, and other relevant information such as possible evidence of contamination, will be recorded as detailed in the SOP included in **Appendix B**.

SAP Worksheet #14—Summary of Project Tasks (continued)

Wells will be constructed of 2-inch polyvinyl chloride (PVC) casing and 10-foot-long 0.010 machine-slotted screens and will be screened with the water table 1 foot below the top of the well screen. Sand filter pack (DSI #1 or equivalent) will be added to a depth of 2 feet above the screened interval. Two to 4 feet of bentonite pellets or chips will be added and then hydrated in the annular space above the sand pack. The remainder of the annular space will be grouted to the surface. Wells will be completed with stick up protective casings and bollards or flush mount protective casings depending on the ground surface at each location.

Newly-installed monitoring wells will be developed in accordance with the SOP included in **Appendix B**.

Monitoring Well Groundwater Sampling

Groundwater samples will be collected from new and existing monitoring wells using low flow sampling and PFC sampling methodology and in accordance with the SOPs included in **Appendix B**. A peristaltic pump will be utilized to collect samples. The pump will be set in the middle of the well screen. Teflon tubing will not be used for sampling. Groundwater quality parameters (pH, conductivity, turbidity, DO, temperature, salinity, and ORP) will be collected during purging of each well using a water quality meter and a flow-through cell. Purging will continue until water quality readings collected 5 minutes apart are stabilized to within 10 percent of one another. After the parameters have stabilized, the flow-through cell will be disconnected and samples will be collected into laboratory-prepared sample bottles and packed on ice for overnight shipment to an offsite laboratory.

Cross-contamination of PFCs in accordance with the SOP (**Appendix B**) will be considered during sampling.

Surveying

Each new monitoring well will be surveyed by a licensed surveyor both vertically and horizontally using the Virginia State Plane Coordinate System. The vertical elevation accuracy will be ± 0.01 foot, and the horizontal location will have an accuracy of ± 0.1 foot. Specifically, the elevation for each monitoring well will be established at the top of the monitoring well's inner PVC casing (this elevation point will be designated by a permanent notch placed on the top of each well's inner casing) and at ground surface. The surveying subcontractor has not been determined for this sampling event; however, once the subcontractor is identified, the Navy will be notified.

Water-Level Survey and Slug Testing

Following monitoring well installation and development, and prior to the start of groundwater sampling, the depth to groundwater will be measured according to the SOP included in **Appendix B** at all wells within the sampling network and an additional nine existing wells throughout the Base in order to better determine groundwater flow directions at the site (**Figure 4**). Rising and falling slug tests will be performed in accordance with the SOP included in **Appendix B** at six wells (three at Site 11 and three near the aircraft hangars) in order to evaluate hydraulic conductivity at the site. The hydraulic conductivity data will be used in conjunction with the measured gradient and estimated effective porosity based on soil type in order to calculate groundwater flow velocity.

Equipment Decontamination

All non-disposable sampling equipment will be decontaminated immediately after each use in accordance with the SOP included in **Appendix B**. Non-disposable equipment will be decontaminated using the following solutions in this order:

1. Distilled water (laboratory certified PFC-free) and Liquinox solution
2. Distilled water (laboratory certified PFC-free) rinse 10 percent isopropanol and distilled water solution (laboratory certified PFC-free) and air-dried, and
3. Laboratory grade deionized water (laboratory certified PFC-free)

SAP Worksheet #14—Summary of Project Tasks (continued)

Nitric acid solution will not be used in the decontamination processes due to potential H&S concerns and because an acid solution can leach metals from metallic equipment. Decontamination fluids will be contained in a tank or 55-gallon drum and disposed of offsite as described below.

Cross-contamination of PFCs in accordance with the SOP (**Appendix B**) will be considered during equipment decontamination.

Investigation-Derived Waste Management

IDW is expected to consist of drill cuttings from the soil borings completed for monitoring well installations, purge water (from well development and groundwater sampling), and decontamination fluids. Aqueous IDW will be contained in 55-gallon drums or a Baker tank. Soil IDW will be stored in 55-gallon drums or a lined roll-off container with a hard, water-resistant lid. A location at NAS Oceana will be identified prior to initiation of the fieldwork where IDW will temporarily be stored. IDW drums will be labeled in accordance with the SOP included in **Appendix B**.

Disposable equipment, including personal protective equipment, will be decontaminated in accordance with the SOP included in **Appendix B** and disposed of with normal facility trash. The IDW subcontractor has not been determined for this sampling event; however, once the subcontractor is identified, the Navy will be notified.

Shipments

All analytical samples and equipment will be shipped by FedEx. All samples will be shipped in accordance with the SOP included in **Appendix B**.

Quality Control

All QC samples are listed on **Worksheet #20**. In reference to the field tasks, all fieldwork will be overseen by a FTL who is responsible for the QC of the sampling and making sure the proper SOPs are followed for each task.

Sample Analysis

The laboratory will maintain, test, inspect, and calibrate analytical instruments (**Worksheets #24 and #25**). The laboratory will analyze aqueous samples for various groups of parameters as shown on **Worksheets # 15 and #18**. QC samples are described on **Worksheet #28**. SOPs for all laboratory analytical tasks are tabulated on **Worksheet #23** and will be provided upon request.

Analytical analyses will be conducted by Vista as listed in **Worksheet #30**.

Data Management

The PC is responsible for data tracking and storage. Definitive analytical laboratory data will undergo Stage 4 validation prior to use for risk assessment purposes and prior to use by the Navy. All screening data will be checked by the PC prior to use. See **Worksheet #36** for more information. All analytical data will be loaded into the NIRIS database.

Procedures for Recording and Correcting Data

- Field data will be recorded in field logbooks or on a digital tablet
- Project Assessment/Audit: **Worksheets #31 and #32**
- Data Validation: **Worksheets #35 and #36**
- Data Usability Assessment: **Worksheet #37**

SAP Worksheet #14—Summary of Project Tasks (continued)

Analytical and Validation Tasks

The analytical laboratory will process and prepare samples for analyses and will analyze all samples per **Worksheet #18**. QC samples are described on **Worksheet #28**. SOPs for all laboratory analytical tasks are tabulated on **Worksheet #23**.

- The laboratory will maintain, test, inspect, and calibrate analytical instruments. (**Worksheets #24 and #25**).
- The laboratory will process and prepare samples for analysis.
- All analytical data to be used for chemical characterization of the site will be validated. See **Worksheet #36** for more details.
- A data usability assessment will be performed on the SI data. See **Worksheet #37** for more details.

SAP Worksheet #15—Reference Limits and Evaluation Table

Matrix: Groundwater, Drinking Water

Analytical Group: PFCs

| Analyte | CAS | USEPA Lifetime Health Advisory ^a (µg/L) | RSLs Tapwater HQ = 1 (June 2016) (µg/L) | Project Quantitation Limit Goal ^b (µg/L) | Laboratory Limits (µg/L) | | | Laboratory Control Samples (LCS) and Matrix Spike/ Matrix Spike Duplicate (MS/MSD) Recovery Limits and RPDC (percent) | | |
|---|-----------|--|---|---|--------------------------|-------|----------|---|-----|-----|
| | | | | | LOQ | LOD | DL | LCL | UCL | RPD |
| PFOS ^e | 1763-23-1 | 0.07 | 0.4 ^d | 0.035 | 0.008 | 0.004 | 0.000424 | 70 | 130 | 30 |
| PFOA ^e | 335-67-1 | 0.07 | 0.4 ^d | 0.035 | 0.008 | 0.004 | 0.00131 | 70 | 130 | 30 |
| PFNA | 375-95-1 | -- | -- | -- | 0.008 | 0.004 | 0.000693 | 50 | 130 | 30 |
| PFHxS ^e | 355-46-4 | -- | -- | -- | 0.008 | 0.004 | 0.00153 | 70 | 130 | 30 |
| PFHpA | 375-85-9 | -- | -- | -- | 0.008 | 0.004 | 0.000817 | 70 | 130 | 30 |
| PFBS ^e | 375-73-5 | -- | 380 | 190 | 0.008 | 0.004 | 0.000927 | 60 | 130 | 30 |
| Total PFOS and PFOA (calculated) ^f | -- | 0.07 | -- | -- | -- | -- | -- | -- | -- | -- |

Notes:

^a The PFOS and PFOA USEPA Lifetime Health Advisories are from the USEPA Office of Water.

^b The Project Quantitation Limit (PQL) Goal is half the lesser of applicable screening levels.

^c Accuracy and precision limits are in house laboratory limits.

^d The RSLs for PFOA and PFOS were calculated using the Tier 3 chronic reference doses (RfDs) derived by the USEPA Office of Water (USEPA, 2016a, 2016b).

^e Branched and linear isomers will be reported for PFOS, PFHxS, and PFBS. At this time, there is no certified standard for branched and linear PFOA; therefore, Vista uses a technical mixture to determine the retention time window for branched and linear isomers and the certified linear standard for calibration.

^f If both PFOS and PFOA are detected, the combined concentration must be less than 0.07 ug/L. Otherwise, the chemicals will be compared to the USEPA Lifetime Health Advisory of 0.070 ug/L individually.

µg/L = microgram per liter

This page intentionally left blank.

SAP Worksheet #16—Project Schedule/Timeline Table

| Activities | Dates | |
|---|-----------------------------------|--------------------------------|
| | Anticipated Date(s) of Initiation | Anticipated Date of Completion |
| Finalize SAP | 11/9/2016 | 11/11/2016 |
| Subcontractor/Field Work Preparation | 11/11/2016 | 11/16/2016 |
| Initiate Utility Location and Well Installation for Phase I Event | 11/16/2016 | 11/17/2016 |
| Complete Well Installation and Development | 11/17/2016 | 12/22/2016 |
| Complete Water Level Survey | 12/22/2016 | 12/24/2016 |
| Phase I Groundwater Sampling | 12/24/2016 | 1/7/2017 |
| Laboratory Analysis | 1/7/2017 | 2/4/2017 |
| Data Management | 2/4/2017 | 2/18/2017 |
| Data Validation | 2/18/2017 | 3/4/2017 |
| Scope Phase II Sampling or Plan Reporting Schedule, as necessary | 3/4/2017 | 3/14/2017 |

This page intentionally left blank.

SAP Worksheet #17—Sampling Design and Rationale

| Matrix | Depth of Samples | Analysis | Method | Number of Samples | Strategy and Rationale |
|---|--|--|--------------------|-------------------|---|
| Off-Base Drinking Water | | | | | |
| Drinking Water | N/A ¹ | PFOS PFOA PFNA PFHxS PFHpA PFBS | Modified USEPA 537 | TBD ² | Drinking water samples will be collected from any properties within 1 mile downgradient of suspected source areas that do not have access to city water. |
| Site 11 (Firefighting Training Area) | | | | | |
| Groundwater | Middle of well screen (approximately 20 to 30 feet below ground surface [bgs]) | PFOS PFOA PFNA PFHxS PFHpA PFBS | Modified USEPA 537 | 7 | Six samples will be collected from new wells: one cross-gradient of Firefighting Training Ring 1 (the jet mock-up) (OW11-MW4), one upgradient (OW11-MW5) and one downgradient (OW11-MW6) of Firefighting Training Ring 2, one downgradient of Firefighting Training Ring 3 (OW11-MW7), one in the land application area west of the training rings (OW11-MW8), and one downgradient of the land application area (OW11-MW9) (Figure 3) to assess potential impacts at and downgradient of likely source areas. One sample will be collected from an existing well (OW11-MW1) upgradient of Firefighting Training Ring 3 (Figure 3). |
| SWMU 26 (Fire Station Burn Pit) | | | | | |
| Groundwater | Middle of well screen (approximately 20 to 30 ft bgs) | PFOS PFOA PFNA PFHxS PFHpA PFBS | Modified USEPA 537 | 1 | One sample will be collected from a new well (OW26-MW1) near the former tank used for fire extinguisher training (Figure 2) to assess potential impacts of the likely source area. |
| Aircraft Hangars and Maintenance Buildings | | | | | |
| Groundwater | Middle of well screen (approximately 20 to 30 ft bgs) | PFOS PFOA PFNA PFHxS PFHpA PFBS | Modified USEPA 537 | 3 | Three samples will be collected from existing monitoring wells (OW2B-MW41, OW2C-MW19, and OW2E-MW19) downgradient of the aircraft hangars, where AFFF releases were documented (Figure 2). |

SAP Worksheet #17—Sampling Design and Rationale (continued)

| Matrix | Depth of Samples | Analysis | Method | Number of Samples | Strategy and Rationale |
|---|---|--|--------------------|-------------------|---|
| 1986 Crash Site | | | | | |
| Groundwater | Middle of well screen (approximately 20 to 30 ft bgs) | PFOS PFOA PFNA PFHxS PFHpA PFBS | Modified USEPA 537 | 1 | One sample will be collected from a new well installed near the site of the 1986 crash (OC-MW01) (Figure 2). |
| 1996 Crash Site | | | | | |
| Groundwater | Middle of well screen (approximately 20 to 30 ft bgs) | PFOS PFOA PFNA PFHxS PFHpA PFBS | Modified USEPA 537 | 1 | One sample will be collected from a new well (OC-MW03) installed near the site of the 1996 crash (Figure 2). |
| 2007 Crash Site | | | | | |
| Groundwater | Middle of well screen (3.0 to 13.0 ft bgs) | PFOS PFOA PFNA PFHxS PFHpA PFBS | Modified USEPA 537 | 1 | One sample will be collected from an existing well (FTWG-MW-02) in the vicinity of the 2007 plane crash (Figure 2). |
| Accidental Release at the Hush House | | | | | |
| Groundwater | Middle of well screen (3.3 to 13.3 ft bgs) | PFOS PFOA PFNA PFHxS PFHpA PFBS | Modified USEPA 537 | 1 | One sample will be collected from an existing well (JTC-MW-B) near the Hush House, where an accidental AFFF release was documented (Figure 2). |

SAP Worksheet #17—Sampling Design and Rationale (continued)

| Matrix | Depth of Samples | Analysis | Method | Number of Samples | Strategy and Rationale |
|---|---|--|--------------------|-------------------|--|
| Groundwater | Middle of well screen (approximately 20 to 30 ft bgs) | PFOS PFOA PFNA PFHxS PFHpA PFBS | Modified USEPA 537 | 1 | One sample will be collected from a new well (OC-MW04) southeast of the Hush House (Figure 2). |
| Perimeter Wells and Golf Course Irrigation Wells | | | | | |
| Groundwater | Middle of well screen (approximately 20 to 30 ft bgs) | PFOS PFOA PFNA PFHxS PFHpA PFBS | Modified USEPA 537 | 13 | Ten samples will be collected from the existing Basewide background monitoring wells (Figure 2) to assess potential offsite migration of contaminants. One sample will be collected from a new well installed near the northeast corner of the Base (OC-MW02) (Figure 2). |
| | Middle of well screen (1.94 to 16.40 ft bgs) | | | | One sample will be collected from an existing well (203MW-19) along the western boundary of the Base (Figure 2). |
| | Middle of well screen (75 to 85 ft bgs) ³ | | | | One sample will be collected from the existing golf course irrigation well (OC-MWGC01) in the southeast area of the Base (Figure 2) ⁴ . |

Notes:

Additional drinking water and/or groundwater samples may be added as part of a Phase II investigation.

- ¹ Drinking water samples will be collected as described in **Worksheet #14**.
- ² Drinking water sample counts will be determined based on groundwater flow evaluation and property record research.
- ³ There is a discrepancy in the well screen interval for OC-MWGC01 and screen interval will be confirmed during the field investigation.
- ⁴ Three additional irrigation wells have been identified at the golf course, but, based on conversations with NAS Oceana, these wells may actually pump surface water from irrigation ponds. As such, these are not currently proposed for sampling, but may be added if withdrawal of groundwater is confirmed.

This page intentionally left blank.

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

| Sampling Station | Sample ID ^a | Matrix | Depth (feet bgs) | Analytical Group | Number of Samples ^{b,c} | Sampling SOP Reference |
|---|------------------------|--------|-----------------------|------------------|----------------------------------|--------------------------|
| Site 11 (Firefighting Training Area) | | | | | | |
| OW11-MW1 | OW11-MW1-MMY | GW | Middle of well screen | PFCs | 1 | See Worksheet #21 |
| OW11-MW4 | OW11-MW4-MMY | | | | 1 | |
| OW11-MW5 | OW11-MW5-MMY | | | | 3 (MS/MSD) | |
| | OW11-MW5-MMY-MS | | | | | |
| | OW11-MW5-MMY-SD | | | | | |
| OW11-MW6 | OW11-MW6-MMY | | | | 1 | |
| OW11-MW7 | OW11-MW7-MMY | | | | 1 | |
| OW11-MW8 | OW11-MW8-MMY | | | | 1 | |
| OW11-MW9 | OW11-MW9-MMY | | | | 2 (FD) | |
| | OW11-MW9P-MMY | | | | | |
| SWMU 26 (Fire Station Burn Pit) | | | | | | |
| OW26-MW1 | OW26-MW1-MMY | GW | Middle of well screen | PFCs | 2 (FD) | See Worksheet #21 |
| | OW26-MW1P-MMY | | | | | |
| 1986 Crash Site | | | | | | |
| OC-MW01 | OC-MW01-MMY | GW | Middle of well screen | PFCs | 1 | See Worksheet #21 |
| 1996 Crash Site | | | | | | |
| OC-MW03 | OC-MW03-MMY | GW | Middle of well screen | PFCs | 1 | See Worksheet #21 |
| Accidental Release at the Hush House | | | | | | |
| JTC-MW-B | JTC-MW-B-MMY | GW | Middle of well screen | PFCs | 1 | See Worksheet #21 |
| OC-MW04 | OC-MW04-MMY | | | | 1 | |

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

| Sampling Station | Sample ID ^a | Matrix | Depth (feet bgs) | Analytical Group | Number of Samples ^{b,c} | Sampling SOP Reference |
|--|------------------------|--------|-----------------------|------------------|----------------------------------|--------------------------|
| Aircraft Hangars and Maintenance Buildings | | | | | | |
| OW2C-MW19 | OW2C-MW19-MMY | GW | Middle of well screen | PFCs | 1 | See Worksheet #21 |
| OW2E-MW19 | OW2E-MW19-MMY | | | | 1 | |
| OW2B-MW41 | OW2B-MW41-MMY | | | | 1 | |
| 2007 Crash Site | | | | | | |
| FTWG-MW-02 | FTWG-MW-02-MMY | GW | Middle of well screen | PFCs | 1 | See Worksheet #21 |
| Perimeter Wells and Golf Course Irrigation Well | | | | | | |
| 203MW-19 | 203MW-19-MMY | GW | Middle of well screen | PFCs | 1 | See Worksheet #21 |
| OC-MW02 | OC-MW02-MMY | | | | 1 | |
| OC-MWGC01 | OC-MWGC02-MMY | | | | 1 | |
| MW-BG01 | MW-BG01-MMY | | | | 1 | |
| MW-BG04 | MW-BG04-MMY | | | | 1 | |
| MW-BG05 | MW-BG05-MMY | | | | 2 (FD) | |
| | MW-BG05P-MMY | | | | | |
| MW-BG06 | MW-BG06-MMY | | | | 1 | |
| MW-BG07 | MW-BG07-MMY | | | | 1 | |
| MW-BG09 | MW-BG09-MMY | | | | 3 (MS/MSD) | |
| | MW-BG09-MMY-MS | | | | | |
| | MW-BG09-MMY-SD | | | | | |
| MW-BG10 | MW-BG10-MMY | | | | 1 | |
| MW-BG11 | MW-BG11-MMY | | | | 1 | |
| MW-BG12 | MW-BG12-MMY | | | | 1 | |
| MW-BG13 | MW-BG13-MMY | 2 (FD) | | | | |
| | MW-BG13P-MMY | | | | | |

SAP Worksheet #18—Sampling Locations and Methods/SOP Requirements Table (continued)

| Sampling Station | Sample ID ^a | Matrix | Depth (feet bgs) | Analytical Group | Number of Samples ^{b,c} | Sampling SOP Reference |
|----------------------------|--------------------------|--------|------------------|------------------|----------------------------------|--------------------------|
| Drinking Water | | | | | | |
| OC-RWXX | OC-RWXX-MMY | GW | NA | PFCs | TBD | See Worksheet #21 |
| Additional Field QC | | | | | | |
| OC-QC | OC-EBMMDDYY ^a | QC | NA | PFCs | TBD ^b | See Worksheet #21 |
| | OC-FBMMDDYY ^a | | | | | |

Notes:

- ^a Additional nomenclature instructions are as follows.
 - Equipment blanks and field reagent blanks will be identified with the two-digit month, day and year, for example: OC-EBMMDDYY or OC-FBMMDDYY
- ^b Field QC counts are dependent upon the duration of the field event. Frequency of QA/QC collection is as follows:
 - Field Duplicate - One per 10 field samples of similar matrix.
 - MS/MSD - One per 20 field samples of similar matrix (including field duplicates)
 - Field Reagent Blank - One per week for MW; one per residence for drinking water
 - Equipment Blank - For decontaminated equipment, one per type of sampling equipment, per day of sampling; for disposable equipment, one per lot.
- ^c Additional groundwater samples may be collected according to team agreement following initial groundwater results. Drinking water samples may also be collected.

This page intentionally left blank.

SAP Worksheet #19—Analytical SOP Requirements Table

| Matrix | Analytical Group | Analytical and Preparation Method/SOP Reference | Containers | Sample Volume | Preservation Requirements | Maximum Holding Time ^a (preparation / analysis) |
|--------------------------------|------------------|---|-----------------|---------------|---|---|
| Groundwater, Drinking Water | PFCs | EPA 537 Mod/SOP49 | 1 X 125-mL HDPE | 125 | ≤10°C for up to 48 hours after sampling, upon sample receipt, then stored at lab ≤ 6°C, but not frozen. | 14 days/28 days |

Notes:

^a Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.

HDPE = high-density polyethylene

This page intentionally left blank.

SAP Worksheet #20—Field Quality Control Sample Summary Table

| Matrix | Analytical Group | Number of Sampling Locations | Number of Field Duplicates | Number of MS/MSDs | Number of Field Reagent Blanks ^a | Number of Equipment Blanks ^a | Number of Trip Blanks ^a | Total Number of Samples to Lab ^b |
|----------------|------------------|------------------------------|----------------------------|-------------------|---|---|------------------------------------|---|
| Groundwater | PFCs | 29 | 3 | 2/2 | 2 | 5 | | 43 |
| Drinking Water | PFCs | TBD ^b | TBD ^b | TBD ^b | TBD ^b | TBD ^b | | TBD ^b |

Notes:

- ^a The number of blanks shown is based on a fundamental assumption of the number of days during which sampling occurs. Refer to **Worksheet #12** for the required frequencies.
- ^b The number of drinking water samples is dependent upon the number of properties identified within 1 mile downgradient of suspected source areas without access to city water.
- ^b Additional groundwater and/or drinking water samples may be collected based upon team agreement following initial results.

This page intentionally left blank.

SAP Worksheet #21—Project Sampling SOP References Table

| Reference Number | Title, Revision Date, and / or Number | Originating Organization of Sampling SOP | Equipment Type | Modified for Project Work? (Y/N) | Comments |
|--------------------------------|--|--|--|----------------------------------|----------|
| 001_PFC ¹ | <i>OPNAV PFC Sampling Policy</i> | OPNAV | Sample bottles, gloves, non-Teflon tubing, sampling equipment and clothing without potential to contain PFCs, as per SOP. | N | |
| 002_DrinkingWater ¹ | <i>Drinking Water Sampling when Analyzing for Per- and Polyfluoroalkyl Substances (PFASs), QCed and reviewed 9/2016</i> | CH2M | Sample bottles, gloves, non-Teflon tubing, sampling equipment and clothing without potential to contain PFCs, as per SOP. | N | |
| 003_Decon | <i>Decontamination of Personnel and Equipment, QCed and revised 06/2015</i> | CH2M | Deionized water, distilled water, potable water, 2.5 percent Liquinox and water solution, methanol, plastic pails, 55-gallon drum for waste, nitrile gloves, decontamination pad, steam cleaner | N | |
| 004_Dispose | <i>Disposal of Waste Fluids and Solids, QCed and reviewed 03/2016</i> | CH2M | Fluids-55-gallon drum, tools to secure drum, funnel, labels, marking pen, seals for drum Solids-55-gallon drum, tools to secure drum, plastic sheets, labels, marking pen | N | |
| 005_DeconRig | <i>Decontamination of Drilling Rigs and Equipment, QCed and reviewed 03/2016</i> | CH2M | Steam cleaner, potable water, Liquinox®, buckets, brushes, distilled water, methanol, deionized water, aluminum foil | N | |
| 006_Log Books | <i>Preparing Field Log Books, QCed and reviewed 4/2015</i> | CH2M | Log book, black indelible pen | N | |
| 007_COC | <i>Chain-of-Custody. QCed and reviewed 4/2015</i> | CH2M | Chain-of-custody, indelible pen | N | |
| 008_Utility | <i>Locating and Clearing Underground Utilities, QCed and revised 4/2015</i> | CH2M | Utility location subcontractor to provide all equipment, phone number for Miss Utility | N | |
| 009_BlankPrep | <i>Equipment Blank and Field Blank Preparation, QCed and reviewed 4/2015</i> | CH2M | Plastic sample bottles, nitrile gloves, blank liquid, preservatives | N | |
| 010_WaterQual | <i>Field Measurement of pH, Specific Conductance, Turbidity, DO, ORP, and Temperature Using A water Quality Parameter Meter with Flow-through Cell, QCed and reviewed 4/2015</i> | CH2M | Water Quality Parameter Meter such as a Horiba U-22 Water Quality Monitoring System or YSI with flow-through cell, distilled water in squirt bottle, Horiba U-22 Auto-Calibration Standard Solution. | N | |
| 011_LowFlow-EPA RegI&III | <i>Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region I and III, QCed and revised 4/2015</i> | CH2M | Adjustable-rate positive-displacement pump, submersible pump, or peristaltic pump, Horiba U-ss or equivalent water quality meter, flow-through cell, generator, water-level indicator, disposable Teflon tubing, plastic sheeting, well-construction information, calibrated container and stopwatch, sample containers, in-line disposable 0.45 µm filters, shipping supplies, field book | N | |
| 012_WaterLevels | <i>Water-Level Measurements, QCed and reviewed 04/2015</i> | CH2M | Electronic water-level meter with 100-foot tape, interface probe | N | |
| 013_MWInstal | <i>General Guidance for Monitoring Well Installation, QCed and reviewed 4/2015</i> | CH2M | Drilling rig, well construction materials, development equipment | N | |
| 014_MWShall | <i>Installation of Shallow Monitoring Wells, QCed and reviewed 04/2015</i> | CH2M | Drilling rig, well riser/screen and associated materials, sand, bentonite, protective casing, well development equipment | N | |
| 015_SlugTest | <i>Aquifer Slug Testing, QCed and reviewed 4/2015</i> | CH2M | In-situ data logger, well-testing assembly, compressed air, soil displacement device | N | |

Notes:

¹ SOPs 001_PFC and 002_DrinkingWater supersede all subsequent SOPs.

This page intentionally left blank.

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

| Field Equipment | Activity ^a | Frequency | Acceptance Criteria | CA | Resp. Person | SOP Reference ^b | Comments |
|--|--|--|--|---|--------------|----------------------------|----------|
| Horiba U-22 pH probe | Calibration | Daily, before use | pH reads 4.0 +/- 3 percent | Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly. | FTL | HoribaU22 | |
| Horiba U-22 Specific conductance probe | Calibration | Daily, before use | Conductivity reads 4.49 +/- 3 percent | Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly. | FTL | HoribaU22 | |
| Horiba U-22 Turbidity probe | Calibration | Daily, before use | Turbidity reads 0 +/- 3 percent | Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly. | FTL | HoribaU22 | |
| Horiba U-22 DO and Temperature Probes | Testing | Daily, before use | Consistent with the current atmospheric pressure and ambient temperature | Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly. | FTL | HoribaU22 | |
| Horiba U-22 | Maintenance - Check mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check | Daily before use, at the end of the day, and when unstable readings occur. | Stable readings after 3 minutes. pH reads 4.0 +/- 3 percent conductivity reads 4.49 +/- 3 percent turbidity reads 0 +/- 3 percent | Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly. | FTL | HoribaU22 | |

Notes:

^a Activities may include: calibration, verification, testing, and/or maintenance.

^b References from **Worksheet #21**.

This page intentionally left blank.

SAP Worksheet #23—Analytical SOP References Table

| Lab SOP Number | Title, Revision Date, and/or Number | Date Last Reviewed if not Revised ^a | Definitive or Screening Data | Matrix and Analytical Group | Instrument | Organization Performing Analysis ^b | Variance to Quality Systems Manual (QSM) | Modified for Project Work? |
|----------------|--|--|------------------------------|-----------------------------------|------------|---|--|----------------------------|
| 49 | <i>Preparation and Analysis for the Determination of Per and Poly-Fluorinated Compounds; Rev. 7; 3/17/16</i> | | Definitive | Groundwater, Drinking Water /PFCs | LC/MS/MS | Vista Analytical | Y ^c | N |
| 12 | <i>Sample Receiving and Sample Control Procedures; rev. 11; 6/15/16</i> | | N/A | Groundwater, Drinking Water /PFCs | N/A | Vista Analytical | N | N |
| 14 | <i>Bottle Order Preparation; rev. 4; 9/03/14</i> | | N/A | Groundwater, Drinking Water/PFCs | N/A | Vista Analytical | N | N |

Notes:

^a Non-analytical SOPs do not require an annual review cycle. This worksheet was prepared in August 2016.

^b Vista Analytical's DoD Environmental Laboratory Accreditation Program (ELAP) accreditation through A2LA is granted through September 30, 2017.

^c Vista Analytical Laboratory performs isotope dilution of PFCs in addition to the more traditional matrix spike samples specified in DoD Quality Systems Manual (QSM) v. 5.0. This has an overall positive effect on data quality because in essence each sample is a matrix spike with associated spike recoveries.

This page intentionally left blank.

SAP Worksheet #24—Analytical Instrument Calibration Table

| Instrument | Calibration Procedure | Frequency of Calibration | Acceptance Criteria | CA | Person Responsible for CA | SOP Reference |
|------------|---|---|--|--|---------------------------|----------------|
| LC/MS/MS | Tune Check | Prior to initial calibration (ICAL) and after any mass calibration or maintenance is performed. | Tuning standard must contain analytes of interest or appropriate substitute. Mass assignments of tuning standard within 0.5 amu of true value. | Retune instrument. If the tuning will not meet acceptance criteria, an instrument mass calibration must be performed and the tuning redone. Sample analysis shall not proceed without acceptable tuning. | Analyst / Supervisor | SOP 49, Rev. 7 |
| | Minimum five-point initial calibration for target analytes, lowest concentration standard at or below limit of detection. | Initial calibration prior to sample analysis | Coefficient of determination ≥ 0.96 for all analytes and an relative standard deviation (RSD) of $\leq 35\%$ for all Internal Standards. Each calibration point for each analyte must calculate to be within 75-125% recovery, except the lowest calibration point which must calculate to within 70-130% recovery. | Evaluate standards, chromatography, and mass spectrometer response. If problem found with above, correct as appropriate, then repeat initial calibration. No samples can be analyzed until initial calibration has passed. | | |
| | Second-source calibration verification | Once per initial calibration, following initial calibration. | All reported analytes and labelled compounds within ± 25 percent of true value. | Correct problem and verify second source standard. Rerun initial calibration verification. If that fails, correct problem and repeat ICAL. No samples may be analyzed until calibration has been verified. | | |
| | Daily calibration verification | Analysis of mid-level standard after every 10 field samples. All samples must be bracketed by the analysis of a standard. | All reported analytes and labelled compounds (internal standards) within ± 25 percent of true value. | Recalibrate, and reanalyze all affected samples since the last acceptable Continuing Calibration Verification (CCV). OR Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take CA(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Data flagging is only appropriate in cases where the samples cannot be reanalyzed. | | |

Notes:

DoD QSM v.5.0 is the basis for specifications on this table. Exceptions to the QSM include the utilization of isotopic dilution with LC/MS/MS.

This page intentionally left blank.

SAP Worksheet #25—Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table

| Instrument / Equipment | Maintenance Activity | Testing Activity | Inspection Activity | Frequency | Acceptance Criteria | CA | Responsible Person | SOP Reference |
|------------------------|---|--------------------|---------------------------------|---|--|---|--------------------|---------------|
| LC/MS/MS | Clean sample and gas cones. Change the column. Clean the T-Wave | Modified USEPA 537 | Check the sample and gas cones. | T-Wave cleaning is performed when the instrument response deteriorates. Other instrument maintenance is done as needed to keep the instrument performing at peak performance. | ICAL within acceptance criteria on Worksheet #24 and IS recovery within acceptance criteria on Worksheet #28 | Recalibrate and/or perform the necessary equipment maintenance. Check the calibration standards. Reanalyze the affected data. | Analyst/Supervisor | SOP 49 |

This page intentionally left blank.

SAP Worksheet #26—Sample Handling System

| SAMPLE COLLECTION, PACKAGING, AND SHIPMENT |
|---|
| <p>Sample Collection (Personnel/Organization): Field Team/CH2M</p> <p>Sample Packaging (Personnel/Organization): FTL/CH2M</p> <p>Coordination of Shipment (Personnel/Organization): FTL/CH2M</p> <p>Type of Shipment/Carrier: Overnight Carrier/FedEx</p> |
| SAMPLE RECEIPT AND ANALYSIS |
| <p>Sample Receipt (Personnel/Organization): Sample Receipt Personnel/Vista Analytical</p> <p>Sample Custody and Storage (Personnel/Organization): Sample Receipt Personnel/Vista Analytical</p> <p>Sample Preparation (Personnel/Organization): Extractions Personnel/Vista Analytical</p> <p>Sample Determinative Analysis (Personnel/Organization): Analysts/Vista Analytical</p> |
| SAMPLE ARCHIVING |
| <p>Field Sample Storage (No. of days from sample collection): 90 Days</p> <p>Sample Extract/Digestate Storage (No. of days from extraction/digestion): Extracts may be disposed of 90 days after extraction</p> <p>Microbial Sample Storage (No. of days from sample collection): N/A</p> |
| SAMPLE DISPOSAL |
| <p>Personnel/Organization: Environmental Health and Safety Officer/Vista Analytical</p> <p>Number of Days from Analysis: Samples may be disposed of 90 days after report mail date</p> |

This page intentionally left blank.

SAP Worksheet #27—Sample Custody Requirements Table

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory):

Samples will be collected by field team members under the supervision of the FTL. As samples are collected, they will be placed into containers and labeled. Labels will be taped to the containers to ensure they do not separate. Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples <6°C until they are received by the laboratory.

The chain-of-custody form will be placed into the cooler in a Ziploc bag. Coolers will be taped up and shipped to the laboratories via Fed Ex overnight, with the air bill number indicated on the chain-of-custody form (to relinquish custody). Upon delivery, the laboratory will log in each cooler and report the status of the samples to CH2M.

See **Worksheet #21** for SOPs containing sample custody guidance.

All PFC samples will be sent to Vista Analytical in El Dorado Hills, California.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal):

Laboratory custody procedures can be found in the laboratory SOPs, which are referenced in **Worksheet #23**. Laboratory SOPs will be provided upon request.

Sample Identification Procedures:

Sample labels will include, at a minimum, client name, site, sample ID, date/time collected, analysis group or method, preservation, and sampler's initials. The field logbook will identify the sample ID with the location and time collected and the parameters requested. The laboratory will assign each field sample a laboratory sample ID based on information in the COC and **Worksheet #18**. The laboratory will send sample log-in forms to the PC to check that sample IDs and parameters are correct.

Chain-of-Custody Procedures:

Chain-of-custody forms will include, at a minimum, laboratory contact information, client contact information, sample information, and relinquished by/received by information. Sample information will include sample ID. Date/time collected, number and type of containers, preservative information, analysis method, and comments. The chain-of-custody will link location of the sample from the field logbook to the laboratory receipt of the sample. The laboratory will use the sample information to populate the Laboratory Information Management Systems database for each sample.

This page intentionally left blank.

SAP Worksheet #28-1—Laboratory QC Samples Table

Matrix: Groundwater, Drinking Water

Analytical Group: PFCs

Analytical Method/ SOP Reference: EPA 537 Mod/SOP 49

| QC Sample | Frequency and Number | Method/SOP QC Acceptance Limits | CA | Person(s) Responsible for CA | Data Quality Indicator | Measurement Performance Criteria |
|--------------------|---|---|---|-------------------------------|-------------------------|---|
| Method Blank | One per preparation batch | No target analytes $\geq \frac{1}{2}$ LOQ and $> 1/10$ the amount measured in any sample or $1/10$ the regulatory limit (whichever is greater). | Verify instrument clean (evaluate calibration blank & samples prior to method blank), then reanalyze. Evaluate to determine if systematic issue within laboratory, correct, then reprepare and reanalyze the method blank and all samples processed with the contaminated blank in accordance with DoD QSM requirements. If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed. | Analyst/Laboratory Supervisor | Bias/Contamination | Same as Method/SOP QC Acceptance Limits |
| Internal Standards | Addition of isotopically labeled analytes to every sample, batch QC sample, standard, instrument blank, and method blank. | 13C-PFOA 50-150 percent 13C-PFOS 50-150 percent | For failed QC samples, correct problem and rerun all associated failed field samples. If reanalysis cannot be performed, the data must be qualified and explained in the case narrative. If recoveries are acceptable for QC samples, but not field samples, the field samples may be considered to suffer from a matrix effect. Failing internal standards should be thoroughly documented in the case narrative. | | Accuracy/Bias | |
| LCS | One LCS per preparation batch | See Worksheet #15 | Correct problem. Reprep and reanalyze the LCS and all samples in the associated preparatory batch, if sufficient sample material is available. If reanalysis cannot be performed, the data must be qualified and explained in the case narrative. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed. | | Accuracy/Bias | |
| MS/MSD | One MS/MSD pair per preparation batch | See Worksheet #15 | Evaluate the data, and re-prepare/reanalyze the native sample and MS/MSD pair if laboratory error is indicated. Examine the project-specific requirements. Contact the client as to additional measures to be taken. If MS results are outside the limits, the data shall be evaluated to determine the source(s) of difference, i.e., matrix effect or analytical error. For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met. | | Precision/Accuracy/Bias | |

Notes:

DoD QSM v.5.0 is the basis for specifications on this table. Exceptions to the QSM include the utilization of isotopic dilution with LC/MS/MS.

This page intentionally left blank.

SAP Worksheet #29—Project Documents and Records Table

| Document | Where Maintained ^a |
|---|---|
| <ul style="list-style-type: none"> • Field Notebooks • Chain-of-Custody Records • Air Bills • Custody Seals • CA Forms • Electronic Data Deliverables (EDDs) • Identification of QC Samples • Meteorological Data from Field • Sampling instrument calibration logs • Sampling locations and sampling plan • Sampling notes and drilling logs • Water quality parameters • Sample Receipt, Chain-of-Custody, and Tracking Records • Standard Traceability Logs • Equipment Calibration Logs • Sample Prep Logs • Run Logs • Equipment Maintenance, Testing, and Inspection Logs • CA Forms • Reported Field Sample Results • Reported Result for Standards, QC Checks, and QC Samples • Instrument printouts (raw data) for Field Samples, Standards, QC Checks, and QC Samples • Data Package Completeness Checklists • Sample disposal records • Extraction/Clean-up Records • Raw Data (stored on disk) • Data Validation Reports • CA Forms • Method Detection Limit Study Information | <ul style="list-style-type: none"> • Field data deliverables (e.g., logbooks entries, chains-of-custody, air bills, EDDs) will be kept on CH2M’s local intranet server. • Field parameter data will be loaded with the analytical data into Data Warehouse • Analytical laboratory hardcopy deliverables and data validation reports will be saved on the network server. Electronic data from the laboratory will be loaded into the Data Warehouse and NIRIS |

Notes:

^a Offsite documents except for analytical laboratory data are archived with Iron Mountain Inc., which is headquartered at 745 Atlantic Avenue, Boston, Massachusetts, 02111. Analytical laboratory data is archived with the Federal Records Center.

This page intentionally left blank.

SAP Worksheet #30—Analytical Services Table

| Matrix | Analytical Group | Sample Locations/ ID Numbers | Analytical SOP | Data Package Turnaround Time | Laboratory / Organization | Backup Laboratory/ Organization ^a |
|----------------|------------------|---------------------------------|--|---|---|--|
| Groundwater | PFCs | Refer to Worksheet 18 | PFC by Modified EPA 537 LC/MS/MS, SOP 49, rev7 | 28 calendar days for full Stage 4 deliverable | Vista Analytical Laboratory Attn: Sample Receiving 1104 Windfield Way El Dorado Hills, California 95762 (916) 673-1520 POC: Martha Maier | TBD |
| Drinking Water | PFCs | | PFC by Modified EPA 537 LC/MS/MS, SOP 49, rev7 | 14 calendar days for full Stage 4 deliverable | | |

Notes:

^a A backup laboratory has not been identified at this time. If circumstances arise that render Vista unable to perform analytical services, a backup laboratory will be selected at that time.

This page intentionally left blank.

SAP Worksheet #31—Planned Project Assessments Table

| Assessment Type | Frequency | Internal or External | Organization Performing Assessment | Person Responsible for Performing Assessment | Person Responsible for Responding to Assessment Findings | Person Responsible for Identifying and Implementing CA | Person Responsible for Monitoring Effectiveness of CA |
|------------------------|------------------|-----------------------------|---|---|---|---|--|
| Project Review | Once | Internal | CH2M | Janna Staszak | PM, FTL, and Field Staff | Laura Cook | Janna Staszak |

This page intentionally left blank.

SAP Worksheet #32—Assessment Findings and Corrective Action Responses

| Assessment Type | Nature of Deficiencies Documentation | Individual(s) Notified of Findings | Timeframe of Notification | Nature of CA Response Documentation | Individual(s) Receiving CA Response | Timeframe for Response |
|------------------------------|--------------------------------------|------------------------------------|--|-------------------------------------|-------------------------------------|---|
| Project Review | Checklist | Laura Cook, PM, CH2M | Within 1 week of audit | Memorandum | John Tomik, AQM | Within 1 week of receipt of CA Form |
| Laboratory Corrective Action | Laboratory Corrective Action Form | Bahar Amiri, Vista Analytical QAO | As soon as issue or nonconformance is identified | Memorandum | Anita Dodson, Program Chemist, CH2M | Within 1 week of receipt of initial notification. |

This page intentionally left blank.

SAP Worksheet #32-1—Laboratory Corrective Action Form

Person initiating CA: _____ Date: _____

Description of problem and when identified:

Cause of problem, if known or suspected:

Sequence of CA (including date implemented, action planned, and personnel/data affected):

CA implemented by: _____ Date: _____

CA initially approved by: _____ Date: _____

Follow-up date: _____

Final CA approved by: _____ Date: _____

Information copies to:

Anita Dodson/ CH2M HILL, Inc. Navy CLEAN Program Chemist

This page intentionally left blank.

SAP Worksheet #32-2—Field Performance Audit Checklist

Project Responsibilities

Project No.: _____ Date: _____

Project Location: _____ Signature: _____

Team Members

Yes No 1) Is the approved work plan being followed?
Comments _____

Yes No 2) Was a briefing held for project participants?
Comments _____

Yes No 3) Were additional instructions given to project participants?
Comments _____

Sample Collection

Yes No 1) Is there a written list of sampling locations and descriptions?
Comments _____

Yes No 2) Are samples collected as stated in the Master SOPs?
Comments _____

Yes No 3) Are samples collected in the type of containers specified in the work plan?
Comments _____

Yes No 4) Are samples preserved as specified in the work plan?
Comments _____

Yes No 5) Are the number, frequency, and type of samples collected as specified in the work plan?
Comments _____

Worksheet #32-2—Field Performance Audit Checklist (continued)

Yes No 6) Are QA checks performed as specified in the work plan?
Comments _____

Yes No 7) Are photographs taken and documented?
Comments _____

Document Control

Yes No 1) Have any accountable documents been lost?
Comments _____

Yes No 2) Have any accountable documents been voided?
Comments _____

Yes No 3) Have any accountable documents been disposed of?
Comments _____

Yes No 4) Are the samples identified with sample tags?
Comments _____

Yes No 5) Are blank and duplicate samples properly identified?
Comments _____

Yes No 6) Are samples listed on a chain-of-custody record?
Comments _____

Yes No 7) Is chain of custody documented and maintained?
Comments _____

SAP Worksheet #33—QA Management Reports Table

| Type of Report | Frequency | Projected Delivery Date | Person Responsible for Report Preparation | Report Recipient(s) |
|----------------|------------------|-------------------------|---|---------------------------------------|
| SI Report | Post-field Event | TBD | Laura Cook/CH2M | Stakeholders, see Worksheet #4 |

The SI report will address the following:

- Summary of project QA/QC requirements/procedures
- Conformance of project to UFP-SAP requirements/procedures
- Status of project schedule
- Deviations from the UFP-SAP and approved amendments that were made
- Results of data review activities (how much usable data was generated)
- CAs if needed and their effectiveness
- Data usability with regards to: precision, accuracy, representativeness, completeness, comparability, and sensitivity
- Limitations on data use

This page intentionally left blank.

SAP Worksheet #34-36—Data Verification and Validation (Steps I and IIa/IIb) Process Table

| Data Review Input | Description | Responsible for Verification | Step I/IIa/IIb ^a | Internal/External |
|---|--|---------------------------------------|-----------------------------|-------------------|
| Field Notebooks | Field notebooks will be reviewed internally and placed into the project file for archival at project closeout. | FTL/CH2M | Step I | Internal |
| Chains of Custody and Shipping Forms | Chain-of-custody forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody will be initialed by the reviewer, a copy of the chain-of-custody retained in the site file, and the original and remaining copies taped inside the cooler for shipment. | FTL/CH2M PC/CH2M | Step I | Internal/External |
| Sample Condition Upon Receipt | Any discrepancies, missing, or broken containers will be communicated to the project data manager in the form of laboratory logins. | PC/CH2M | Step I | External |
| Documentation of Laboratory Method Deviations | Laboratory Method Deviations will be discussed and approved by the PC. Documentation will be incorporated into the case narrative which becomes part of the final hardcopy data package. | PC/CH2M | Step I | External |
| Electronic Data Deliverables | Electronic Data Deliverables will be compared against hardcopy laboratory results (10 percent check). | PC/CH2M | Step I | External |
| Case Narrative | Case narratives will be reviewed by the DV during the data validation process. This is verification that they were generated and applicable to the data packages. | Herb Kelly/CH2M (DV) | Step I | External |
| Laboratory Data | All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal. | Martha Maier/Vista (Laboratory PM) | Step I | Internal |
| Laboratory Data | The data will be verified for completeness by the PC. | PC/CH2M | Step I | External |
| CA Reports | Upon report completion, a copy of all audit reports will be placed in the site file. If CAs are required, a copy of the documented CA taken will be attached to the appropriate audit report in the QA site file. Periodically, and at the completion of site work, site file audit reports and CA forms will be reviewed internally to ensure that all appropriate CAs have been taken and that CA reports are attached. If CAs have not been taken, the site manager will be notified to ensure action is taken. | PM/CH2M PC/CH2M | Step I | Internal/External |
| | CA reports will be reviewed by the PC or PM and placed into the project file for archival at project closeout. | PM/CH2M PC/CH2M | Step I | External |
| Laboratory Methods | During the pre-validation check, ensure that the laboratory analyzed samples using the correct methods specified in the UFP-SAP. If methods other than those specified in the SAP were used, the reason will be determined and documented. | PC/CH2M | Step IIa | External |
| Target Compound List | During the pre-validation check, ensure that the laboratory reported all analytes from each analysis group as per Worksheet #15. If the target compound list is not correct, then it must be corrected prior to sending the data for validation. Once the checks are complete, the project manager is notified via email | PC/CH2M | Step IIa | External |
| RLs | During the pre-validation check, the laboratory reporting limits will be compared to those listed in the project SAP. If reporting limits were not met, the laboratory will be contacted and asked to provide an explanation which will then be discussed in the associated project report. Often times the cause for minor laboratory reporting limit deviation from those presented in the SAP is due to the quarterly update of laboratory LOD. | PC/CH2M | Step IIb | External |
| Laboratory SOPs | Ensure that approved analytical laboratory SOPs were followed. | Herb Kelly/CH2M (DV) | Step IIa | External |
| Sample Chronology | Holding times from collection to extraction or analysis and from extraction to analysis will be considered by the data validator during the data validation process. | Herb Kelly/CH2M (DV) | Step IIa / IIb | External |
| Raw Data ^b | 10 percent review of raw data to confirm laboratory calculations. For a recalculated result, the data validator attempts to re-create the reported numerical value. The laboratory is asked for clarification if a discrepancy is identified which cannot reasonably be attributed to rounding. In general, this is outside 5% difference. | Herb Kelly/CH2M (DV) | Step IIa | External |
| Onsite Screening | All non-analytical field data will be reviewed against UFP-SAP requirements for completeness and accuracy based on the field calibration records. | FTL/CH2M | Step IIb | Internal |
| Documentation of Method QC Results | Establish that all required QC samples were run and met limits, and will be discussed in the associated project report. | Herb Kelly/CH2M (DV) | Step IIa | External |
| Documentation of Field QC Sample Results | Establish that all required UFP-SAP QC samples were run and met limits. | PC/CH2M Herb Kelly/CH2M (DV) | Step IIb | External |
| Data Validation ^b (SVOCs) | Analytical methods and laboratory SOPs as presented in this SAP will be used to evaluate compliance against QA/QC criteria. Should adherence to QA/QC criteria yield deficiencies, data may be qualified. Data may be qualified if QA/QC exceedances have occurred. Guidance and qualifiers from "USEPA National Functional Guidelines for Superfund Organic Methods Data Review (SOM02.2)" (USEPA; 2014). | Herb Kelly/CH2M (DV) | Step IIa and IIb | External |

Notes:

^a I = verification

IIa = compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.]

IIb = comparison with measurement performance criteria in the UFP-SAP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005]

^b Stage IV data validation will be performed on 100 percent of definitive analyses. Of the 100 percent validated, 10 percent of results will be recalculated from the raw data in order to verify calculations.

This page intentionally left blank.

SAP Worksheet #37—Usability Assessment

Summarize the usability assessment process and all procedures, including interim steps and any statistics, equations, and computer algorithms that will be used:

- Non-detected site contaminants will be evaluated to ensure that PQL goals in **Worksheet #15** were achieved. If PQLs were achieved and the verification and validation steps yielded acceptable data, then the data are considered usable.
- During verification and validation steps, data may be qualified as estimated with the following qualifiers: J, J+, J-, or UJ. These qualifiers represent minor QC deficiencies that will not affect the usability of the data. When major QC deficiencies are encountered, data will be qualified with an R and in most cases is not considered usable for project decisions. If R-qualified data are used in evaluations and, ultimately, project decisions, the rationale for their use will be included in the investigation report
 - J = Analyte present. Reported value may or may not be accurate or precise.
 - UJ = Analyte not detected. QL may be inaccurate or imprecise.
 - J+ = Analyte present. Reported value may be biased high. Actual value is expected to be lower.
 - J- = Analyte present. Reported value may be biased low. Actual value is expected to be higher.
 - R = Rejected result. Result not reliable.
- If statistical comparisons are necessary, non-detect values will be represented by a concentration equal to one-half the sample RL. For duplicate sample results, the most conservative value will be used for project decisions.
- Additional qualifiers that may be given by the validator are:
 - B = Not detected substantially above the level reported in laboratory or FBs.
 - N = Tentative identification. Consider present. Special methods may be needed to confirm its presence or absence in future sampling efforts
 - NJ = Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity.
 - U = Not detected.
- Analytical data will be checked to ensure the values and any qualifiers are appropriately transferred to the electronic database. These checks include comparison of hardcopy data and qualifiers to the electronic data deliverable (EDD). Once the data has been uploaded into the electronic database, another check will be performed to ensure all results were loaded accurately.
- Field and laboratory precision will be compared as RPD between the two results.
- Deviations from the SAP will be reviewed to assess whether CA is warranted and to assess impacts to achievement of project objectives.
- To assess whether a sufficient quantity of acceptable data are available for decision-making, the data will be compared to a 95 percent completeness goal and will be reconciled with MPC following validation and review of data quality indicators.
- If significant biases are detected with laboratory QA/QC samples they will be evaluated to assess impacts on decision-making. Low biases will be described in detail as they represent a possible inability to detect compounds that may be present at the site.
- If significant deviations are noted between laboratory and field precision the cause will be further evaluated to assess impact on decision making.

SAP Worksheet #37—Usability Assessment (continued)

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

- Data tables will be produced to reflect detected and non-detected analytes. Data qualifiers will be reflected in the tables and discussed in the data quality evaluation.
- A data quality evaluation will be provided as part of the SI Report.
- The SI Report will identify any data usability limitations and make recommendations for CA if necessary.

Identify the personnel responsible for performing the usability assessment.

- The PM, PC, and other team members will be responsible for compiling the data. The data will then be presented to the NAS Oceana Partnering Team who, as a whole, will evaluate the data usability according to project objectives.

References

CH2M HILL, Inc. (CH2M). 2001. *Decision Document – SWMUs 11, 16, 16GC, 21, 22, and 26 - Naval Air Station, Oceana, Virginia Beach, Virginia*. December.

Meng and Harsh. 1984. Hydrogeologic Framework of the Virginia Coastal Plain, U.S. Geological Survey Open File Report 84-728, 78 p.

Department of the Navy (Navy). 2014. *Memorandum for Deputy Chief of Naval Operations (Fleet Readiness and Logistics) (N4) Deputy Commandant of the Marine Corps (Installations and Logistics), Perflourinated Compounds (PFCs) – An Emerging Environmental Issue*. October.

Navy. 2015. *Perfluorinated Compounds (PFCs) Interim Guidance/Frequently Asked Questions*. January.

Sizemore, B., 2012. *Oceana has had 25-plus aircraft crashes over decades. The Virginian Pilot*. Retrieved from <http://www.pilotonline.com>. April.

United States Environmental Protection Agency (USEPA). 2002. *Guidance for Quality Assurance Project Plans, USEPA QA/G-5*. EPA/240/R-02/009. December.

USEPA. 2005. *Uniform Federal Policy for Quality Assurance Project Plans: Evaluating, Assessing, and Documenting Environmental Data Collection and Use Programs - Part 1: UFP-QAPP Manual*. Intergovernmental Data Quality Task Force. EPA-505-B-04-900A. Final Version 1. March.

USEPA. 2012. *Revisions to the Unregulated Contaminant Monitoring Regulation (UCMR 3) for Public Water Systems; Final Rule*. May.

USEPA. 2014. *National Functional Guidelines for Superfund Organic Methods Data Review*. EPA-540-R-D14-002. Office of Superfund remediation and Technology Innovation (ORSTI).

USEPA. 2016a. *Drinking Water Health Advisory for Perfluorooctanoic Acid (PFOA)*. EPA 822-R-16-005. Office of Water. May.

USEPA. 2016b. *Drinking Water Health Advisory for Perfluorooctane Sulfonate (PFOS)*. EPA 822-R-16-004. Office of Water. May.

United States Geological Survey (USGS). 2006. *The Virginia Coastal Plain Hydrogeologic Framework Professional Paper 1731*.

Virginia Department of Environmental Quality (VDEQ). 2004. *Site Characterization Report, Jet Test Cell Area, NAS Oceana, Virginia Beach, Virginia*. March.

This page intentionally left blank.

Figures



Legend

 Base Boundary

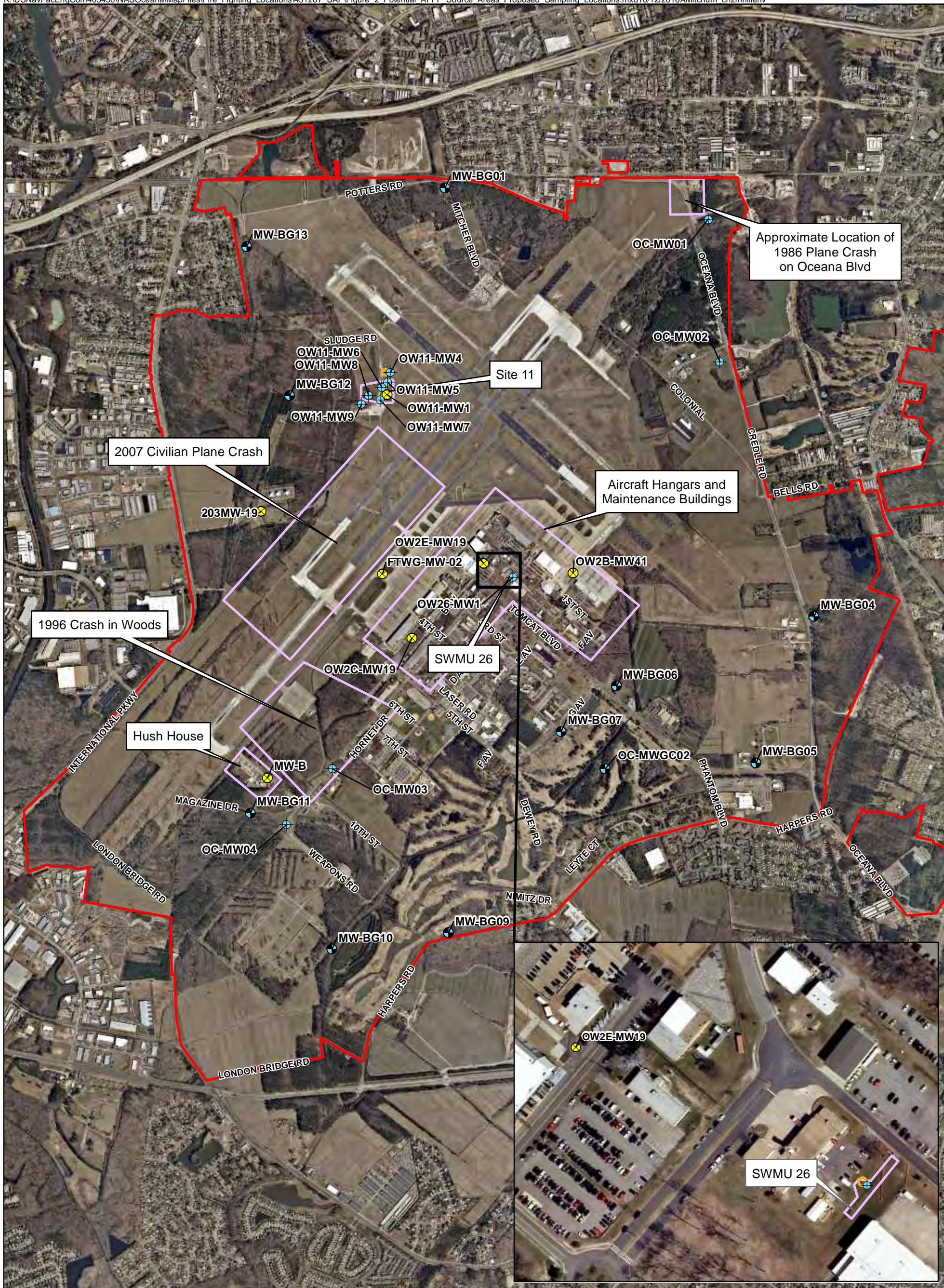


0 1,375 2,750
Feet

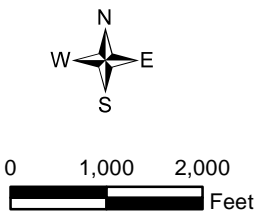
Imagery and Basemap Source: ©2016 Esri

Figure 1
Installation Location Map
Basewide Site Inspection for Perfluorinated Compounds
Sampling and Analysis Plan
NAS Oceana, Virginia Beach, Virginia





- Legend**
- ⊕ Proposed New Wells
 - ⊙ Existing Wells
 - Background Monitoring Wells
 - ▭ Potential AFFF Release Areas
 - ▭ Firefighting Rings
 - ▭ Installation Boundary







Imagery Source: ©2016 Esri

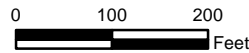
Figure 2
 Potential AFFF Source Areas and Potential Sampling Locations
 Basewide Site Inspection for Perfluorinated Compounds
 Sampling and Analysis Plan
 NAS Oceana, Virginia Beach, Virginia





Legend

-  Proposed New Wells
-  Existing Wells
-  Firefighting Rings
-  Site 11 Boundary



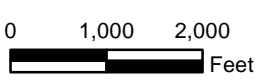
Imagery Source: ©2016 Esri

Figure 3
Proposed Monitoring Well Locations - Site 11
Basewide Site Inspection for Perfluorinated Compounds
Sampling and Analysis Plan
NAS Oceana, Virginia Beach, Virginia





- Legend**
- Monitoring Wells to be Gauged
 - Potential AFFF Release Areas
 - Firefighting Rings
 - Site 11 Boundary
 - SWMU 26 Boundary
 - Installation Boundary



Imagery Source: ©2016 Esri

Figure 4
Water Level Survey Locations
Basewide Site Inspection for Perfluorinated Compounds
Sampling and Analysis Plan
NAS Oceana, Virginia Beach, VA



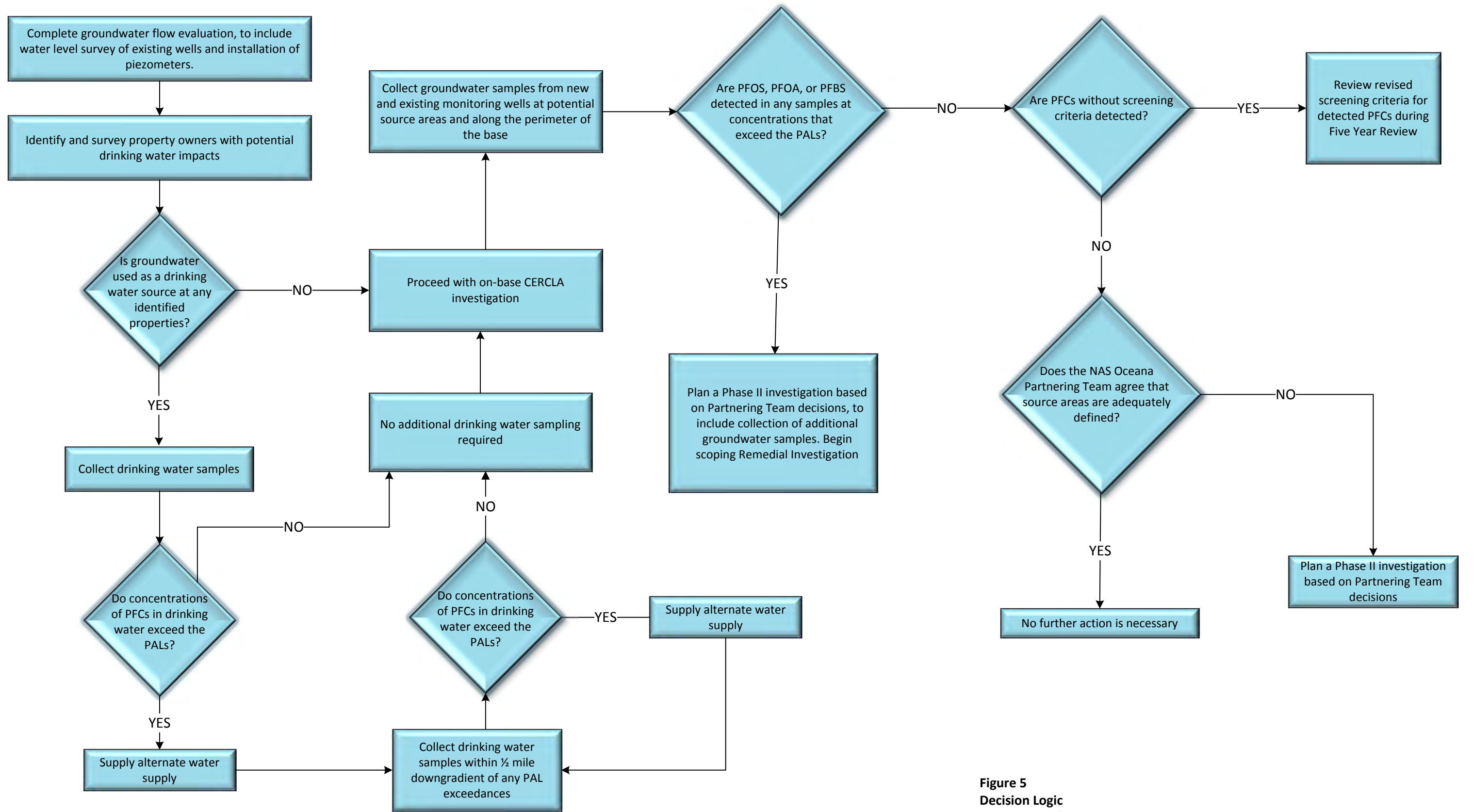


Figure 5
Decision Logic
 Basewide Perfluorinated Compound Investigation Sampling and Analysis Plan
 NAS Oceana, Virginia Beach, Virginia

Appendix A
Fire Department Interview Report

Interview to Evaluate Use of Aqueous Film-Forming Foam Use at NAS Oceana

ATTENDEES: Capt. Vincent Jackson/NALF Fentress Angela Jones/NAVFAC
 Chief Kenny Russell/NAS Oceana Amy Brand/CH2M

COPY TO: Laura Cook/CH2M

PREPARED BY: Amy Brand/CH2M

MEETING DATE: November 2, 2015

In November, 2015, Ms. Jones and Ms. Brand interviewed Captain Vincent Jackson of Naval Auxiliary Landing Field (NALF) Fentress and Assistant Fire Chief Kenny Russell of Naval Air Station (NAS) Oceana about use of Aqueous Film-Forming Foams (AFFFs) in firefighter training and emergency operations at NAFL Fentress and NAS Oceana. This report summarizes the information regarding use of AFFF at NAS Oceana only. A separate memo was generated for NALF Fentress.

AFFF Use at NAS Oceana

Captain Jackson reported that firefighter training activities at NAS Oceana are currently conducted only using water; no AFFF is used in training. AFFF is currently used in crash trucks in preparation for emergency use. In addition, automated fire suppression systems in the aircraft hangars are charged with AFFF; these systems are maintained by a contractor, Kinetix.

AFFF Use by the NAS Oceana Fire Department

AFFF is ordered at NAS Oceana following current military specifications. Only 3-percent AFFF is used. 3M and Ansul brands have been used previously, but headquarters is using primarily Chemguard brand now.

AFFF is stored in Building 118 at NAS Oceana. A total 3350 gallons is stored in 54 five-gallon cans and 28 55-gallon drums. To load the crash trucks, the trucks are brought to Building 118 and AFFF is replenished manually from the 5-gallon cans. Empty AFFF cans are disposed of as Hazardous Materials (at Building 1114 at NAS Oceana.) Occasionally, AFFF is pumped from 55-gallon drums into 5-gallon cans. When that occurs, the pump is not cleaned; but rather, is kept in the can for future use. There is secondary containment in the area in front of Building 118 where the trucks are filled with AFFF.

Four trucks are kept supplied with AFFF at NAS Oceana, with tanks ranging from 200 to 405 gallons each. Spray tests are performed quarterly at Site 11 (Figure 1). This site has been approved for spray testing. The spray test involves checking the roof turret, pumper turret, and hand lines under the truck nozzles to ensure the foam is the right consistency and to test the distance and width of the spray pattern. Plans for spray testing are coordinated in advance, and spray testing is not conducted if it is raining or if rain is predicted within the new few days. Old foam is flushed at the site where spray testing is done – in the grassy area near Site 11, with care to avoid any storm drains or ditches. Valves are only cleaned if there is a problem with the metering valve; this maintenance, which is rare, is performed by the Public Works and Transportation Department at NAS Oceana.

All current firefighter training areas are mobile, using water only. Firefighter training is conducted quarterly, using propane to create the fire.

AFFF Use in Fire Suppression Systems in the Hangars

AFFF storage for fire suppression in the hangars is handled by a contractor, Kinetix. The automated fire suppression systems in the hangars are currently charged with AFFF. Kinetix brings in 55-gallon drums of AFFF and pumps it into plastic holding tanks, located within the mechanical rooms in the hangars. The tanks are not leak-tested. There is concentrated AFFF in the pipes up to the mixing valve. Interviewees reported never having seen the system flushed; however, flushing the line is part of the cleanup process if there is an activation. When the system is flushed, there is a holding tank, which is checked for adequate capacity. The holding tank has an overflow to the storm sewer system.

If AFFF gets on airplane parts, the parts are discarded (rather than washed) because AFFF is very corrosive.

AFFF Releases

AFFF was reportedly used or presumed to have been used during several emergency response incidents (Figure 1):

- In 1986, a plane crashed off Oceana Boulevard, killing a pregnant woman on the ground. Interviewees indicated that AFFF was probably used for this crash.
- In 1995, a plane crashed in the woods on the installation, but interviewees could not recall whether there was an associated fire.
- In 2007, a civilian plane crashed during an air show practice, right off runway 5L. Interviewees were not sure whether AFFF was used.
- In April, 2012, an F18 crashed into the Mayview Apartments. Interviewees believed that AFFF was used on the subsequent fire.

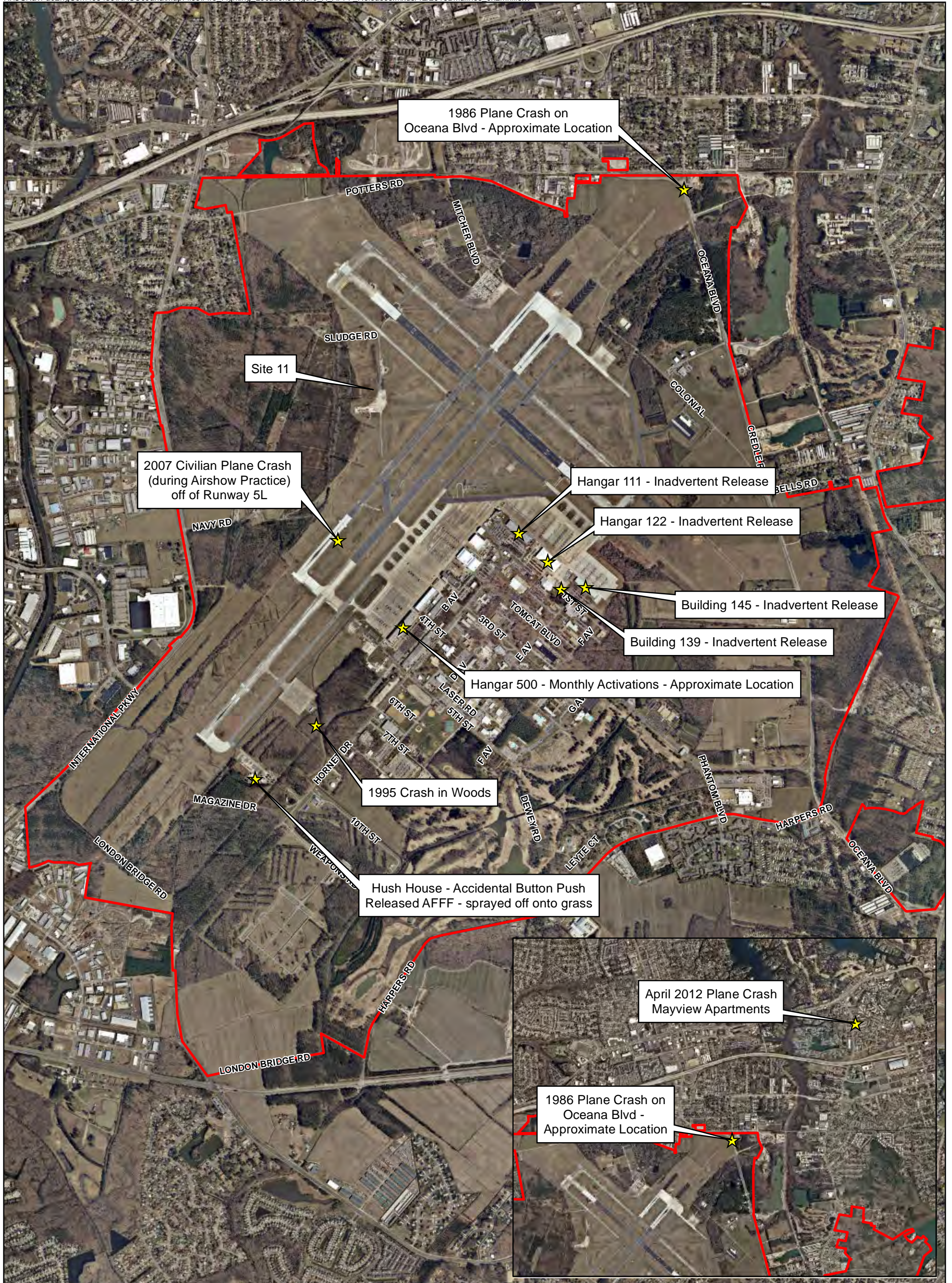
An accidental release has occurred once during firefighter training activities (Figure 1):

- During training in the 1100 area near the Hush House, a person accidentally pressed the wrong button, releasing AFFF. Personnel called Environmental and were told to spray down the concrete area into the grass. There is an underground storage tank at Hush House that acts as a holding tank if there is a discharge.

While AFFF has not been used in the hangars for a fire, there have also been several inadvertent releases (Figure 1):

- In Building 145, a worker accidentally pushed the wrong button, releasing AFFF which went into the parking lot. Personnel were advised to cover the storm drains as well as they could, and then spray water to wash the AFFF onto the grass. A contractor was brought in to vacuum up any remaining foam. The buttons have now been covered with plastic to avoid similar accidents.
- A release reportedly occurred in Hangar 111 during retrofit of the floor nozzles.
- An “activation” (which is technically not considered a “spill”) used to occur monthly in Hangar 500 due to sensitive sensors. The sensors have been adjusted and there have been no additional activations.
- In 2010, there was a spill at the corrosion control facility (Building 139). There are no drains in that area. The foam was pushed outside to the grass swale on the southeast side of the building, and then cleaned up with a vacuum truck. An interviewee noted that there have been multiple previous releases at Building 139.
- In July, 2011, a very large storm caused stormwater to back up and fill the overflow tanks in Hangar 122, releasing AFFF to the environment, including the storm drain and storm ditch. Information about this release is well-documented in the spill log, and the Hampton Roads Sanitation District was notified.

When AFFF releases have occurred, the cleanup has been focused on avoiding any release into water or storm drains. Releases of AFFF into the environment have been documented in spill logs for the past 6-7 years.



- Legend**
- ★ AFFF Release Locations
 - Potential PFC Release Areas
 - Firefighting Areas
 - Installation Boundary



0 1,000 2,000
Feet

Imagery Source: ©2016 Esri

Figure 1
AFFF Release Locations
Perfluorinated Compound Investigation Sampling and Analysis Plan
NAS Oceana, Virginia Beach, Virginia

Appendix B
Field SOPs

1 **FIELD SAMPLING PROTOCOLS TO AVOID CROSS-CONTAMINATION DURING WATER SAMPLING**
2 **FOR PERFLUORINATED COMPOUNDS (PFCs)**

3 **1.0 PURPOSE**

4 While EPA method 537 provides basic guidance on sampling for PFC's in drinking water, due to
5 the potential for cross contamination this Standard Operating Procedure (SOP) addendum
6 describes additional precautionary procedures/considerations when collecting groundwater or
7 drinking water samples. Sampling specific SOPs should also be reviewed prior to conducting
8 field sampling activities at PFC sites.

9 **2.0 SCOPE**

10 This procedure applies to all qualified personnel and subcontractors who collect or otherwise
11 handle water samples for analysis of PFCs. This SOP should be reviewed by all on-site
12 personnel prior to implementation of field activities.

13 **3.0 GENERAL**

14 Given the low detection limits associated with PFC analysis and the many potential sources of
15 trace levels of PFCs, field personnel are advised to act on the side of caution by strictly following
16 these protocols, frequently replacing nitrile gloves, and rinsing field equipment to help mitigate
17 the potential for background contamination detections of PFCs. Specific items related to field
18 sampling are discussed below.

19 **4.0 PROCEDURES/CONSIDERATIONS**

20 The following are procedures/considerations to be made during field activities at potential PFC
21 release sites.

22 **Field Equipment**

- 23
- 24 • **Do not use Teflon®-containing materials** (e.g., Teflon® tubing, bailers, tape, plumbing
25 paste, or other Teflon® materials) since Teflon® contains fluorinated compounds.
 - 26 • High-density polyethylene (HDPE), low-density polyethylene (LDPE), and silicon
27 materials are acceptable for sampling. Samples should not be stored in containers made
28 of LDPE materials.
 - 29 • To avoid plastic coating or glue materials, **do not use waterproof field books**. Field
30 reports should be documented on loose paper on masonite or aluminum clipboards (i.e.
31 plastic clipboards, binders, or spiral hard cover notebooks are not acceptable).
Sharpies®/markers should be avoided.
 - 32 • **Post-It Notes are not allowed** on project sites.

- 33 • **Do not use markers.** Pens should be used when documenting field activities in the field
34 log and on field forms as well as labeling sample containers and preparing the Chain of
35 Custody.
- 36 • **Do not use chemical (blue) ice packs** during the sampling program. This includes the
37 use of ice packs for the storage of food and/or samples.

38 **Field Clothing and Personal Protective Equipment**

- 39 • **Do not wear water resistant, waterproof, or stain-treated clothing** during the field
40 program. Field clothing made of synthetic and natural fibers (preferably cotton) are
41 acceptable. Field clothing should be laundered avoiding the use of fabric softener.
42 Preferably, field gear should be cotton construction and well laundered (a minimum of 6
43 times from time of purchase). New clothing may contain PFC related treatments. **Do**
44 **not use new clothing** while sampling or sample handling.
- 45 • **Do not wear clothing or boots containing Gore-Tex™** during the sampling program as it
46 consists of a PFC membrane.
- 47 • All safety footwear will consist of steel-toed boots made with polyurethane and
48 polyvinyl chloride (PVC).
- 49 • **Do not wear Tyvek® clothing** on-site since it contains fluorinated compounds.
- 50 • Disposable nitrile gloves must be worn at all times. Further, a new pair of nitrile gloves
51 should be donned prior to the following activities at each sample location:
 - 52 - Decontamination of re-usable sampling equipment;
 - 53 - Prior to contact with sample bottles or water containers;
 - 54 - Insertion of anything into the well (e.g. HDPE tubing, HydraSleeve bailer, etc.);
 - 55 - Insertion of silicon tubing into the peristaltic pump;
 - 56 - Completion of monitor well purging, prior to sample collection;
 - 57 - Handling of any quality assurance/quality control samples including field blanks and
58 equipment blanks; and,
 - 59 - After the handling of any non-dedicated sampling equipment, contact with non-
60 decontaminated surfaces, or when judged necessary by field personnel.

61 **Sample Containers**

- 62 • Samples should be collected in polypropylene or HDPE bottles fitted with an unlined (no
63 Teflon®), polypropylene HDPE screw cap. This is an especially important point as many
64 laboratories utilize Teflon-lined bottles.
- 65 • Container labels will be completed using pen (**NO MARKERS**) after the caps have been
66 placed back on each bottle.

- 67 • Glass containers should also be avoided due to potential loss of analyte through
68 adsorption.

69 **Wet Weather**

- 70 • Field sampling occurring during wet weather (e.g., rainfall and snowfall) should be
71 conducted while wearing appropriate clothing that will not pose a risk for cross-
72 contamination. Teams should avoid synthetic gear that has been treated with water-
73 repellent finishes containing PFCs. Use rain gear made from polyurethane and wax-
74 coated materials.

75 **Equipment Decontamination**

76 For GW sampling, it is highly recommended that disposable equipment be utilized. However, if
77 equipment re-use is performed, field sampling equipment, including oil/water interface meters
78 and water level indicators, that are utilized at each sample location will require cleaning
79 between uses. Alconox® and Liquinox® soap is acceptable for use since the Material Safety
80 Data Sheets do not list fluoro-surfactants as an ingredient. However, **Decon 90 must not be**
81 **used** during decontamination activities. Water used for the decontamination of sampling
82 equipment will be laboratory certified “PFC-free” water.

83 **Personnel Hygiene**

- 84 • Field personnel should not use cosmetics, moisturizers, hand cream, or other related
85 products as part of their personal cleaning/showering routine on the morning of a
86 sampling event, as these products may contain surfactants and represent a potential
87 source of PFCs.
- 88 • Many manufactured sunblock and insect repellants contain PFCs and should not be
89 brought or used on-site. Sunblock and insect repellants that are used on-site should
90 consist of 100% natural ingredients.

91 **Food Considerations**

- 92 • No food or drink shall be brought on-site, with the exception of bottled water and
93 hydration drinks (i.e., Gatorade® and Powerade®).

94 **Blanks**

- 95 • Utilization of blanks is a good quality check to monitor and control the effects of
96 contamination. Trip blanks and field blanks are recommended.

97 **REFERENCES**

- 98 • Transport Canada, 2013. *Perfluorochemical (PFC) Field Sampling Protocol*. May.

99 • Delta Consultants, 2010. *Report of Investigation Activities at Select Firefighting Foam*
100 *Training Areas and Foam Discharge Sites in Minnesota*. February.
101 • MPCA, 2008. *Closed Landfill Program Sampling Protocol for Monitoring Wells*. October.
102 • Oregon State University, 2015. *COLLECTION AND HANDLING OF SAMPLES FOR*
103 *FLUORO-CHEMICAL ANALYSIS*. July.
104 • EPA, 2009. EPA Document #: EPA/600/R-08/092, *METHOD 537. DETERMINATION OF*
105 *SELECTED PERFLUORINATED ALKYL ACIDS IN DRINKING WATER BY SOLID PHASE*
106 *EXTRACTION AND LIQUID CHROMATOGRAPHY/TANDEM MASS SPECTROMETRY*
107 *(LC/MS/MS)*. Version 1.1. September
108
109

Drinking Water Sampling when Analyzing for Per- and Polyfluoroalkyl Substances (PFASs)

I. Purpose and Scope

This SOP provides guidelines for drinking water sample collection for samples that will be analyzed for Per- and Polyfluoroalkyl Substances (PFASs), aka perfluorinated compounds (PFCs), including perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) via EPA Method 537 (not modified).

Standard techniques for collecting representative samples are summarized. These procedures are specific to the Navy Comprehensive Long-term Environmental Action Navy (CLEAN) Program under Contract N62470-16-D-9000.

II. Equipment and Materials

Equipment and Materials Required

- Drinking water sample containers (polypropylene bottle with polypropylene screw cap and Trizma preservative)
- Laboratory pre-filled polypropylene bottles containing field reagent blank water and Trizma preservative
- Field Reagent Blank sample containers (polypropylene bottle with polypropylene screw cap and no preservative)
- Shipping supplies (labels, coolers, and ice)
- Loose leaf paper without waterproof coating
- Clip board
- Pen (not Sharpie)
- Nitrile or latex gloves

Equipment and Materials to Avoid During Sampling

Equipment and materials used to collect drinking water samples should not contain any fluorinated compounds, including polytetrafluoroethylene (PTFE), Teflon[®] or synthetic rubber with fluoropolymer elastomers (e.g., Viton[®]).

Specifically, the following material should be avoided during sampling:

- Gore-Tex brand or similar high-performance outdoor clothing, clothing treated with ScotchGuard[®] brand or similar water repellent, fluoropolymer-coated Tyvek[®],

wrinkle-resistant fabrics, and fire resistant clothing with fluorochemical treatment or anything advertised as water repellent.

- Weather-proof log books with fluorochemical coatings

The sample collection area should be clear of the following items:

- Pre-packaged food wrappers (e.g., fast food sandwich wrappers, pizza boxes, etc.)
- Microwave popcorn bags
- Blue ice containers
- Aluminum foil
- Kim-Wipes
- Sunscreen, insect repellent and other personal hygiene products that may contain PFAS

Sample bottles should be polypropylene in accordance with Method 537. PFASs have a tendency to adhere to glass surfaces. Contact the project manager (PM) if the lab sends glass bottles. Sample vials should not have PTFE/Teflon[®] lined bottles or caps.

III. Procedures and Guidelines

A. Setup

1. Obtain well construction information from homeowner, if available, in accordance with homeowner questionnaire developed for your project.
2. Record personnel onsite, address, homeowner name, and designated sample ID in the field logbook. Sample IDs should not contain identifying information about the property location due to potential privacy issues, so be sure both address and designated ID are carefully recorded for tracking. Sample IDs and addresses on the sample bottles and in the sample notebook must be checked by both field team members and the address in the field notebook should be confirmed with the homeowner or resident.
3. As feasible, select a sampling collection point prior to any treatment system installed by the homeowner. For example, if the homeowner has a point of use reverse osmosis or granular activated carbon filter in their kitchen sink, collect at the bathroom sink. If there is a point of entry filtration system, ask if there is a sampling port between the well and the system. If there is no way to bypass the existing treatment system without disconnecting pump components or potentially damaging the system, collect a treated sample and note that the sample was collected post-treatment. Avoid collecting samples through hoses. Instead, disconnect the hose and sample from the spigot if an outside collection station is selected.

3. Wash hands before sampling with dish detergent and don nitrile gloves.
4. Open the tap and allow the system to flush for three to five minutes. Do not open bottles until you are ready to sample.

B. Sample Collection

Once flushing is complete, samples can be collected.

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

1. Turn the tap off briefly. Remove the cap from the sample bottle. Position the sample bottle under the tap and turn the tap on.
2. Fill the bottle, taking care not to flush out the sample preservative. Samples do not need to be collected headspace free.
3. After collecting the sample, cap the bottle and agitate by hand until the preservative is dissolved.
4. Pack the sample on ice immediately for shipment to the offsite laboratory.

C. Field Reagent Blank Collection

A field reagent blank is required at each drinking water sampling location and is to be collected immediately following collection of the drinking water sample. The steps to complete collection of the field reagent blank are as follows:

1. A preserved field reagent blank for each sample location will be provided by the laboratory along with empty bottles for the field reagent blanks. While still at the drinking water sample collection point, open the preserved field reagent blank water bottle and an empty unpreserved sample bottle.
2. Pour the preserved reagent blank water from the preserved bottle into the unpreserved blank container.
3. Be sure the field reagent blank bottle is labeled and will be labeled and packed in the same cooler as the associated drinking water sampling for shipment to the offsite laboratory.

V. References

United States Environmental Protection Agency (USEPA), 2009. *Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS)*. September

Decontamination of Personnel and Equipment

I. Purpose

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

II. Scope

This is a general description of decontamination procedures.

III. Equipment and Materials

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

IV. Procedures and Guidelines

A. PERSONNEL DECONTAMINATION

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

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

B. SAMPLING EQUIPMENT DECONTAMINATION – GROUNDWATER SAMPLING PUMPS

Sampling pumps are decontaminated after each use as follows.

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

C. SAMPLING EQUIPMENT DECONTAMINATION – OTHER EQUIPMENT

Reusable sampling equipment is decontaminated after each use as follows.

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

D. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

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

E. SAMPLE CONTAINER DECONTAMINATION

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

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

F. HEAVY EQUIPMENT AND TOOLS

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

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

V. Attachments

None.

VI. Key Checks and Items

- Clean with solutions of Liquinox[®], Liquinox[®] solution (optional), and distilled water.
- Do not use acetone for decontamination.
- Drum all contaminated rinsate and materials.
- Decontaminate filled sample bottles before relinquishing them to anyone.

Disposal of Waste Fluids and Solids

I. Purpose and Scope

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

II. Equipment and Materials

A. Fluids

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

B. Solids

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

III. Procedures and Guidelines

A. Methodology

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

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

The drum contents will be sampled to determine the disposal requirements of the drilling wastes. Check with the Environmental Manager (EM) assigned to the project prior to sample collection for frequency and analysis. Unless otherwise specified by the EM, the drum sampling will be accomplished through the collection and submittal of composite samples, one sample per 10 drums (check with disposal facility to determine sample frequency) containing the same media. Similar compositing will be performed in each rolloff to obtain a representative sample. The compositing of the sample will be accomplished by collecting a specific volume of the material in each drum into a large sample container. When samples from each of the drums being sampled in a single compositing are collected, the sample will be submitted for TCLP, ignitability, corrosivity, and reactivity analysis. Additional analysis may be required by your EM.

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

B. Labels

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

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

C. Fluids

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

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

D. Solids

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

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

E. Storage and Disposal

The wastes generated at the site at individual locations will be transported to the drum storage area by the drilling services subcontractor. Drums should be stored on plastic sheeting with a short berm wall (hay bales or 2 x 4 planks or equivalent) to capture small spills. The drums should be staged such that the labels are all visible and there should be enough room to walk between rows of drums if applicable.

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

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

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

- Contact the project Environmental Manager prior to containerizing waste to determine containerization method and sampling frequency and analysis.
- Check that representative samples of the containerized materials are obtained.
- Be sure that all state and federal regulations are considered when classifying waste for disposal.

Decontamination of Drilling Rigs and Equipment

I. Purpose and Scope

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

II. Equipment and Materials

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

III. Procedures and Guidelines

A. Drilling Rigs and Monitoring Well Materials

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

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

B. Downhole Drilling Tools

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

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

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

C. Field Analytical Equipment

1. Water Level Indicators

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

- a. Rinse with tap water
- b. Rinse with de-ionized water
- c. Solvent rinse with isopropanol (Optional)
- d. Rinse with de-ionized water

2. Probes

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

IV. Attachments

None.

V. Key Checks and Preventative Maintenance

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

Preparing Field Log Books

I. Purpose

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

II. Scope

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

III. Equipment and Materials

- Log book
- Indelible pen

IV. Procedures and Guidelines

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

A. PROCEDURES FOR COMPLETING FIELD LOG BOOKS

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

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

B. INFORMATION TO BE INCLUDED IN FIELD LOG BOOKS

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

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

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

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

C. SUGGESTED FORMAT FOR RECORDING FIELD DATA

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

V. Attachments

Example field notes.

47

MAY 12, 2003

EXAMPLE

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

AT SITE 17

0725 BB ~~STARTS~~ JS CALIBRATES

PID: 101 ppm / 100 ppm OK

PID MODEL #, SERIAL #

0730 BB CALIBRATES HORIBA METER

MODEL #, SERIAL #

→ LIST CALIBRATION RESULTS

0738 SURVEY CREW ARRIVES ON SITE

→ LIST NAMES

0745 BB HOLDS H+S TALK ON SLIPS,

TRIPS, FALLS, TICKETS + AIR MONITORING

JS + SURVEY CREW ATTEND

NO H+S ISSUES IDENTIFIED AS
 CONCERNS. ALL WORK IS IN "LEVEL D."

0755 JS CONDUCTS SITE-WIDE AIR MONITORING

ALL READINGS = 0.0 PPM IN

JS
5-12-03

MAY 12, 2003

EXAMPLE

48

SITE 14 LTM

BREATHING ZONE (BZ)

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

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

0820 Purging MW-22

→ RECORD WATER QUALITY DATA

JS
5-12-03

0843 Collect SAMPLE AT MW-22 for
 total TAL Metals AND VOC'S. NO
 Dissolved Metals Needed PER PPL

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

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

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

0955 Mobilize to well MW-19

JS
5-12-03

Chain-of-Custody

I Purpose

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

II Scope

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

III Definitions

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

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

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

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

IV. Procedures

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

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

Sample Identification

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

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

- Field Sampler(s),
- Contract Task Order (CTO) Number,
- Project Sample Number,
- Sample location or sampling station number,
- Date and time of sample collection and/or measurement,
- Field observations,
- Equipment used to collect samples and measurements, and
- Calibration data for equipment used

Measurements and observations shall be recorded using waterproof ink.

Sample Label

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

- Project - CTO Number.
- Station Location - The unique sample number identifying this sample.
- Date - A six-digit number indicating the day, month, and year of sample collection (e.g., 08/21/12).

- Time - A four-digit number indicating the 24-hour time of collection (for example: 0954 is 9:54 a.m., and 1629 is 4:29 p.m.).
- Medium - Water, soil, sediment, sludge, waste, etc.
- Sample Type - Grab or composite.
- Preservation - Type and quantity of preservation added.
- Analysis - VOA, BNAs, PCBs, pesticides, metals, cyanide, other.
- Sampled By - Printed name of the sampler.
- Remarks - Any pertinent additional information.

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

Chain-of-Custody Procedures

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

Field Custody Procedures

- Samples are collected as described in the site Sampling and Analysis Plan. Care must be taken to record precisely the sample location and to ensure that the sample number on the label matches the Chain-of-Custody Record exactly.
- A Chain-of-Custody Record will be prepared for each individual cooler shipped and will include *only* the samples contained within that particular cooler. The Chain-of-Custody Record for that cooler will then be sealed in a zip-log bag and placed in the cooler prior to sealing. This ensures that the laboratory properly attributes trip blanks with the correct cooler and allows for easier tracking should a cooler become lost during transit.
- The person undertaking the actual sampling in the field is responsible for the care and custody of the samples collected until they are properly transferred or dispatched.
- When photographs are taken of the sampling as part of the documentation procedure, the name of the photographer, date, time, site location, and site description are entered sequentially in the site logbook as photos are taken. Once downloaded to the server or developed, the electronic files or photographic prints shall be serially numbered, corresponding to the logbook descriptions; photographic prints will be stored in the project files. To identify

sample locations in photographs, an easily read sign with the appropriate sample location number should be included.

- Sample labels shall be completed for each sample, using waterproof ink unless prohibited by weather conditions (e.g., a logbook notation would explain that a pencil was used to fill out the sample label if the pen would not function in freezing weather.)

Transfer of Custody and Shipment

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

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

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

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

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

V Quality Assurance Records

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

VI Attachments

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

VII References

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

Attachment A
Example Sample Label



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

Client _____
 Sample No. _____
 Location _____

 Analysis _____
 Preservative **HCL** _____
 Date _____ By _____

CEIMIC CORPORATION

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

| | |
|---|---------------------|
| SITE NAME | DATE |
| ANALYSIS | TIME |
| | PRESERVATIVE |
| SAMPLE TYPE | |
| <input type="checkbox"/> Grab <input type="checkbox"/> Composite <input type="checkbox"/> Other _____ | |
| COLLECTED BY: | |

Attachment B
Example Chain-of-Custody Record

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|--|------|------|---|--------|---|--|---|---|---|--|---|--|-----------------------|---------|---|---|---|---------------|---|----------------|---|--|--|--|-------------|-------------|--|--|--|--|--|------------|-----------|--|--|------------------------------|--|------|--|
| CH2M Hill Project # Purchase Order # Project Name Company Name CH2M HILL Office | | | | | | | | | | | | # O F C O N T A I N E R S | LAB TEST CODES | | | | | | | | | | SHADED AREA-- FOR LAB USE ONLY | | | | | | | | | | | | | | | | |
| Report Copy to: Mr. [] Ms. [] Dr. [] | | | | | | | | | | | | | | | | | | | | | | | Lab 1 # | | Lab 2 # | | | | | | | | | | | | | | |
| Requested Completion Date: | | | | | | Sampling Requirements SDWA <input type="checkbox"/> NPDES <input type="checkbox"/> RCRA <input type="checkbox"/> OTHER <input type="checkbox"/> | | | | Sample Disposal: Dispose <input type="checkbox"/> Return <input type="checkbox"/> | | | | Quote # | | | | Kit Request # | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | ANALYSES REQUESTED | | | | | | | | | | Project # | | | | | | | | | | | | | | | | | | | |
| Sampling | | Type | | Matrix | | CLIENT SAMPLE ID (9 CHARACTERS) | | | | | | | | | | | | | | No. of Samples | | Page of | | | | | | | | | | | | | | | | | |
| Date | Time | C | O | M | P | G | R | A | B | W | A | | T | E | R | S | O | I | L | A | I | R | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | Login | | LIMS Ver | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | REMARKS | | LAB 1 ID | LAB 2 ID | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Sampled By & Title (Please sign and print name) | | | | | | | | | | | | | Date/Time | | | | | | | | | | Relinquished By (Please sign and print name) | | | | | | | | | | Date/Time | | | | | | |
| Received By (Please sign and print name) | | | | | | | | | | | | Date/Time | | | | | | | | | | Relinquished By (Please sign and print name) | | | | | | | | | | Date/Time | | | | OC Level: 1 2 3 Other: _____ | | | |
| Received By (Please sign and print name) | | | | | | | | | | | | Date/Time | | | | | | | | | | Relinquished By (Please sign and print name) | | | | | | | | | | Date/Time | | | | COC Rec | | ICE | |
| Received By (Please sign and print name) | | | | | | | | | | | | Date/Time | | | | | | | | | | Shipped Via UPS BUS Fed-Ex Hand Other _____ | | | | | | | | | | Shipping # | | | | Ana Req | | TEMP | |
| Work Authorized By (Please sign and print name) | | | | | | | | | | | | Date/Time | | | | | | | | | | Remarks | | | | | | | | | | | | | | Cust Seal | | Ph | |

Attachment C
Example Custody Seal



CUSTODY SEAL

Date _____

Signature _____

Locating and Clearing Underground Utilities

I. Purpose

The purpose of this SOP is to provide general guidelines and specific procedures that must be followed on Navy CLEAN projects for locating underground utilities and clearing dig locations in order to maximize our ability to avoid hitting underground utilities and to minimize liabilities to CH2M HILL and its subcontractors and health and safety risks to our project staff.

This SOP shall be used by Activity Managers and Project Managers to, in-turn, develop Activity-specific and project-specific utility location procedures. The activity and project-specific procedures will become part of work plans and project instructions and will be used to prepare scopes of work (SOWs) for the procurement of utility location subcontractors to meet the needs of individual projects.

This SOP also identifies the types of utility locating services that are available from subcontractors and the various tools that are used to locate utilities, and discusses when each type of service and tool may or may not be applicable.

II. Scope

Depending on the Navy/Marine Activity we typically find ourselves in one of two scenarios:

Scenario 1

The Activity provides utility locating (or dig clearance) services through the public works department or similar organization, or has a contract with an outside utility clearance service. Some of these services are provided in the form of dig permits which are required before you can dig or drill. In other cases no official permit is required and the process is somewhat vague.

Scenario 2

The Activity does not get involved in any utility locating processes aside from possibly providing the most recent utility maps, and relies on CH2M HILL to clear the dig locations.

Table 1 provides an up to date summary of which scenarios apply to the various primary Activities served under the Navy CLEAN program.

Scenario 1 is preferred because under this scenario the Navy tends to assume the responsibility if the location is improperly cleared, a utility is struck, and property damage results. However, our experience has been that the clearance services provided

by the Navy do not meet the standards that we consider to be adequate, in that they often simply rely on available base maps to mark utilities and do not verify locations using field geophysics. And if they do use locating tools, they do not provide adequate documentation or marking to confirm that a location has been cleared. So while the Navy's process may protect us from liability for property damage, it does not adequately protect our staff and subcontractors from health risks nor does it compensate us for down time, should a utility be hit.

Therefore, regardless of what services the Navy provides, in most cases we still need to supplement this effort with clearance services from our own third party utility location subcontractor following the procedures and guideline outlined in Section IV of this SOP. The cost implications of providing this service will range from \$500 to several \$1,000 depending on the size of the project.

The scope of services that we ask our subcontractors to provide can involve utility marking/mapping or the clearing of individual dig locations. In the former we ask our subs to mark all utilities within a "site" and often ask them to prepare a map based on their work. In the later, we ask them to clear (identify if there are any utilities within) a certain radius of a proposed dig/drill location.

The appropriate requested scope of services for a project will depend on the project. Clearing individual boreholes is often less expensive and allows the sub to concentrate their efforts on a limited area. However if the scope of the investigation is fluid (all borehole locations are not predetermined) it may be best to mark and map an entire site or keep the subcontractor on call.

Clearance of individual dig locations should be done to a minimum 20 foot radius around the location.

An example SOW for a utility subcontractor procurement is provided in Attachment A.

III. Services and Equipment

This section provides a general description of the services available to help us locate subsurface utilities and describes the types of equipment that these services may (or may not) use to perform their work. It identifies the capabilities of each type of equipment to help the PM specify what they should require from our utility location subs.

Services

The services that are available to us for identifying and marking underground utilities are:

- The local public/private utility-run service such as Miss Utility
- Utility location subcontractors (hired by us)

Attachment B provides a detailed description of each type of organization. It also provides contact numbers and web sites for the various Miss-Utility-type organizations in the areas where we do work for the Navy and contacts and services provided by several subcontractors that we have used or spoken to in the past.

Equipment

Attachment C provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the PM determine if the equipment being used by a subcontractor is adequate.

It is important to make the potential subcontractors aware of the possible types of utilities (and utility materials) that are at the site, and to have them explain in their bid what types of equipment they will use to locate utilities /clear dig locations, and what the limitations of these equipment are.

A list of in-house experts that can be used to help you evaluate bids or answer questions you may have is provided in **Appendix C**.

IV. Procedures and Guidelines

This section presents specific procedures to be followed for the utility location work to be conducted by CH2M HILL and our subcontractors. In addition, a PM will have to follow the procedures required by the Activity to obtain their approvals, clearances and dig permits where necessary. These “dig permit” requirements vary by Activity and must be added to the project-specific SOP, or project instructions. It is preferable that the Activity perform their clearance processes before we follow up with our clearance work.

Activity Notification and Dig Permit Procedures

Identify Activity-specific permit and/or procedural requirements for excavation and drilling activities. Contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.

Activity Specific: To be provided by Activity or Project Manager

CH2M HILL Utility Clearance Procedures

Do not begin subsurface construction activities (e.g., trenching, excavation, drilling, etc.) until a check for underground utilities and similar obstructions has been conducted by CH2M HILL as a follow-up to the services provided by the Navy. The use of as-built drawings and utility company searches must be supplemented with a geophysical or other survey by a qualified, independent survey contractor (subcontracted to CH2M HILL) to identify additional and undiscovered buried utilities.

Examples of the type of geophysical technologies include (these are further described in Attachment C):

- **Ground Penetrating Radar (GPR)**, which can detect pipes, including gas pipes, tanks, conduits, cables etc, both metallic and non-metallic at depths up to 30 feet depending on equipment. Sensitivity for both minimum object size and maximum depth detectable depends on equipment selected, soil conditions, etc.
- **Radio Frequency (RF)**, involves inducing an RF signal in the pipe or cable and using a receiver to trace it. Some electric and telephone lines emit RF naturally and can be

detected without an induced signal. This method requires knowing where the conductive utility can be accessed to induce RF field if necessary.

- **Dual RF**, a modified version of RF detection using multiple frequencies to enhance sensitivity but with similar limitations to RF
- **Ferromagnetic Detectors**, are metal detectors that will detect ferrous and non-ferrous utilities. Sensitivity is limited, e.g. a 100 mm iron disk to a depth of about one meter or a 25 mm steel paper clip to a depth of about 20 cm.
- **Electronic markers**, are emerging technologies that impart a unique electronic signature to materials such as polyethylene pipe to facilitate location and tracing after installation. Promising for future installations but not of help for most existing utilities already in place.

The following procedures shall be used to identify and mark underground utilities during subsurface construction activities on the project:

- Contact utility companies or the state/regional utility protection service (such as Miss Utility) at least two (2) working days prior to intrusive activities to advise of the proposed work, and ask them to establish the location of the utility underground installations prior to the start of actual excavation: this is a law. These services will only mark the location of public-utility-owned lines and not Navy-owned utilities. In many cases there will not be any public-utility-owned lines on the Activity. There may also be Base-access issues to overcome.
- Procure and schedule the independent survey.
- The survey contractor shall determine the most appropriate geophysical technique or combinations of techniques to identify the buried utilities on the project site, based on the survey contractor's experience and expertise, types of utilities anticipated to be present and specific site conditions. *The types of utilities must be provided to the bidding subcontractors in the SOW and procedures to be used must be specified by the bidder in their bid. It is extremely helpful to provide the sub with utility maps, with the caveat that all utilities are not necessarily depicted.*
- The survey subcontractor shall employ the same geophysical techniques used to identify the buried utilities, to survey the proposed path of subsurface investigation/construction work to confirm no buried utilities are present.
- Obtain utility clearances for subsurface work on both public and private property.
- Clearances provided by both the "Miss Utility" service and the CH2M HILL-subcontracted service are to be in writing, signed by the party conducting the clearance. The Miss Utility service will have standard notification forms/letters which typically simply state that they have been to the site and have done their work. The CH2M HILL subcontractor shall be required to fill out the form provided in Attachment D (this can be modified for a particular project) indicating that each dig/drill location has been addressed. *This documentation requirement (with a copy of the form) needs to be provided in the subcontractor SOW.*

- Marking shall be done using the color coding presented in Attachment E. The type of material used for marking must be approved by the Activity prior to marking. Some base commanders have particular issues with persistent spray paint on their sidewalks and streets. *Any particular marking requirements need to be provided in the subcontractor SOW.*
- Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, the Project Manager must notify the utility company or utility protection service to inform them that the markings have been destroyed.
- Perform a field check prior to drilling/digging (preferably while the utility location sub is still at the site) to see if field utility markings coincide with locations on utility maps. Look for fire hydrants, valves, manholes, light poles, lighted signs, etc to see if they coincide with utilities identified by the subcontractor.
- Underground utility locations must be physically verified (or dig locations must be physically cleared) by hand digging using wood or fiberglass-handled tools, air knifing, or by some other acceptable means approved by CH2M HILL, when the dig location (e.g. mechanical drilling, excavating) is expected to be within 5 feet of a marked underground system. Hand clearance shall be done to a depth of four feet unless a utility cross-section is available that indicates the utility is at a greater depth. In that event, the hand clearance shall proceed until the documented depth of the utility is reached.
- Conduct a site briefing for employees at the start of the intrusive work regarding the hazards associated with working near the utilities and the means by which the operation will maintain a safe working environment. Detail the method used to isolate the utility and the hazards presented by breaching the isolation.
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon during drilling or change in color, texture or density during excavation that could indicate the ground has been previously disturbed).

IV. Attachments

- A- Example SOW for Utility Location Subcontractor Procurement
- B - Services Available for Identifying and Marking Underground Utilities
- C - Equipment Used for Identifying Underground Utilities
- D - Utility Clearance Documentation Form
- E - Utility Marking Color Codes

Attachment A – Example SOW for Subcontracting Underground Utilities Locating Services

CTO-XXX

Scope of Work

Subsurface Utility Locating

Site XX

Navy Activity

City, State

A licensed and insured utility locator will be subcontracted to identify and mark out subsurface utilities for an environmental investigation/remediation project at Site XX of <<insert name of base, city, and state>>. The subcontractor will need to be available beginning at <<insert time>> on <<insert date>>. It is estimated that the work can be completed within XX days.

Proposed Scope of Work

The subcontractor will identify and mark all subsurface utilities (CHOOSE 1) that lie within a radius of 20 feet of each of XX sampling locations at Site XX shown on the attached Figure 1; (OR) that lie within the bounds of Site XX as delineated on the attached Figure 1. (If multiple sites are to be cleared, provide maps of each site with sample locations or clearance boundaries clearly delineated and a scale provided.)

Utilities will be identified using all reasonably available as-built drawings, electronic locating devices, and any other means necessary to maintain the safety of drilling and sampling personnel and the protection of the base infrastructure. The location of utilities identified from as-built drawings or other maps must be verified in the field prior to marking.

Base utility drawings for the Site(s) (CHOOSE 1) can be found at <<insert specific department and address or phone number on the base>> and should be reviewed by the subcontractor and referenced as part of the utility locating. (OR), will be provided to the subcontractor by CH2M HILL upon the award of the subcontract. (OR), are not available. Utility drawings shall not be considered definitive and must be field verified.

Field verification will include detection using nonintrusive subsurface detection equipment (magnetometers, GPR, etc) as well as opening manhole covers to verify pipe directions. As part of the bid, the Subcontractor shall provide a list of the various subsurface investigation tools they propose to have available and use at the site and what the limitations are of each tool.

A CH2M HILL representative shall be present to coordinate utility clearance activities and identify points and features to be cleared.

Field Marking and Documentation

All utilities located within **(CHOOSE 1) a 20-ft radius of the XX proposed soil boring locations (OR) within the boundary of the site(s)** as identified on the attached figure(s) will be marked using **paint (some Bases such as the WNY may have restrictions on the use of permanent paint)** and/or pin flags color coded to indicate electricity, gas, water, steam, telephone, TV cable, fiber optic, sewer, etc. The color coding shall match the industry standard as described on the attached form. In addition, the **Buried Utility Location Tracking Form** (attached) will be completed by the Subcontractor based upon what is identified in the field during the utility locating and submitted back to CH2M HILL (field staff or project manager) within 24 hours of completing the utility locating activities.

(OPTIONAL) The subcontractor shall also provide a map (or hand sketch) of the identified utilities to the Engineer within XX days of field demobilization. The map shall include coordinates or ties from fixed surface features to each identified subsurface utility.

Bid Sheet/Payment Units

The subcontractor will bid on a time and materials basis for time spent on site and researching utility maps. Mobilization (including daily travel to the site) should be bid as a lump sum, as well as the preparation of the AHA **and any required mapping**. The per diem line item should be used if the field crew will require overnight accommodations at the project site.

Health and Safety Requirements

The utility locating subcontractor is to provide and assume responsibility for an adequate corporate Health and Safety Plan for onsite personnel. Standard personal safety equipment including: hard hat, safety glasses, steel-toed boots, gloves are recommended for all project activities. Specific health and safety requirements will be established by the Subcontractor for each project. The health and safety requirements will be subject to the review of CH2M HILL.

The subcontractor shall also prepare and provide to the Engineer, at least 48 hours prior to mobilization, an acceptable Activity Hazard Analysis (AHA) using the attached AHA form or similar.

It is also required that all subcontractor personnel who will be on site attend the daily 15-minute health and safety tailgate meeting at the start of each day in the field.

Subcontractor personnel showing indications of being under the influence of alcohol or illegal drugs will be sent off the job site and their employers will be notified. Subcontractor personnel under the influence of prescription or over-the-counter medication that may impair their ability to operate equipment will not be permitted to do so. It is expected that the subcontractor will assign them other work and provide a capable replacement (if necessary) to operate the equipment to continue work.

Security

The work will be performed on US Navy property. CH2M HILL will identify the Subcontractor personnel who will perform the work to the appropriate Navy facility point-of-contact, and will identify the Navy point-of-contact to the Subcontractor crew. The Subcontractor bears final responsibility for coordinating access of his personnel onto Navy property to perform required work. This responsibility includes arranging logistics and providing to CH2M HILL, in advance or at time of entry as specified, any required identification information for the Subcontractor personnel. Specifically, the following information should be submitted with the bid package for all personnel that will perform the work in question (this information is required to obtain a base pass):

- Name
- Birth Place
- Birth Date
- Social Security Number
- Drivers License State and Number
- Citizenship

Please be advised that no weapons, alcohol, or drugs will be permitted on the Navy facility at any time. If any such items are found, they will be confiscated, and the Subcontractor will be dismissed.

Quality Assurance

The Subcontractor will be licensed and insured to operate in the State of <<state>> and will comply with all applicable federal, state, county and local laws and regulations. The subcontractor will maintain, calibrate, and operate all electronic locating instruments in accordance with the manufacturer's recommendations. Additionally, the Subcontractor shall make all reasonable efforts to review as-built engineering drawings maintained by Base personnel, and shall notify the CH2M HILL Project Manager in writing (email is acceptable) whenever such documentation was not available or could not be reviewed.

Subcontractor Standby Time

At certain periods during the utility locating activities, the Subcontractor's personnel may be asked to stop work and standby when work may normally occur. During such times, the Subcontractor will cease activities until directed by the CH2M HILL representative to resume operations. Subcontractor standby time also will include potential delays caused by the CH2M HILL representative not arriving at the site by the agreed-upon meeting time for start of the work day. Standby will be paid to the

Subcontractor at the hourly rate specified in the Subcontractor's Bid Form attached to these specifications.

Cumulative Subcontractor standby will be accrued in increments no shorter than 15 minutes (i.e., an individual standby episode of less than 15 minutes is not chargeable).

During periods for which standby time is paid, the surveying equipment will not be demobilized and the team will remain at the site. At the conclusion of each day, the daily logs for the Subcontractor and CH2M HILL representative will indicate the amount of standby time incurred by the Subcontractor, if any. Payment will be made only for standby time recorded on CH2M HILL's daily logs.

Down Time

Should equipment furnished by the Subcontractor malfunction, preventing the effective and efficient prosecution of the work, or inclement weather conditions prevent safe and effective work from occurring, down time will be indicated in the Subcontractor's and CH2M Hill representative's daily logs. No payment will be made for down time.

Schedule

It is anticipated that the subsurface utility locating activities will occur on <<insert date>>. It is estimated that the above scope will be completed within XXX days.

Attachment B - Services Available for Identifying and Marking Underground Utilities

The services that are available to us for identifying and marking underground utilities are:

- The Activity's PWC (or similar organization)
- The local public/private utility -run service such as Miss Utility
- Utility location subcontractors (hired by CH2M HILL)

Each are discussed below.

Navy Public Works Department

A Public Works Department (PWD) is usually present at each Activity. The PWD is responsible for maintaining the public works at the base including management of utilities. In many cases, the PWD has a written permit process in place to identify and mark-out the locations of Navy-owned utilities [Note: The PWD is usually NOT responsible for the locations/mark-outs of non-Navy owned, public utilities (e.g., Washington Gas, Virginia Power, municipal water and sewer, etc.). Therefore, it is likely that we will have to contact other organizations besides the PWD in order to identify non-Navy owned, public utilities].

At some Activities, there may not be a PWD, the PWD may not have a written permit process in place, or the PWD may not take responsibility for utility locating and mark-outs. In these cases, the PWD should still be contacted since it is likely that they will have the best understanding of the utility locations at the Activity (i.e., engineering drawings, institutional knowledge, etc.). Subsequently, the PWD should be brought into a cooperative arrangement (if possible) with the other services employed in utility locating and mark-out in order to have the most comprehensive assessment performed.

At all Activities we should have a contact (name and phone number), and preferably an established relationship, with PWD, either directly or through the NAVFAC Atlantic, Midlant, or Washington NTR or Activity Environmental Office that we can work with and contact in the event of problems.

Miss Utility or "One Call" Services for Public Utility Mark-outs

Miss Utility or "One Call" service centers are information exchange centers for excavators, contractors and property owners planning any kind of excavation or digging. The "One Call" center notifies participating public utilities of the upcoming excavation work so they can locate and mark their underground utilities in advance to prevent possible damage to underground utility lines, injury, property damage and service outages. In some instances, such with southeastern Virginia bases, the Navy has entered into agreement with Ms. Utilities and is part of the response process for Miss

Utilities. Generally, a minimum of 48 hours is required for the public utility mark-outs to be performed. The "One Call" services are free to the public. Note that the "One Call" centers only coordinate with participating public utilities. There may be some public utilities that do NOT participate in the "One Call" center which may need to be contacted separately. For example, in Washington, DC, the Miss Utility "One Call" center does not locate and mark public sewer and water lines. Therefore, the municipal water and sewer authority must be contacted separately to have the sewer and water lines marked out. The AM should contact the appropriate one-call center to determine their scope of services.

For the Mid-Atlantic region, the following "One Call" service centers are available.

| Name | Phone | Website | Comments |
|--|------------------------------|--|--|
| Miss Utility of DELMARVA | 800-257-7777 | www.missutility.net | Public utility mark-outs in Delaware, Maryland, Washington, DC, and Northern Virginia |
| Miss Utility of Southern Virginia (One Call) | 800-552-7001 | not available | Public utility mark-outs in Southern Virginia |
| Miss Utility of Virginia | 800-257-7777 800-552-7007 | www.missutilityofvirginia.com | General information on public utility mark-outs in Virginia, with links to Miss Utility of DELMARVA and Miss Utility of Southern Virginia (One Call) |
| Miss Utility of West Virginia, Inc | 800-245-4848 | none | Call to determine what utilities they work with in West Virginia |
| North Carolina One Call Center | 800-632-4949 | www.ncocc.org/ncocc/default.htm | Public Utility Markouts in North Carolina |

Private Subcontractors

- Utility-locating support is required at some level for most all CH2M HILL field projects in "clearing" proposed subsurface boring locations on the project site. Utility location and sample clearance can include a comprehensive effort of GIS map interpretation, professional land surveying, field locating, and geophysical surveying. Since we can usually provide our own GIS-related services for projects and our professional land surveying services are normally procured separately, utility-locating subcontractors will normally only be required for some level of geophysical surveying support in the field. This level of geophysical surveying support can range widely from a simple electromagnetic (EM) survey over a known utility line, to a blind geophysical effort, including a ground-penetrating radar (GPR) survey and/or a comprehensive EM survey to delineate and characterize all unknown subsurface anomalies.

The level of service required from the subcontractor will vary depending on the nature of the site. At sites where utility locations are well defined on the maps and recent construction is limited, CH2M HILL may be confident with a limited effort from a traditional utility-locating subcontractor providing a simple EM survey. At

sites where utility locations are not well defined, where recent constructions may have altered utility locations, or the nature of the site makes utility location difficult, CH2M HILL will require the services of a comprehensive geophysical surveying subcontractor, with a wide range of GPR and EM services available for use on an "as-needed" basis. Typical costs for geophysical surveying subcontractors will range from approximately \$200 per day for a simple EM effort (usually one crew member and one instrument) to approximately \$1,500 per day for a comprehensive geophysical surveying effort (usually a two-person crew and multiple instruments). Comprehensive geophysical surveying efforts may also include field data interpretation (and subsequent report preparation) and non-destructive excavation to field-verify utility depths and locations.

The following table provides a list of recommended geophysical surveying support subcontractors that can be used for utility-locating services:

| Company Name and Address | Contact Name and Phone Number | Equipment ¹ | | | | | Other Services ² | | |
|--|---------------------------------|------------------------|---|---|---|---|-----------------------------|---|---|
| | | 1 | 2 | 3 | 4 | 5 | A | B | C |
| US Radar, Inc.* PO Box 319 Matawan, NJ 07747 | Ron LaBarca 732-566-2035 | | | 4 | | | | | |
| Utilities Search, Inc.* | Jim Davis 703-369-5758 | 4 | | | | 4 | 4 | 4 | 4 |
| So Deep, Inc.* 8397 Euclid Avenue Manassas Park, VA 20111 | 703-361-6005 | 4 | | | | | 4 | 4 | 4 |
| Accurate Locating, Inc. 1327 Ashton Rd., Suite 101 Hanover, MD 21076 | Ken Shipley 410-850-0280 | 4 | 4 | | | | | | |
| NAEVA Geophysics, Inc. P.O. Box 7325 Charlottesville, VA 22906 | Alan Mazurowski 434-978-3187 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| Earth Resources Technology, Inc. 8106 Stayton Rd. Jessup, MD 20794 | Peter Li 240-554-0161 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | |
| Geophex, Ltd 605 Mercury Street Raleigh, NC 27603 | I. J. Won 919-839-8515 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| | | | | | | | | | |

Notes:

*Companies denoted with an asterisk have demonstrated reluctance to assume responsibility for damage to underground utilities or an inability to accommodate the insurance requirements that CH2M HILL requests for this type of work at many Navy sites.

¹Equipment types are:

1. Simple electromagnetic instruments, usually hand-held
2. Other, more innovative, electromagnetic instruments, including larger instruments for more area coverage
3. Ground-penetrating radar systems of all kinds
4. Audio-frequency detectors of all kinds
5. Radio-frequency detectors of all kinds

²Other services include:

- A. Data interpretation and/or report preparation to provide a permanent record of the geophysical survey results and a professional interpretation of the findings, including expected accuracy and precision.
- B. Non-destructive excavation to field-verify the depths, locations, and types of subsurface utilities.
- C. Concrete/asphalt coring and pavement/surface restoration.

Attachment C – Equipment Used for Identifying Underground Utilities

This attachment provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the AM and PM determine if the equipment being proposed by a subcontractor or Navy is adequate. A list of in-house experts that can be used to answer questions you may have is provided below.

CH2M HILL In-house Utility Location Experts

Tamir Klaff/WDC

Home Office Phone – 703-669-9611

Electromagnetic Induction (EMI) Methods

EMI instruments, in general, induce an electromagnetic field into the ground (the primary field) and then record the response (the secondary field), if any. Lateral changes in subsurface conductivity, such as caused by the presence of buried metal or by significant soil variations, cause changes in the secondary field recorded by the instrument and thus enable detection and mapping of the subsurface features. It should be noted that EMI only works for electrically conductive materials--plastic or PVC pipes are generally not detected with EMI. Water and gas lines are commonly plastic, although most new lines include a copper “locator” strip on the top of the PVC to allow for detection with EMI.

EMI technology encompasses a wide range of instruments, each with inherent strengths and weaknesses for particular applications. One major division of EMI is between “time-domain” and “frequency-domain” instruments that differ in the aspect of the secondary field they detect. Another difference in EMI instruments is the operating frequency they use to transmit the primary field. Audio- and radio-frequencies are often used for utility detection, although other frequencies are also used. Consideration of the type of utility expected, surface features that could interfere with detection, and the “congestion” of utilities in an area, should be made when choosing a particular EMI instrument for a particular site.

One common EMI tool used for utility location is a handheld unit that can be used to quickly scan an area for utilities and allows for marking locations in “real time”. This method is most commonly used by “dig-safe” contractors marking out known utilities prior to excavation. It should be noted that this method works best when a signal (the primary field) can be placed directly onto the line (i.e., by clamping or otherwise connecting to the end of the line visible at the surface, or for larger utilities such as sewers, by running a transmitter through the utility). These types of tools also have a limited capability to scan an area for unknown utilities. Usually this requires having enough area to separate a hand held transmitter at least a hundred feet from the

receiver. Whether hunting for unknown, or confirming known, utilities, this method will only detect continuous lengths of metallic conductors.

In addition to the handheld EMI units, larger, more powerful EMI tools are available that provide more comprehensive detection and mapping of subsurface features. Generally, data with these methods are collected on a regular grid in the investigation area, and are then analyzed to locate linear anomalies that can be interpreted as utilities. These methods will usually detect *all* subsurface metal (above a minimum size), including pieces of abandoned utilities. In addition, in some situations, backfill can be detected against native soils giving information on trenching and possible utility location. Drawbacks to these methods are that the secondary signals from utilities are often swamped (i.e., undetectable) close to buildings and other cultural features, and that the subsurface at heavily built-up sites may be too complicated to confidently interpret completely.

Hand-held metal detectors (treasure-finders) are usually based on EMI technology. They can be used to locate shallow buried metal associated with utilities (e.g., junctions, manholes, metallic locators). Advantages of these tools is the ease of use and real-time marking of anomalies. Drawbacks include limited depths of investigations and no data storage capacity.

Ground Penetrating Radar (GPR)

GPR systems transmit radio and microwave frequency (e.g., 80 megaHertz to 1,000 megaHertz) waves into the ground and then record reflections of those waves coming back to the surface. Reflections of the radar waves typically occur at lithologic changes, subsurface discontinuities, and subsurface structures. Plastic and PVC pipes can sometimes be detected in GPR data, especially if they are shallow, large, and full of a contrasting material such as air in a wet soil, or water in a dry soil. GPR data are usually collected in regular patterns over an area and then analyzed for linear anomalies that can be interpreted as utilities. GPR is usually very accurate in x-y location of utilities, and can be calibrated at a site to give very accurate depth information as well. A significant drawback to GPR is that depth of investigation is highly dependant on background soil conductivity, and it will not work on all sites. It is not uncommon to get only 1-2 feet of penetration with the signal in damp, clayey environments. Another drawback to GPR is that sites containing significant fill material (e.g., concrete rubble, scrap metal, garbage) will result in complicated anomalies that are difficult or impossible to interpret.

Magnetic Field Methods

Magnetic field methods rely on detecting changes to the earth's magnetic field caused by ferrous metal objects. This method is usually more sensitive to magnetic metal (i.e., deeper detection) than EMI methods. A drawback to this method is it is more susceptible to being swamped by surface features such as fences and cars. In addition, procedures must usually be implemented that account for natural variations in the earth's background field as it changes throughout the day. One common use of the method is to measure and analyze the gradient of the magnetic field, which eliminates most of the drawbacks to the method. It should be noted this method only detects

ferrous metal, primarily iron and steel for utility location applications. Some utility detector combine magnetic and EMI methods into a single hand-held unit.

Optical Methods

Down the hole cameras may be useful in visually reviewing a pipe for empty conduits and/or vaults.

Attachment D – Utility Clearance Documentation Form

Attachment E – Utility Marking Color Codes

The following is the standard color code used by industry to mark various types of utilities and other features at a construction site.

White – Proposed excavations and borings

Pink – Temporary survey markings

Red – Electrical power lines, cables, conduits and lighting cables

Yellow – Gas, oil, steam, petroleum or gaseous materials

Orange – Communication, alarm or signal lines, cables, or conduits

Blue – Potable water

Purple – Reclaimed water, irrigation and slurry lines

Green – Sewer and storm drain lines

Buried Utility Location Tracking Form

(Submit to CH2M HILL PM within 24 hrs of location activities)

Project Location:

CH2M HILL Project No.:

CH2M HILL Project Manager: Name/Phone:

Fax:

Email:

CH2M HILL Field Team Leader: Name/Phone:

CH2M HILL Purchase Order:

Utility Location Subcontractor:

Subcontractor POC:

Dates of location activities:

Check each box using an "X" if a buried utility is present within 5 feet of a marked Station ID. If color of the flag or paint differs from listed color, note change in color on the form.

| Station ID | Gas (Yellow) | Electric (Red) | Fiber optic (Orange) | Cable (Orange) | Water (Blue) | San. Sewer (Green) | Storm Sewer (Green) | Steam (Yellow) | Petroleum (Yellow) | Compressed air (Yellow) | Other _____ | Other _____ | Other _____ | Other _____ | Date completed | Technician initials | Notes (methods/tools used) |
|------------|--------------|----------------|----------------------|----------------|--------------|--------------------|---------------------|----------------|--------------------|-------------------------|-------------|-------------|-------------|-------------|----------------|---------------------|----------------------------|
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | |

The findings of the buried utility location activities summarized herein were conducted in strict accordance with the CH2M HILL scope of work.

Subcontractor's

Date

Signature

PMS 219

PMS 1795*

PMS 108









PMS 144*

13.5 parts process
2.5 parts reflex

PMS 253

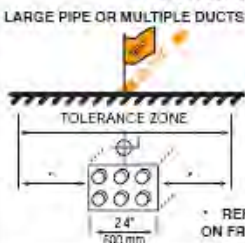
PMS 3415

ADWA **UNIFORM COLOR CODE**

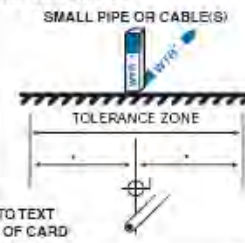
| | |
|--|---|
|  | WHITE - Proposed Excavation |
|  | PINK - Temporary Survey Markings |
|  | RED - Electric Power Lines, Cables, Conduit and Lighting Cables |
|  | YELLOW - Gas, Oil, Steam, Petroleum or Gaseous Materials |
|  | ORANGE - Communication, Alarm or Signal Lines, Cables or Conduit |
|  | BLUE - Potable Water |
|  | PURPLE - Reclaimed Water, Irrigation and Slurry Lines |
|  | GREEN - Sewers and Drain Lines |

TYPICAL MARKING

LARGE PIPE OR MULTIPLE DUCTS



SMALL PIPE OR CABLE(S)



* REFER TO TEXT ON FRONT OF CARD

Customize with your center's phone and address information

GUIDELINES FOR UNIFORM TEMPORARY MARKING OF UNDERGROUND FACILITIES

This marking guide provides for universal use and understanding of the temporary marking of subsurface facilities to prevent accidents and damage or service interruption by contractors, excavators, utility companies, municipalities or any others working on or near underground facilities.

ONE-CALL SYSTEMS

The One-Call damage prevention system shall be contacted prior to excavation.

PROPOSED EXCAVATION

Use white marks to show the location, route or boundary of proposed excavation. Surface marks on roadways do not exceed 1.5" by 15" (40 mm by 450 mm). The facility color and facility owner identity may be added to white flags or stakes.

USE OF TEMPORARY MARKING

Use color-coded surface marks (i.e., paint or chalk) to indicate the location or route of active and out-of-service buried lines. To increase visibility, color coded vertical markers (i.e., stakes or flags) should supplement surface marks. Marks and markers indicate the name, initials or logo of the company that owns or operates the line, and width of the facility if it is greater than 2" (50 mm). Marks placed by other than line owner/operator or its agent indicate the identity of the designating firm. Multiple lines in joint trench are marked in tandem. If the surface over the buried line is to be removed, supplementary offset markings are used. Offset markings are on a uniform alignment and clearly indicate the actual facility is a specific distance away.

TOLERANCE ZONE

Any excavation within the tolerance zone is performed with non-powered hand tools or non-invasive method until the marked facility is exposed. The width of the tolerance zone may be specified in law or code. If not, a tolerance zone including the width of the facility plus 15" (450 mm) measured horizontally from each side of the facility is recommended.

ADOPT UNIFORM COLOR CODE

The American Public Works Association encourages public agencies, utilities, contractors, other associations, manufacturers and all others involved in excavation to adopt the APWA Uniform Color Code, using ANSI standard Z535.1 Safety Colors for temporary marking and facility identification.

Rev. 4/99

Equipment Blank and Field Blank Preparation

I. Purpose

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

II. Scope

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

III. Equipment and Materials

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

IV. Procedures and Guidelines

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

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

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

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

V. Attachments

None.

VI. Key Checks and Items

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

Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature Using a Water Quality Meter with Flow-Through Cell

I. Purpose and Scope

The purpose of this procedure is to provide a general guideline for using a water quality meter for field measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of aqueous samples. The operator's manual should be consulted for detailed operating procedures.

II. Equipment and Materials

- Water Quality Monitoring System with flow-through cell (Horiba, YSI, In-Situ, Ion Science, etc)
- Auto-Calibration Standard Solution (provided by rental company)
- Distilled water in squirt bottle

III. Procedures and Guidelines

A. General Parameters and Specifications:

Note: the general parameters listed below may not be available for every type of meter used. Please refer to the specific meter's manual to determine meter's range of measurement and accuracy.

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

B. Calibration:

Prior to each day's use, clean the probe and flow-through cell using deionized water and calibrate using the Standard Solution. Refer to the specific instrumentation manual for the proper calibration methods.

C. Sample Measurement:

The water quality probes are inserted into a flow-through cell, and the purged groundwater is directed through the cell by connecting the pump discharge tubing to the bottom port on the flow through cell, allowing measurements to be collected before the water contacts the atmosphere. The flow-through cell should be positioned out of direct sunlight to reduce solar heating, and wrapped in aluminum foil to minimize heat loss or gain.

As water passes through the flow-through the flow cell, press MEAS to obtain readings or the readings are displayed on the meter for each parameter (dependent on the type of meter used). Record the water quality parameter data in a field notebook.

Once the parameters have stabilized (see *Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region I and III* or *Low-Flow Groundwater Sampling from Monitoring Wells – EPA Region IV* depending on project site location), remove the tubing from the bottom port of the flow-through cell.

Never collect a groundwater sample for laboratory analysis from the flow-through cell. Rinse the flow-through cell between wells to remove any sediment buildup within the cell.

IV. Key Checks and Preventive Maintenance

- Calibrate meter
- Clean probe with deionized water when done
- Refer to operations manual for recommended maintenance and troubleshooting
- Check batteries, and have a replacement set on hand
- Due to the importance of obtaining these parameters, the field team should have a spare unit readily available in case of an equipment malfunction.

Field Measurement of pH, Specific Conductance, Turbidity, Dissolved Oxygen, ORP, and Temperature Using a Horiba or YSI Water Quality Parameter Meter with Flow-through Cell

I. Purpose and Scope

The purpose of this procedure is to provide a general guideline for using a water quality parameter meter (e.g., Horiba® or YSI) for field measurements of pH, specific conductance, turbidity, dissolved oxygen, oxidation-reduction potential (ORP), and temperature of aqueous samples. The YSI instrument does not measure turbidity. A separate turbidity meter (i.e., Hanna Turbidity Meter) will need to be used in conjunction with the YSI meter. The operator's manual should be consulted for detailed operating procedures.

II. Equipment and Materials

- Water Quality Parameter Meter such as a Horiba® Water Quality Monitoring System or YSI with flow-through cell
- Auto-Calibration Standard Solution (provided by rental company)
- Distilled water in squirt bottle

III. Procedures and Guidelines

A. Parameters and Specifications:

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

B. Calibration:

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

Horiba Calibration procedure:

1. Fill a calibration beaker with standard solution to the recommended fill line.
2. Insert the probe into the beaker. All the parameter sensors will now be immersed in the standard solution except the D.O. sensor; the D.O. calibration is done using atmospheric air.
3. Turn power on and allow some time for the machine to warm-up prior to starting the calibration. When the initial readings appear to stabilize the instrument is ready to calibrate.
4. Press CAL key to put the unit in the calibration mode.
5. Press the ENT key to start automatic calibration. Wait a moment, and the upper cursor will gradually move across the four auto-calibration parameters one by one: pH, COND, TURB, and DO. When the calibration is complete, the readout will briefly show END. The instrument is now calibrated.
6. If the unit is calibrated properly the instrument readings, while immersed in the standard solution, will match the standard solution values provided on the solution container. The typical standard solution values are: pH = 4.0 +/- 3%, conductivity 4.49 mS/cm +/- 3%, and turbidity = 0 NTU +/- 3%.
7. Record the calibration data (e.g. time, instrument ID, solution lot number and expiration date, final calibrated readings, and solution temperature in the field logbook.

YSI Calibration procedure:

1. Press the **On/off** key to display the run screen
2. Press the **Escape** key to display the main menu screen
3. Use the arrow keys to highlight the **Calibrate**
4. Press the **Enter** key. The Calibrate screen is displayed
5. Choose the parameter to calibrate

A. *Conductivity Calibration:*

This procedure calibrates specific conductance (recommended), conductivity and salinity. Calibrating any one option automatically calibrates the other two.

- 1) Use the arrow keys to highlight the **Conductivity** selection
- 2) Press **Enter**. The Conductivity Calibration Selection Screen is displayed.
- 3) Use the arrow keys to highlight the Specific Conductance selection.
- 4) Press **Enter**. The Conductivity Calibration Entry Screen is displayed.

- 5) Place the correct amount of conductivity standard (see Instrument Manual) into a clean, dry or pre-rinsed transport/calibration cup.
- 6) Carefully immerse the sensor end of the probe module into the solution.
- 7) Gently rotate and/or move the probe module up and down to remove any bubbles from the conductivity cell.

NOTE: The sensor must be completely immersed past its vent hole. Using the recommended volumes from the Instrument Manual Calibration Volumes should ensure that the vent hole is covered.
- 8) Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

NOTE: Do not over tighten as this could cause damage to the threaded portions.
- 9) Use the keypad to enter the calibration value of the standard you are using.

NOTE: Be sure to enter the value in **mS/cm at 25°C**.
- 10) Press **Enter**. The Conductivity Calibration Screen is displayed.
- 11) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
- 12) Observe the reading under Specific Conductance. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
- 13) Press **Enter**. This returns you to the Conductivity Calibrate Selection Screen
- 14) Press **Escape** to return to the calibrate menu.
- 15) Rinse the probe module and sensors in tap or purified water and dry.

B. Dissolved Oxygen Calibration:

This procedure calibrates dissolved oxygen. Calibrating any one option (% or mg/L) automatically calibrates the other.

- 1) Go to the calibrate screen as described in Section

NOTE: The instrument must be on for at least 20 minutes to polarize the DO sensor before calibrating.
- 2) Use the arrow keys to highlight the **Dissolved Oxygen** selection.
- 3) Press **Enter**. The dissolved oxygen calibration screen is displayed.
- 4) DO calibration in mg/L is carried out in a water sample which has a known concentration of dissolved oxygen (usually determined by a Winkler titration).
- 5) Use the arrow keys to highlight the **DO mg/L** selection.
- 6) Press **Enter**. The DO mg/L Entry Screen is displayed.
- 7) Place the probe module in water with a known DO concentration.

NOTE: Be sure to completely immerse all the sensors.
- 8) Use the keypad to enter the known DO concentration of the water.
- 9) Press **Enter**. The Dissolved Oxygen mg/L Calibration Screen is displayed.
- 10) Stir the water with a stir bar, or by rapidly moving the probe module, to provide fresh sample to the DO sensor.
- 11) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

- 12) Observe the DO mg/L reading, when the reading is stable (shows no significant change for approximately 30 seconds), press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
- 13) Press **Enter**. This returns you to the DO calibration screen.
- 14) Press **Escape** to return to the calibrate menu.
- 15) Rinse the probe module and sensors in tap or purified water and dry.

C. *pH Calibration:*

- 1) Go to the calibrate screen.
- 2) Use the arrow keys to highlight the **pH** selection.
- 3) Press **Enter**. The pH calibration screen is displayed.
 - Select the **1-point** option only if you are adjusting a previous calibration. If a 2-point or 3-point calibration has been performed previously, you can adjust the calibration by carrying out a one point calibration. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select only one pH buffer.
 - Select the **2-point** option to calibrate the pH sensor using only two calibration standards. Use this option if the media being monitored is known to be either basic or acidic. For example, if the pH of a pond is known to vary between 5.5 and 7, a two-point calibration with pH 7 and pH 4 buffers is sufficient. A three point calibration with an additional pH 10 buffer will not increase the accuracy of this measurement since the pH is not within this higher range.
 - Select the **3-point** option to calibrate the pH sensor using three calibration solutions. In this procedure, the pH sensor is calibrated with a pH 7 buffer and two additional buffers. The 3-point calibration method assures maximum accuracy when the pH of the media to be monitored cannot be anticipated. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select a third pH buffer.
- 4) Use the arrow keys to highlight the **2-point** selection.
- 5) Press **Enter**. The pH Entry Screen is displayed.
- 6) Place the correct amount of pH buffer into a clean, dry or pre-rinsed transport/calibration cup.

NOTE: For maximum accuracy, the pH buffers you choose should be within the same pH range as the water you are preparing to sample.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the pH sensor with a small amount of buffer that can be discarded. Be certain that you avoid cross-contamination of buffers with other solutions.
- 7) Carefully immerse the sensor end of the probe module into the solution.
- 8) Gently rotate and/or move the probe module up and down to remove any bubbles from the pH sensor.

NOTE: The sensor must be completely immersed. Using the recommended volumes from Table 6.1 Calibration Volumes, should ensure that the sensor is covered.
- 9) Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

NOTE: Do not over tighten as this could cause damage to the threaded portions.

- 10) Use the keypad to enter the calibration value of the buffer you are using **at the current temperature**.

NOTE: pH vs. temperature values are printed on the labels of all YSI pH buffers.

- 11) Press **Enter**. The pH calibration screen is displayed.
- 12) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
- 13) Observe the reading under pH, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
- 14) Press **Enter**. This returns you to the Specified pH Calibration Screen.
- 15) Rinse the probe module, transport/calibration cup and sensors in tap or purified water and dry.
- 16) Repeat steps 6 through 13 above using a second pH buffer.
- 17) Press **Enter**. This returns you to the pH Calibration Screen.
- 18) Press **Escape** to return to the calibrate menu.
- 19) Rinse the probe module and sensors in tap or purified water and dry.

D. ORP Calibration:

- 1) Go to the calibrate screen.
- 2) Use the arrow keys to highlight the **ORP** selection.
- 3) Press **Enter**. The ORP calibration screen is displayed.
- 4) Place the correct amount of a known ORP solution into a clean, dry or pre-rinsed transport/calibration cup.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the ORP sensor with a small amount of solution that can be discarded. Be certain that you avoid cross-contamination with other solutions.

- 5) Carefully immerse the sensor end of the probe module into the solution.
- 6) Gently rotate and/or move the probe module up and down to remove any bubbles from the ORP sensor.
NOTE: The sensor must be completely immersed.
- 7) Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.
- 8) Use the keypad to enter the correct value of the calibration solution you are using at the current temperature.
- 9) Press **Enter**. The ORP calibration screen is displayed.
- 10) Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
- 11) Observe the reading under ORP, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
- 12) Press **Enter**. This returns you to the Calibrate Screen.
- 13) Rinse the probe module and sensors in tap or purified water and dry.

Record the calibration data (e.g. time, instrument ID, solution lot number and expiration date, final calibrated readings, and solution temperature in the field logbook.

C. Sample Measurement:

Horiba measurement procedure:

As water passes through the flow-through the flow cell, press MEAS to obtain reading; record data in a field notebook.

YSI measurement procedure:

As water passes through the flow-through the flow cell, the readings are displayed for each parameter. Record the water quality parameter data in a field notebook. In addition, the data is recorded in the YSI and can be downloaded to a computer following completion of the sampling event.

IV. Key Checks and Preventive Maintenance

- Calibrate meter
- Clean probe with deionized water when done
- Refer to operations manual for recommended maintenance and troubleshooting
- Check batteries, and have a replacement set on hand
- Due to the importance of obtaining these parameters, the field team should have a spare unit readily available in case of an equipment malfunction.

V. References

YSI 556 Multi Probe System Operator Manual

YSI Environmental



Pure Data for a Healthy Planet.™



YSI 556 MPS
Multi Probe System

**Operations
Manual**

Contents

| | |
|--|-----------|
| 1. Safety | 1 |
| 1.1 General Safety Information | 1 |
| 2. General Information | 7 |
| 2.1 Description..... | 7 |
| 2.2 Unpacking the Instrument..... | 8 |
| 2.3 Features of the YSI 556 Multi-Probe System | 9 |
| 2.4 Batteries | 10 |
| 2.5 Power On | 15 |
| 2.6 Setting Display Contrast | 15 |
| 2.7 Backlight..... | 16 |
| 2.8 General Screen Features | 16 |
| 2.9 Keypad Use..... | 17 |
| 2.10 Instrument Reset | 18 |
| 2.11 Menu Flowchart..... | 19 |
| 3. Probe Module | 21 |
| 3.1 Introduction..... | 21 |
| 3.2 Unpacking the Probe Module | 21 |
| 3.3 Features of the YSI 5563 Probe Module | 22 |
| 3.4 Preparing the Probe Module | 22 |
| 3.5 Transport/Calibration Cup | 26 |
| 3.6 Instrument/Cable Connection | 27 |
| 4. Sensors | 29 |
| 5. Report | 33 |
| 6. Calibrate | 37 |
| 6.1 Getting Ready to Calibrate | 37 |
| 6.2 Calibration Procedures..... | 40 |
| 6.3 Return to Factory Settings | 56 |
| 7. Run | 59 |
| 7.1 Real-Time Data..... | 59 |
| 8. File | 61 |
| 8.1 Accessing the File Screen..... | 61 |
| 8.2 Directory | 62 |
| 8.3 View File | 63 |
| 8.4 Upload to PC..... | 64 |
| 8.5 File Memory | 69 |

Contents

| | | |
|------------|--|------------|
| 8.6 | Delete All Files..... | 70 |
| 9. | Logging..... | 73 |
| 9.1 | Accessing the Logging Setup Screen | 73 |
| 9.2 | Setting Logging Interval..... | 74 |
| 9.3 | Storing Barometer Readings | 74 |
| 9.4 | Creating a Site List | 75 |
| 9.5 | Editing a Site List | 79 |
| 9.6 | Logging Data Without a Site List..... | 81 |
| 9.7 | Logging Data With a Site List..... | 84 |
| 9.8 | Adding Data to Existing Files | 85 |
| 10. | System Setup..... | 89 |
| 10.1 | Accessing the System Setup Screen..... | 89 |
| 10.2 | Date and Time Setup | 90 |
| 10.3 | Data Filter..... | 92 |
| 10.4 | Shutoff Time..... | 94 |
| 10.5 | Comma Radix..... | 95 |
| 10.6 | ID..... | 95 |
| 10.7 | GLP Filename..... | 95 |
| 10.8 | TDS Constant | 96 |
| 10.9 | Barometer Units | 97 |
| 10.10 | Calibrate Barometer | 98 |
| 11. | Maintenance | 101 |
| 11.1 | Sensor Care and Maintenance | 101 |
| 11.2 | Upgrading YSI 556 MPS Software | 107 |
| 12. | Storage..... | 111 |
| 12.1 | General Recommendations for Short Term Storage..... | 111 |
| 12.2 | General Recommendations for Long Term Storage..... | 111 |
| 13. | Troubleshooting | 115 |
| 14. | Appendix A YSI 556 MPS Specifications..... | 119 |
| 14.1 | Sensor Specifications | 119 |
| 14.2 | Instrument Specifications | 120 |
| 15. | Appendix B Instrument Accessories..... | 121 |
| 16. | Appendix C Required Federal Communications Notice | 123 |
| 17. | Appendix D Health and Safety..... | 125 |
| 18. | Appendix E Customer Service | 129 |

Contents

| | | |
|------------|--|------------|
| 18.1 | YSI Environmental Authorized Service Centers | 129 |
| 18.2 | Cleaning Instructions | 131 |
| 18.3 | Packing Procedure | 132 |
| 18.4 | Cleaning Certificate | 132 |
| 18.5 | Warranty | 133 |
| 19. | Appendix F Ferrite Bead Installation | 135 |
| 20. | Appendix G EcoWatch..... | 137 |
| 20.1 | Installing EcoWatch for Windows..... | 137 |
| 20.2 | EcoWatch Tutorial..... | 139 |
| 21. | Appendix H Calibration Record Information | 151 |
| 21.1 | Viewing the Calibration Record (.glp) File | 151 |
| 21.2 | Uploading the Calibration Record (.glp) File | 151 |
| 21.3 | Understanding the Calibration Record (.glp) File..... | 151 |

Contents

1. Safety

1.1 General Safety Information

Read all safety information in this manual carefully before using the YSI 556 Multi-Probe System (MPS). Reagents that are used to calibrate and check this instrument may be hazardous to your health. Take a moment to review *Appendix D Health and Safety*.

WARNING


Warnings are used in this manual when misuse of the instrument could result in death or serious injury to a person.

CAUTION

Cautions are used in this manual when misuse of the instrument could result in mild or serious injury to a person and/or damage to equipment.

IMPORTANT SAFETY INSTRUCTIONS!

SAVE THESE INSTRUCTIONS!

 In essence, the most important safety rule for use of the YSI 556 MPS is to utilize the instrument **ONLY** for purposes documented in this manual. This is particularly true of the YSI 6117 rechargeable battery pack that contains nickel metal hydride (NiMH) batteries. The user should be certain to read all of the safety precautions outlined below before using the instrument.

YSI 6117 Rechargeable Battery Pack Safety Information

Restrictions on Usage

1. Never dispose of the battery pack in a fire.
2. Do not attempt to disassemble the YSI 6117 battery pack.
3. Do not tamper with any of the electronic components or the batteries within the battery pack. Tampering with either the electronic circuitry or the batteries will result in the voiding of the warranty and the compromising of the system performance, but, more importantly, can cause safety

hazards which result from overcharging such as overheating, venting of gas, and loss of corrosive electrolyte.

4. Do not charge the battery pack outside the 0–40°C temperature range.
5. Do not use or store the battery at high temperature, such as in strong direct sunlight, in cars during hot weather, or directly in front of heaters.
6. Do not expose the battery pack to water or allow the terminals to become damp.
7. Avoid striking or dropping the battery pack. If the pack appears to have sustained damage from these actions or malfunctions after an impact or drop, the user should not attempt to repair the unit. Instead, contact YSI Customer Service. Refer to *Appendix E Customer Service*.
8. If the battery pack is removed from the YSI 556 MPS, do not store it in pockets or packaging where metallic objects such as keys can short between the positive and negative terminals.



Precautions for Users with Small Children

Keep the battery pack out of reach of babies and small children.



Danger Notifications – Misuse creates a **STRONG** possibility of death or serious injury.

FAILURE TO CAREFULLY OBSERVE THE FOLLOWING PROCEDURES AND PRECAUTIONS CAN RESULT IN LEAKAGE OF BATTERY FLUID, HEAT GENERATION, BURSTING, AND SERIOUS PERSONAL INJURY.

1. Never dispose of the battery pack in a fire or heat it.
2. Never allow the positive and negative terminals of the battery pack to become shorted or connected with electrically conductive materials. When the battery pack has been removed from the YSI 556 MPS, store it in a heavy plastic bag to prevent accidental shorting of the terminals.

3. Never disassemble the battery pack and do not tamper with any of the electronic components or the batteries within the battery pack. The battery pack is equipped with a variety of safety features. Accidental deactivation of any of these safety features can cause a serious hazard to the user.
4. The NiMH batteries in the battery pack contain a strong alkaline solution (electrolyte). The alkaline solution is extremely corrosive and will cause damage to skin or other tissues. If any fluid from the battery pack comes in contact with a user's eyes, immediately flush with clean water and consult a physician immediately. The alkaline solution can damage eyes and lead to permanent loss of eyesight.



Warning Notifications – Misuse creates a possibility of death or serious injury

1. Do not allow the battery pack to contact freshwater, seawater, or other oxidizing reagents that might cause rust and result in heat generation. If a battery becomes rusted, the gas release vent may no longer operate and this failure can result in bursting.
2. If electrolyte from the battery pack contacts the skin or clothing, thoroughly wash the area immediately with clean water. The battery fluid can irritate the skin.



Caution Notifications – Misuse creates a possibility of mild or serious injury or damage to the equipment.

1. Do not strike or drop the battery pack. If any impact damage to the battery pack is suspected, contact YSI Customer Service. Refer to *Appendix E Customer Service*.
2. Store the battery pack out of reach of babies and small children.
3. Store the battery pack between the temperatures of -20 and 30°C.
4. Before using the battery pack, be sure to read the operation manual and all precautions carefully. Then store this information carefully to use as a reference when the need arises.

 **YSI 616 Cigarette Lighter Charger Safety Information**


1. This section contains important safety and operating instructions for the YSI 556 MPS cigarette lighter battery charger (YSI 616; RadioShack Number 270-1533E). **BE SURE TO SAVE THESE INSTRUCTIONS.**
2. Before using the YSI 616 cigarette lighter charger, read all instructions and cautionary markings on battery charger, battery pack, and YSI 556 MPS.
3. Charge the YSI 6117 battery pack with the YSI 616 cigarette lighter charger **ONLY** when the YSI 6117 is installed in the YSI 556 MPS.
4. Do not expose charger to rain, moisture, or snow.
5. Use of an attachment not recommended or sold by the battery charger manufacturer may result in a risk of fire, electric shock, or injury to persons.
6. To reduce risk of damage to cigarette lighter and cord, pull by cigarette lighter rather than cord when disconnecting charger.
7. Make sure that the cord is located so that it will not be stepped on, tripped over, or otherwise subjected to damage or stress.
8. Do not operate charger with damaged cord or cigarette lighter connector – replace it immediately.
9. Do not operate charger if it has received a sharp blow, been dropped, or otherwise damaged in any way; contact YSI Customer Service. Refer to *Appendix E Customer Service*.
10. Do not disassemble charger other than to change the fuse as instructed. Replace the part or send it to YSI Product Service if repair is required (refer to *Appendix E Customer Service*). Incorrect reassembly may result in a risk of electric shock or fire.
11. To reduce risk of electric shock, unplug charger before attempting any maintenance or cleaning. Turning off controls will not reduce this risk.

 **YSI 556 MPS Water Leakage Safety Information**


The YSI 556 MPS has been tested and shown to comply with IP67 criterion, i.e. submersion in 1 meter of water for 30 minutes with no leakage into either the battery compartment or the main case. However, if the instrument is submersed for periods of time in excess of 30 minutes, leakage may occur with subsequent damage to the batteries, the rechargeable battery pack circuitry, and/or the electronics in the main case.

If leakage into the battery compartment is observed when using alkaline C cells, remove batteries, dispose of batteries properly, and dry the battery compartment completely, ideally using compressed air. If corrosion is present on the battery terminals, contact YSI Customer Service for instructions. Refer to *Appendix E Customer Service*.

If leakage into the battery compartment is observed when using the YSI 6117 rechargeable battery pack, remove the battery assembly and set aside to dry. Return the battery pack to YSI Product Service for evaluation of possible damage. Finally dry the battery compartment completely, ideally using compressed air. If corrosion is present on the battery terminals, contact YSI Customer Service for instructions. Refer to *Appendix E Customer Service*.

 **CAUTION:** If water has contacted the rechargeable battery pack, do not attempt to reuse it until it has been evaluated by YSI Product Service (refer to *Appendix E Customer Service*). Failure to follow this precaution can result in serious injury to the user.

If it is suspected that leakage into the main cavity of the case has occurred, remove the batteries immediately and return the instrument to YSI Product Service for damage assessment. Refer to *Appendix E Customer Service*.

 **CAUTION:** Under no circumstances should the user attempt to open the main case.

2. General Information

2.1 Description

The rugged and reliable YSI 556 MPS (Multi-Probe System) combines the versatility of an easy-to-use, easy-to-read handheld unit with all the functionality of a multi-parameter system. Featuring a waterproof, impact-resistant case, the YSI 556 MPS simultaneously measures dissolved oxygen, conductivity, temperature, and optional pH and ORP. A simple cellular phone style keypad and large display make the instrument easy to use. The YSI 556 MPS is compatible with YSI EcoWatch™ for Windows™ software.

The YSI 556 MPS assists the user in conforming to Good Laboratory Practice (GLP) standards which help ensure that quality control/quality assurance methods are followed. Battery life is displayed with a fuel gauge, and the user can choose standard alkaline batteries or an optional rechargeable battery pack.

The 1.5 MB memory can store more than 49,000 data sets. Other options include a flow cell and barometer. The internal barometer can be user-calibrated and displayed along with other data, used in dissolved oxygen calibrations, and logged to memory for tracking changes in barometric pressure.

Features

- Waterproof - meets IP67 specifications
- Field-replaceable DO electrode module; pH and pH/ORP sensors
- Compatible with Ecowatch™ for Windows™ data analysis software
- Assists with Good Laboratory Practice Standards (GLP)
- Choice of DO membrane material for different applications
- Easy-to-use, screw-on cap DO membranes
- User-upgradable software from YSI website
- Three-year warranty on the instrument; one-year on the probe modules
- Available with 4,10, and 20 m cable lengths
- Stores over 49,000 data sets, time and date stamped

- Auto temperature compensating display contrast
- Optional barometer
- Optional rechargeable battery pack or standard alkaline batteries

2.2 Unpacking the Instrument

1. Remove the instrument from the shipping box. Note that the probe module and sensors are shipped in a separate box and will be unpacked later in Section 3.2 *Unpacking the Probe Module*.

NOTE: Do not discard any parts or supplies.

2. Use the packing list to ensure all items are present.
3. Visually inspect all components for damage.

NOTE: If any parts are missing or damaged, contact your YSI Service Center immediately. Refer to *Appendix E Customer Service* or www.ysi.com.

2.3 Features of the YSI 556 Multi-Probe System

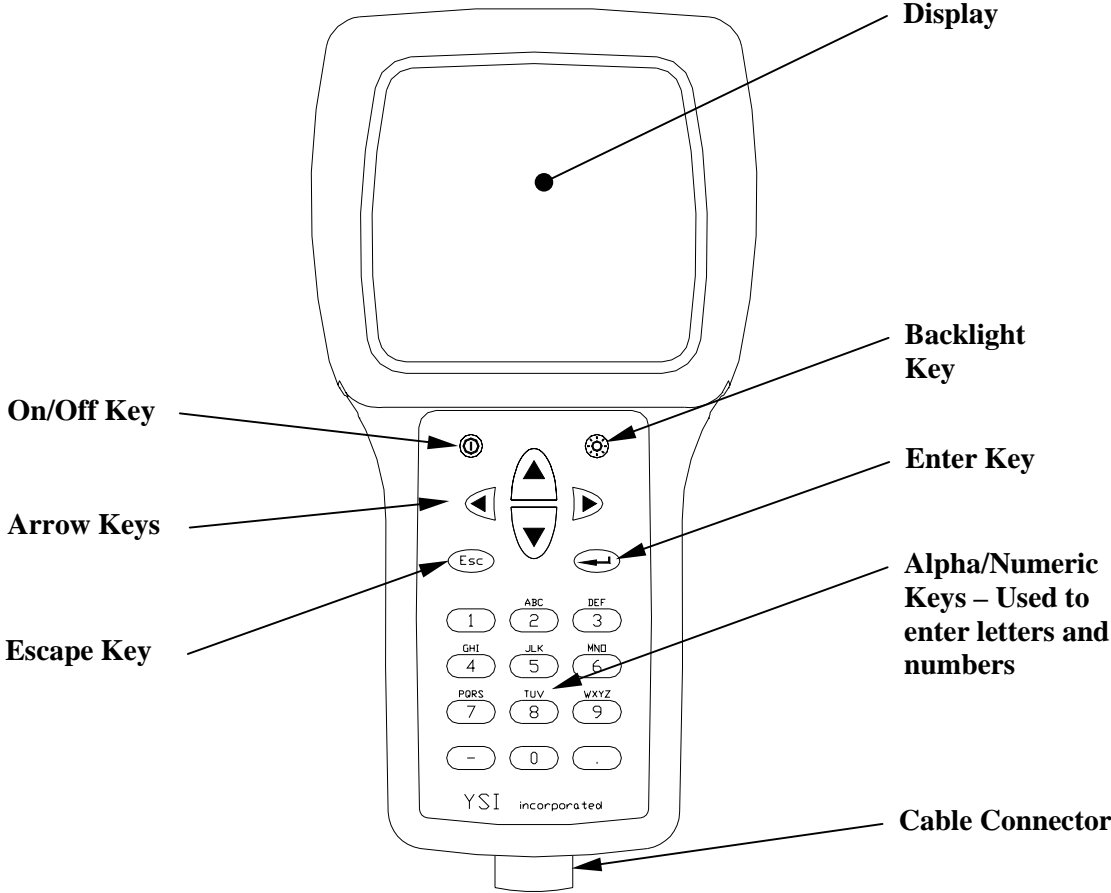


Figure 2.1 Front View of YSI 556 MPS

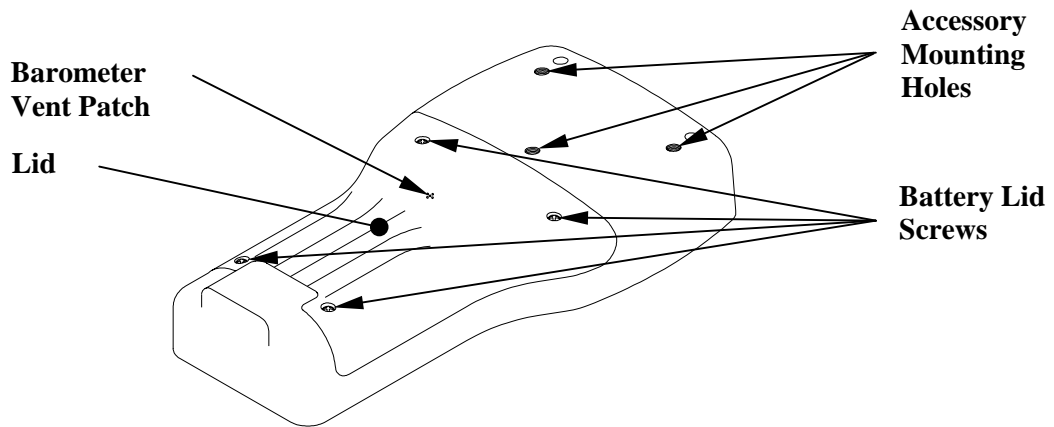


Figure 2.2 Back View of YSI 556 MPS

2.4 Batteries

2.4.1 Battery Life

Standard Alkaline Batteries

With the standard battery configuration of 4 alkaline C cells, the YSI 556 MPS will operate continuously for approximately 180 hours. Assuming a standard usage pattern when sampling of 3 hours of “on time” in a typical day, the alkaline cells will last approximately 60 days.

Optional Rechargeable Battery Pack

When fully charged, the optional rechargeable battery pack will provide approximately 50 hours of battery life.

2.4.2 Inserting 4 C Batteries

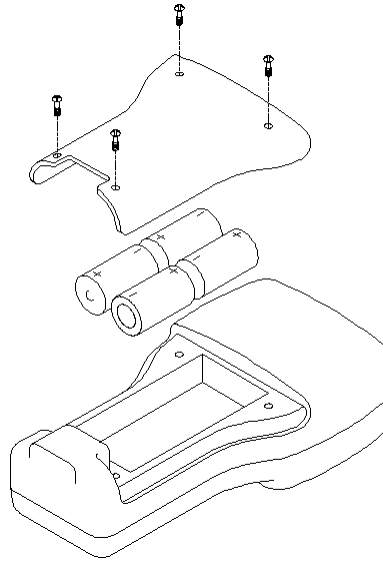


Figure 2.3 Inserting C Cells

⚠ CAUTION: Install batteries properly to avoid damage to the instrument.

1. Loosen the four screws in the battery lid on the back of the instrument using any screwdriver.
2. Remove the battery lid.
3. Insert four C batteries between the clips following the polarity (+ and -) labels on the bottom of the battery compartment.
4. Check gasket for proper placement on the battery lid.
5. Replace the battery lid and tighten the 4 screws securely and evenly.

NOTE: Do not over-tighten the screws.

2.4.3 Inserting Optional Rechargeable Battery Pack

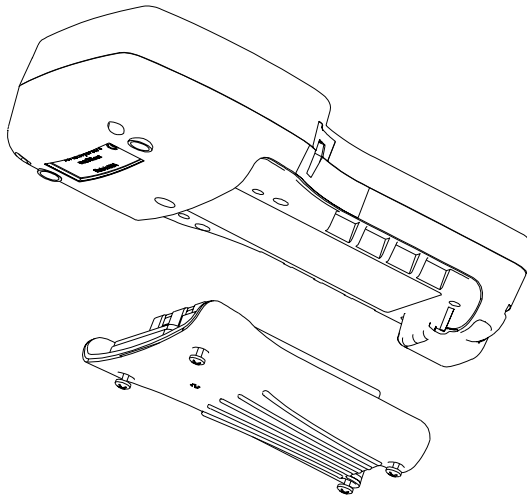


Figure 2.4 Inserting Battery Pack

⚠ CAUTION: Read all cautions and warnings that come with the battery pack *before* using the battery pack.

1. Loosen the four screws in the battery lid on the back of the instrument using any screwdriver.
2. Remove the C battery lid and store for future use. Remove C batteries, if installed.
3. Check for proper placement of gasket on the rechargeable battery pack and lid.
4. Install the rechargeable battery pack and lid and tighten the 4 screws securely and evenly.

NOTE: Do not over tighten the screws.

2.4.4 Charging the Optional Rechargeable Battery Pack

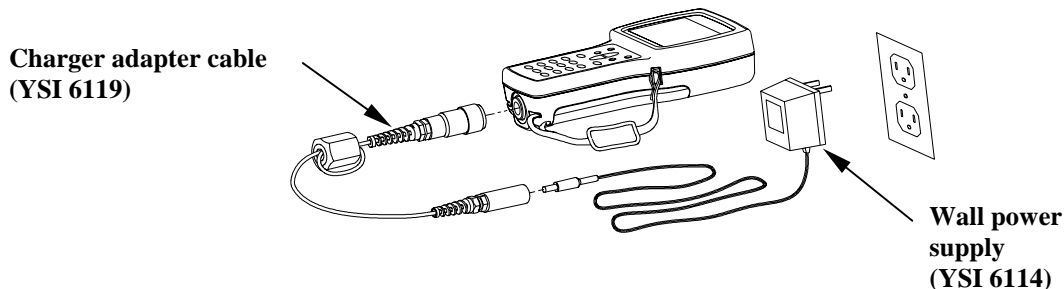


Figure 2.5 Charging the Battery Pack

⚠ CAUTION: Do not use or store the battery pack at extreme temperatures such as in strong direct sunlight, in cars during hot weather or close to heaters.

1. Install the rechargeable battery pack into the instrument as described in Section 2.4.3 *Inserting Optional Rechargeable Battery Pack*.
2. Attach the charger adapter cable (YSI 6119) to the instrument.

NOTE: Wall power supplies for use in countries outside the US and Canada can be found in *Appendix B Instrument Accessories*.

3. Insert the barrel connector of the wall power supply into the barrel of the adapter cable.

⚠ CAUTION: Do not charge the battery pack continuously for more than 48 hours.

⚠ CAUTION: Do not drop or expose to water.

⚠ CAUTION: Do not charge the battery pack at temperatures below 0°C or above 40°C.

4. Plug the wall power supply into an AC power outlet for approximately 2 hours to obtain an 80% to 90% charge and for 6 hours to get a full charge.


NOTE: The battery pack can be recharged whether the instrument is on or off.


2.4.5 Storing the Battery Pack

Remove the battery pack from the instrument when the instrument will not be used for extended periods of time to prevent over discharge of the battery pack.

Store the battery pack in a heavy plastic bag to prevent accidental shorting of the terminals. Store between -20 and 30°C .

2.4.6 Optional Cigarette Lighter Charger

 **CAUTION: Read all warnings and cautions that come with the charger before using the charger.**

 **CAUTION: Only use cigarette lighter charger when *rechargeable* battery pack is inserted into instrument.**

 **CAUTION: Do not mishandle cigarette lighter charger. Do not expose to moisture.**

1. Plug the barrel connector of the cigarette lighter charger into the mating end of the YSI 6119 Charger Adapter Cable.
2. Attach the MS-19 end of the YSI 6119 Charger Adapter Cable to the instrument.
3. Make one of the following modifications to the other end of the charger:

Slide the adapter ring off the plug to use the device with an American or Japanese vehicle.

American and Japanese Vehicles

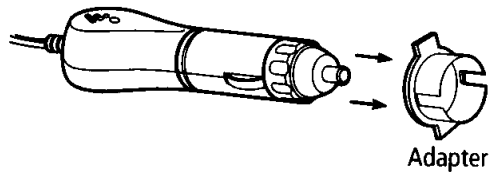


Figure 2.6 Charger Plug Adapter Use

Leave the adapter ring on the plug and position it so that the slots on the adapter ring line up with the plug's spring clips to use the device on a European vehicle.

European Vehicles

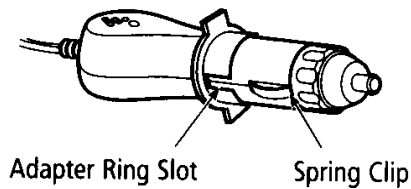


Figure 2.7 European Charger Plug Adapter Use

NOTE: If the charger stops working properly, refer to Section 13 *Troubleshooting*.

2.5 Power On

Press and release the on/off button in the upper left corner of the instrument keypad to turn the instrument on or off. See Figure 2.1 Front View of YSI 556 MPS.

2.6 Setting Display Contrast

The display contrast automatically compensates for temperature changes. However, under extreme temperature conditions you may wish to optimize the display by manual adjustment as follows:

1. Press and *hold down* the backlight key in the upper right corner of the keypad and press the “up” arrow to increase (darken) the contrast.
2. Press and *hold down* the backlight key in the upper right corner of the keypad and press the “down” arrow to decrease (lighten) the contrast.

2.7 Backlight

Press and *release* the backlight key in the upper right corner of the keypad to turn the backlight on or off. See Figure 2.1 Front View of YSI 556 MPS.

NOTE: The backlight turns off automatically after two minutes of non-use.

2.8 General Screen Features

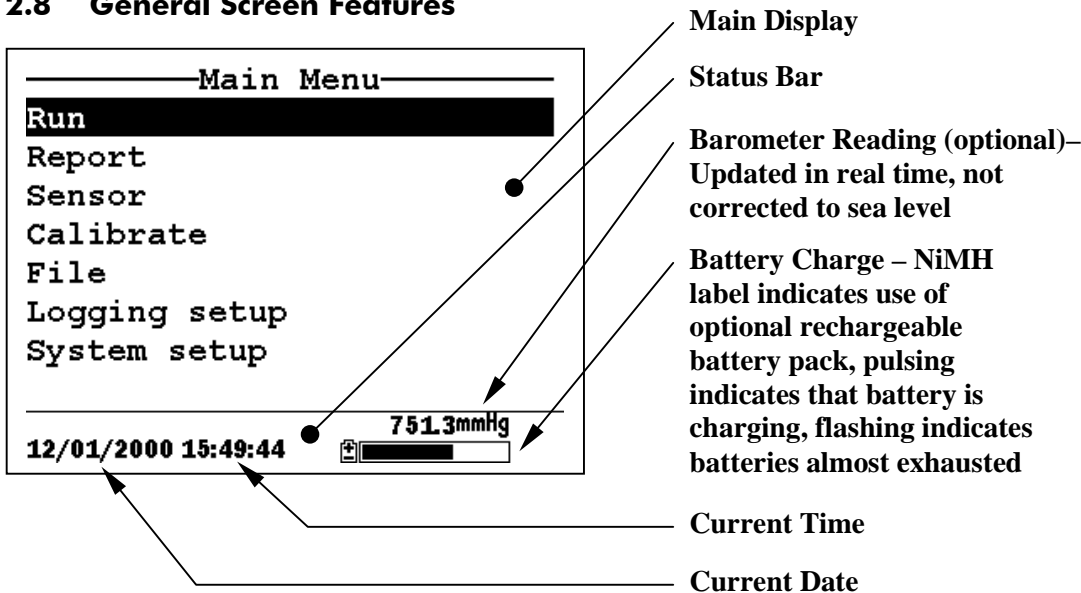


Figure 2.8 Main Menu Screen

2.9 Keypad Use

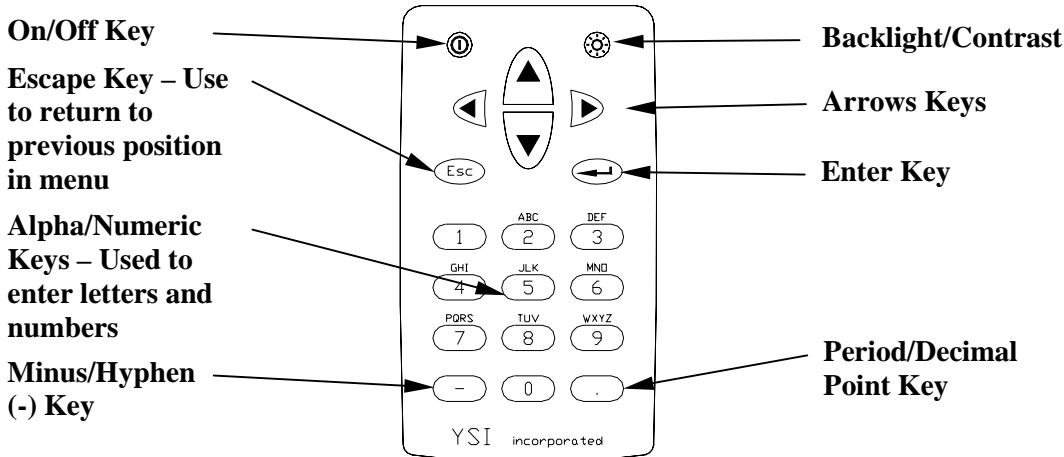


Figure 2.9 Keypad Features

| KEY | LETTER/ NUMBER |
|-----|----------------|
| 1 | 1 |
| 2 | ABC2abc3 |
| 3 | DEF3def3 |
| 4 | GHI4ghi4 |
| 5 | JKL5jkl5 |
| 6 | MNO6mno6 |
| 7 | PQRS7pqrs7 |
| 8 | TUV8tuv8 |
| 9 | WXYZ9wxyz9 |
| 0 | 0 |

Figure 2.10 Keypad Letters & Numbers

1. See Figure 2.10 Keypad Letters & Numbers and press the appropriate key repeatedly until letter or number desired appears in display.

NOTE: Press the key repeatedly in rapid succession to get to the desired letter or number. If you pause for more than a

second, the cursor automatically scrolls to the right to prepare for the next input.

EXAMPLE 1: Press the **6** key *once* and *release* to display an uppercase “M.”

EXAMPLE 2: Press the **6** key *four times* and *release* to display the number “6.”

EXAMPLE 3: Press the **6** key *five times* and *stop* to display a lowercase “m.”

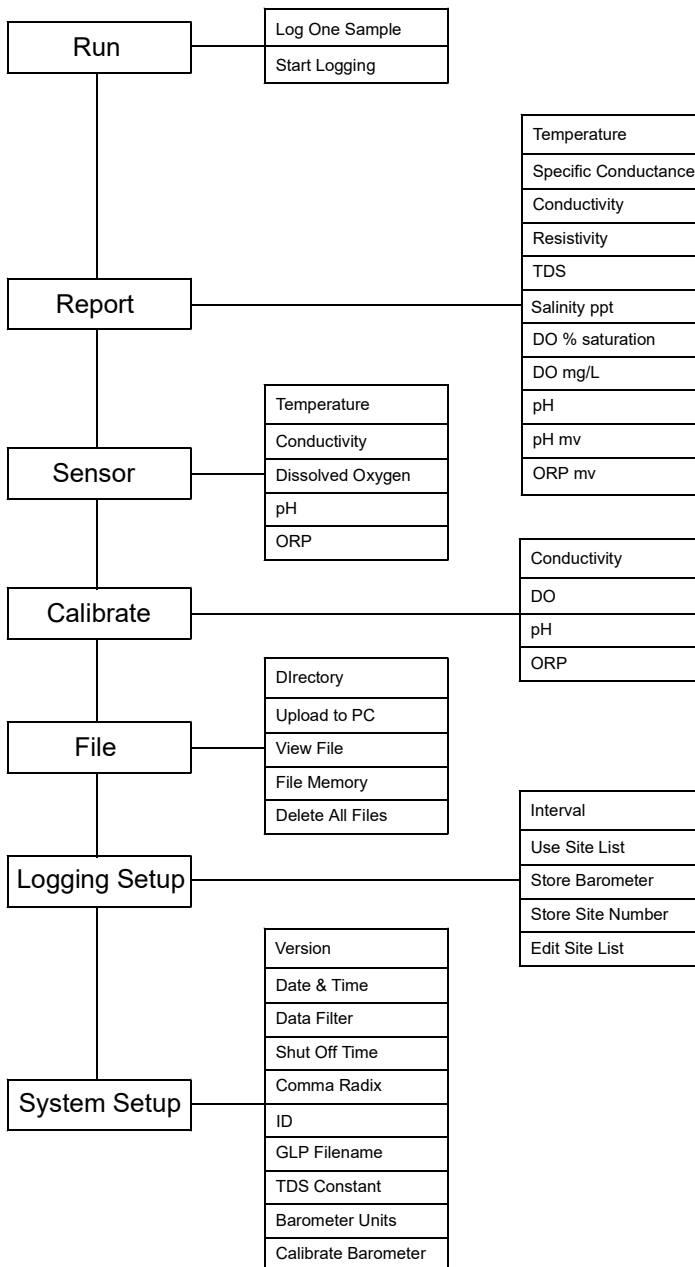
- 2.** Press the left arrow key to go back and reenter a number or letter that needs to be changed.
- 3.** Press the **Enter** key when your entry is complete.

NOTE: The instrument software permits only numeric entries in many instances, such as when setting the clock or entering calibration parameters.

2.10 Instrument Reset

The YSI 556 MPS is characterized by sophisticated software that should provide trouble-free operation. However as with all high-capability software packages, it is always possible that the user will encounter circumstances in which the instrument does not respond to keypad entry. If this occurs, the instrument function can easily be restored by removing and then reapplying battery power. Simply remove either your C-cells or rechargeable battery pack from the battery compartment, wait 30 seconds and then replace the batteries. See Section 2.4 *Batteries* for battery removal/reinstallation instructions.

2.11 Menu Flowchart



3. Probe Module

3.1 Introduction

The YSI 5563 Probe module is used for measuring dissolved oxygen, temperature, conductivity, and optional pH and ORP. The probe module is rugged, with the sensors enclosed in a heavy duty probe sensor guard with attached sinking weight. A 4, 10 or 20 meter cable is directly connected to the probe module body making it waterproof. An MS-19 connector at the end of the cable makes the YSI 5563 fully compatible with the YSI 556 Multi-Probe System.

3.2 Unpacking the Probe Module

1. Remove the YSI 5563 Probe module from the shipping boxes.

NOTE: Do not discard any parts or supplies.

2. Use the packing list to ensure all items are present.
3. Visually inspect all components for damage.

NOTE: If any parts are missing or damaged, contact your YSI Service Center immediately. Refer to *Appendix E Customer Service* or www.ysi.com.

3.3 Features of the YSI 5563 Probe Module

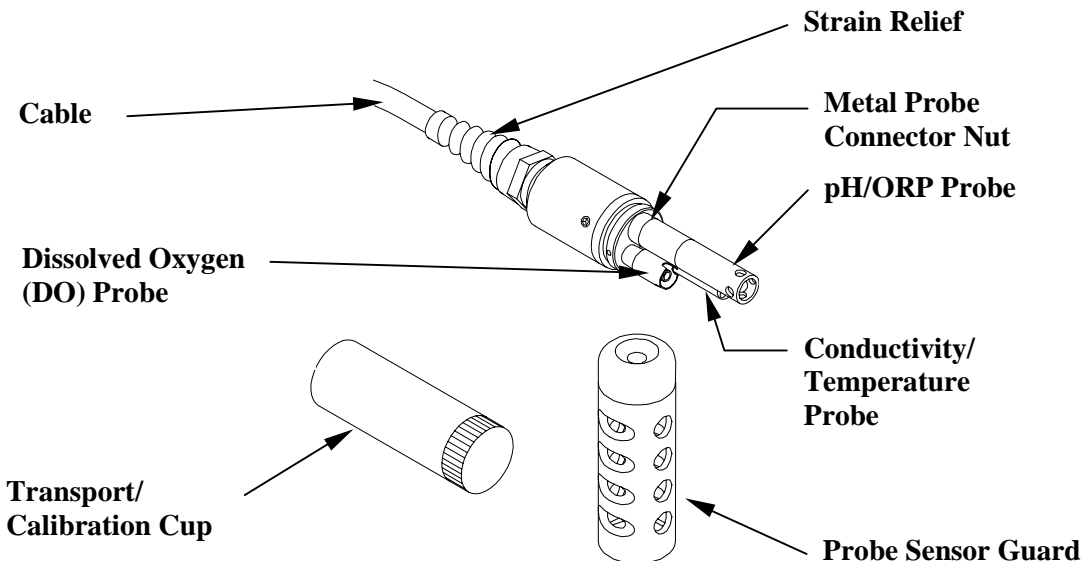


Figure 3.1 Probe Module

3.4 Preparing the Probe Module

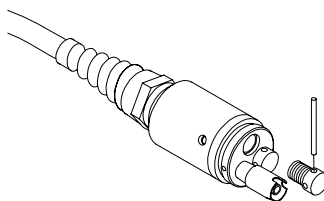
To prepare the probe module for calibration and operation, you need to install the sensors into the connectors on the probe module bulkhead. In addition to sensor installation, you need to install a new DO membrane cap.

3.4.1 Sensor Installation

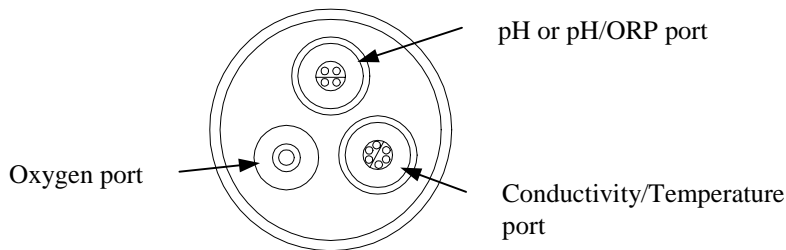
Whenever you install, remove or replace a sensor, it is extremely important that the entire probe module and all sensors be thoroughly dried prior to the removal of a sensor or a sensor port plug. This will prevent water from entering the port. Once you remove a sensor or plug, examine the connector inside the probe module sensor port. If any moisture is present, use compressed air to completely dry the connector. If the connector is corroded, return the probe module to your dealer or directly to YSI Customer Service. Refer to *Appendix E Customer Service*.

Conductivity/Temperature and pH, pH/ORP Sensor Installation

1. Unscrew and remove the probe sensor guard.
2. Using the sensor installation tool supplied in the YSI 5511 maintenance kit, unscrew and remove the sensor port plugs.

**Figure 3.2 Port Plug Removal**

3. Locate the port with the connector that corresponds to the sensor that is to be installed.

**Figure 3.3 Sensor Port Identification**

4. Apply a thin coat of o-ring lubricant (supplied in the YSI 5511 maintenance kit) to the o-rings on the connector side of the sensor (see Figure 3.4 O-Ring Lubrication).

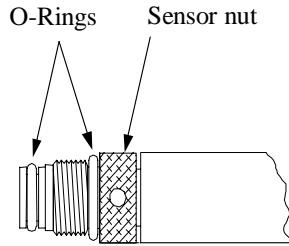


Figure 3.4 O-Ring Lubrication

⚠ CAUTION: Make sure that there are **NO** contaminants between the O-ring and the sensor. Contaminants that are present under the O-ring may cause the O-ring to leak.

5. Be sure the probe module sensor port is free of moisture and then insert the sensor into the correct port. Gently rotate the sensor until the two connectors align.
6. With connectors aligned, screw down the sensor nut using the sensor installation tool.

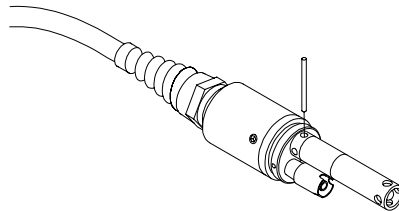


Figure 3.5 Sensor Installation

⚠ CAUTION: Do not cross thread the sensor nut. Tighten the nut until it is flush with the face of the probe module bulkhead. Do not over tighten.

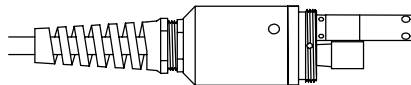


Figure 3.6 Bulkhead Seating

7. Repeat steps 3-6 for any other sensors.
8. Replace the probe sensor guard.

Dissolved Oxygen Sensor Installation

The YSI 5563 comes with the DO sensor already installed. Refer to Section *11.1.2 DO Sensor Replacement* for instructions on installing the YSI 558 Replaceable DO Module Kit.

3.4.2 Membrane Cap Selection

The YSI 5563 is shipped with a YSI 5909 kit that contains membrane caps made with 2 mil polyethylene (PE), a material which should be ideal for most field applications of the 556. However, YSI also offers membrane caps made with two other materials (1 mil polyethylene and 1 mil Teflon) which some users may also prefer. All membranes available for the 556/5563 system provide comparable accuracy if used properly. The difference between the two thicknesses of PE is found in the trade-off of flow dependence and response time as described below. Teflon is offered because some users may prefer to continue using the traditional membrane material used by YSI. To avoid confusion, the membrane caps are color coded as described below and can be ordered in kits as noted:

- 1 mil Teflon – Black Caps (Kit = YSI 5906)
- 1 mil Polyethylene (PE) – Yellow Caps (Kit = YSI 5908)
- 2 mil Polyethylene (PE) – Blue Caps (Kit = YSI 5909)

The 1 mil Teflon caps will offer traditional, reliable performance for most dissolved oxygen applications. The 1 mil PE caps will provide a significantly faster dissolved oxygen response (as long as your 556 Data Filter is set correctly as described below in Sections 10.2 and 10.3.1)) while also giving readings which are significantly less flow dependent than the 1 mil Teflon caps. Finally, 2 mil PE caps will show a large reduction in flow dependence over 1 mil Teflon while not significantly increasing the response time. Generally, one of the PE caps is likely to provide better performance for your application.

IMPORTANT: No matter which type of membrane cap you select, you will also have to confirm your selection in the 556

software from the Sensor menu as described in Section 4 *Sensors*.

3.4.3 Membrane Cap Installation

NOTE: The YSI 5563 DO sensor (already installed in the probe module) was shipped dry. A shipping membrane was installed to protect the electrode. **A new membrane cap must be installed before the first use.**

1. Unscrew and remove the probe sensor guard.
2. Unscrew, remove, and discard the old membrane cap.
3. Thoroughly rinse the sensor tip with distilled water.
4. Prepare the electrolyte according to the directions on the electrolyte solution bottle.
5. Hold the new membrane cap and fill it at least 1/2 full with the electrolyte solution.
6. Screw the membrane cap onto the sensor moderately tight. A small amount of electrolyte should overflow.



CAUTION: Do not touch the membrane surface.

7. Screw the probe sensor guard on moderately tight.

3.5 Transport/Calibration Cup

The YSI 5563 Probe module has been supplied with a convenient transport/calibration cup. This cup is an ideal container for calibration of the different sensors, minimizing the amount of solution needed. Refer to Section 6 *Calibrate*.

3.5.1 Transport/Calibration Cup Installation

1. Remove probe sensor guard, if already installed.
2. Ensure that an o-ring is installed in the o-ring groove on the threaded end of the probe module body.
3. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

NOTE: Do not overtighten as this could cause damage to the threaded portions.

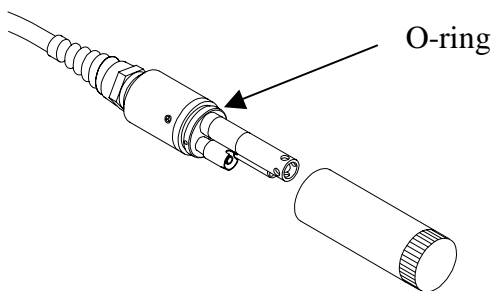


Figure 3.7 Transport/Calibration Cup Installation

3.6 Instrument/Cable Connection

Attach the cable to the instrument as follows:

1. Line up the pins and guides on the cable with the holes and indentations on the cable connector at the bottom of the YSI 556 instrument. See Figure 2.1 Front View of YSI 556 MPS.
2. Holding the cable firmly against the cable connector, turn the locking mechanism clockwise until it snaps into place.

Remove the cable from the instrument by turning the cable connector counterclockwise until the cable disengages from the instrument.

4. Sensors

The Sensors Enabled screen allows the user to enable or disable each of the sensors and select which membrane material will be used for the dissolved oxygen sensor. Disabled sensors will not be displayed on the screen in real time or logged to files.

1. Press the **On/off** key to display the run screen.
2. Press the **Escape** key to display the main menu screen.

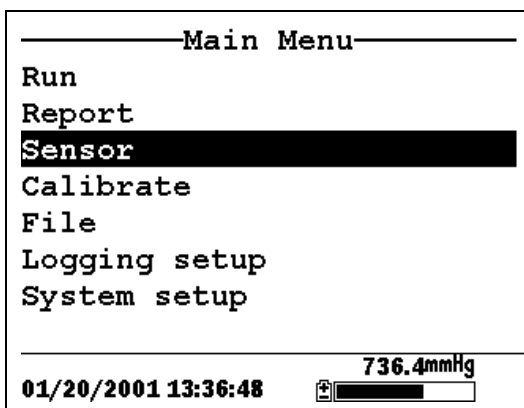


Figure 4.1 Main Menu Screen

3. Use the arrow keys to highlight the **Sensor** selection.
4. Press the **Enter** key to display the sensors enabled screen.

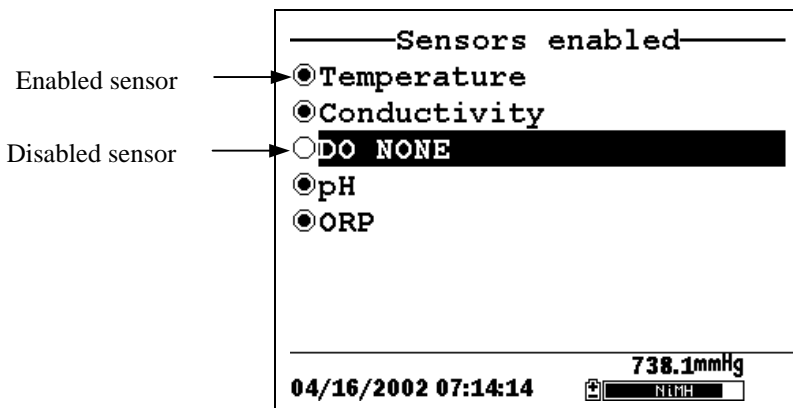


Figure 4.2 Sensors Enabled Screen Before DO Membrane Selection

A black dot to the left of a sensor indicates that sensor is enabled. Sensors with an empty circle are disabled.

Highlight the “DO None” entry as shown above and press **Enter** to display the membrane choice screen. Consult Section 3.4.2 *Membrane Cap Selection* for information on the advantages of each type of membrane material. Blue membrane caps using 2 mil polyethylene (PE) were shipped with your YSI 5563 and are likely to be the best choice for most 556 field applications.

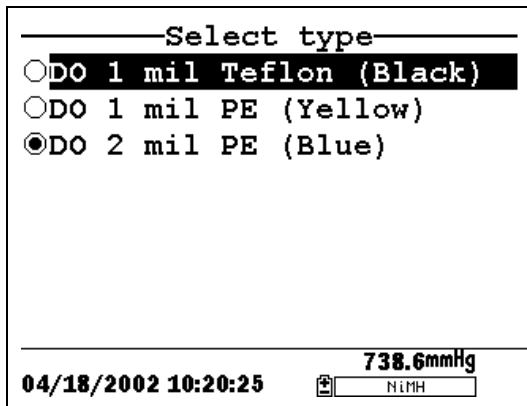


Figure 4.3 Membrane Selection Screen

Highlight the desired membrane choice – in this case, 2 mil PE -- and press Enter to activate your selection with a dot to the left of the screen. Then press **Escape** to return to the Sensor menu that now shows your DO membrane selection.

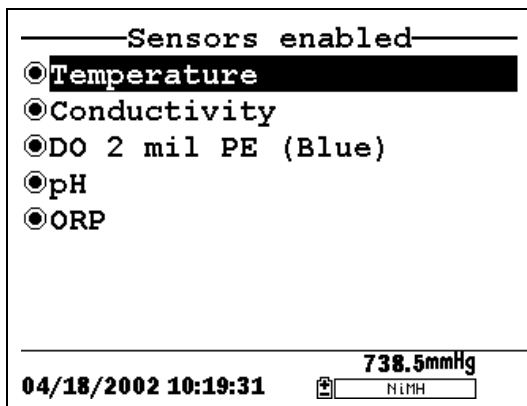


Figure 4.4 Sensors Enabled Screen After DO Membrane Selection

NOTE: The Temperature sensor cannot be disabled. Most other sensors require temperature compensation for accurate readings. In addition, the conductivity sensor must be activated in order to obtain accurate dissolved oxygen mg/L readings.

- 5.** Use the arrow keys to highlight the sensor you want to change, then press the **Enter** key to enable or disable it.
- 6.** Repeat step 5 for each sensor you want to change.
- 7.** Press the **Escape** key to return to the main menu screen.

5. Report

The Report Setup screen allows the user to select which sample parameters and units the YSI 556 MPS will display on the screen. It does NOT determine which parameters are logged to memory. Refer to Section 4 *Sensors*.

1. Press the **On/off** key to display the run screen.
2. Press the **Escape** key to display the main menu screen.

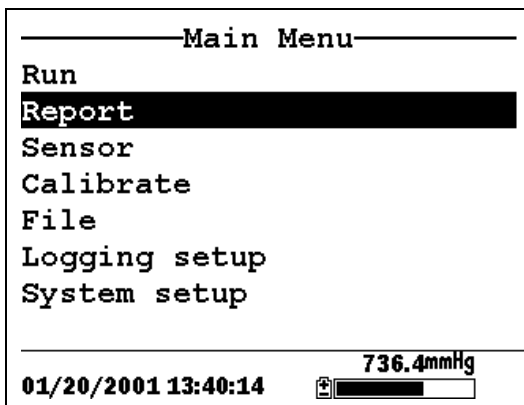


Figure 5.1 Main Menu

3. Use the arrow keys to highlight the **Report** selection.
4. Press the **Enter** key to display the report setup screen.

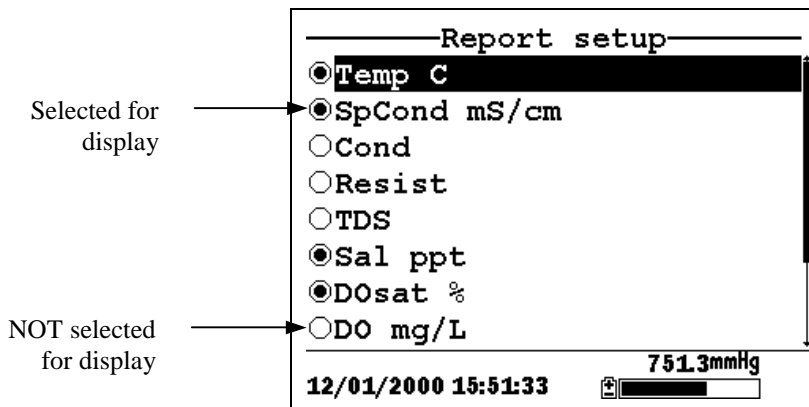


Figure 5.2 Report Setup Screen

NOTE: A black dot to the left of a parameter indicates that parameter is selected for display. Parameters with an empty circle will not be displayed.

NOTE: You may have to scroll down past the bottom of the screen to see all the parameters.

5. Use the arrow keys to highlight the parameter you want to change, then press the **Enter** key. If you can't find the parameter you want, even after scrolling down past the bottom of the screen, the sensor used for that parameter is disabled. Refer to Section 4 *Sensors*.
6. If you selected Temperature, Specific Conductivity, Conductivity, Resistance or Total Dissolved Solids, the Units screen will appear.

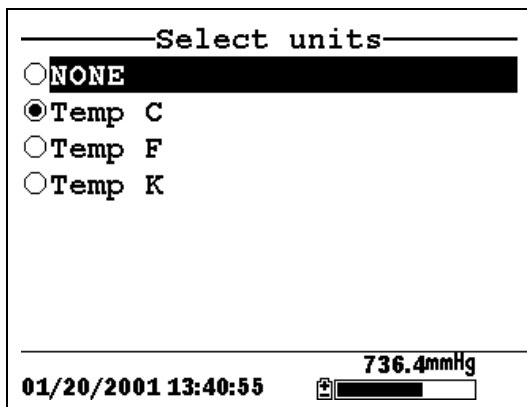


Figure 5.3 Units Screen

7. Use the arrow keys to select the units desired, then press the **Enter** key to return to the report setup screen.
If you selected Salinity, Dissolved Oxygen %, Dissolved Oxygen mg/L, pH, pH mv or ORP mv, the selection dot will simply toggle on or off.
8. Repeat steps 5 and 6 for each parameter you want to change.

NOTE: All parameters may be enabled at the same time.

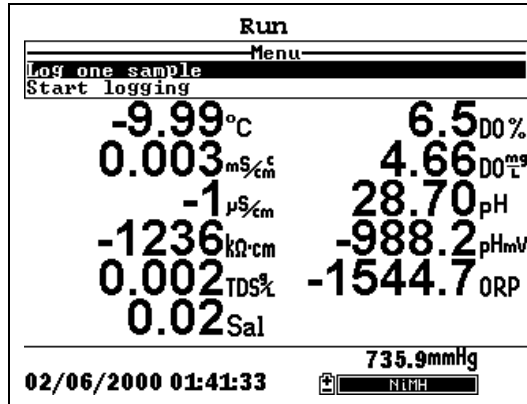


Figure 5.4 All Parameters Displayed

9. Press the **Escape** key to return to the Main menu screen.

6. Calibrate

All of the sensors, except temperature, require periodic calibration to assure high performance. You will find specific calibration procedures for all sensors that require calibration in the following sections. If a sensor listed is not installed in your probe module, skip that section and proceed to the next sensor until the calibration is complete.



CAUTION: Reagents that are used to calibrate and check this instrument may be hazardous to your health. Take a moment to review *Appendix D Health and Safety*. Some calibration standard solutions may require special handling.

6.1 Getting Ready to Calibrate

6.1.1 Containers Needed to Calibrate the Probe Module

The transport/calibration cup that comes with your probe module serves as a calibration chamber for all calibrations and minimizes the volume of calibration reagents required.

Instead of the transport/calibration cup, you may use laboratory glassware to perform calibrations. If you do not use the transport/calibration cup that is designed for the probe module, you are cautioned to do the following:

- ✓ Perform all calibrations with the Probe Sensor Guard installed. This protects the sensors from possible physical damage.
- ✓ Use a ring stand and clamp to secure the probe module body to prevent the module from falling over. Most laboratory glassware has convex bottoms.
- ✓ Ensure that all sensors are immersed in calibration solutions. Many of the calibrations factor in readings from other sensors (e.g., temperature sensor). The top vent hole of the conductivity sensor must also be immersed during some calibrations.

6.1.2 Calibration Tips

1. If you use the Transport/Calibration Cup for dissolved oxygen (DO) calibration, make certain to loosen the seal to allow pressure equilibration before calibration. The DO calibration is a water-saturated air calibration.
2. The key to successful calibration is to ensure that the sensors are completely submersed when calibration values are entered. Use recommended volumes when performing calibrations.
3. For maximum accuracy, use a small amount of previously used calibration solution to pre-rinse the probe module. You may wish to save old calibration standards for this purpose.
4. Fill a bucket with ambient temperature water to rinse the probe module between calibration solutions.
5. Have several clean, absorbent paper towels or cotton cloths available to dry the probe module between rinses and calibration solutions. Shake the excess rinse water off of the probe module, especially when the probe sensor guard is installed. Dry off the outside of the probe module and probe sensor guard. Making sure that the probe module is dry reduces carry-over contamination of calibrator solutions and increases the accuracy of the calibration.
6. If you are using laboratory glassware for calibration, you do not need to remove the probe sensor guard to rinse and dry the sensors between calibration solutions. The inaccuracy resulting from simply rinsing the sensor compartment and drying the outside of the guard is minimal.
7. If you are using laboratory glassware, remove the stainless steel weight from the bottom of the probe sensor guard by turning the weight counterclockwise. When the weight is removed, the calibration solutions have access to the sensors without displacing a lot of fluid. This also reduces the amount of liquid that is carried between calibrations.
8. Make certain that port plugs are installed in all ports where sensors are not installed. It is extremely important to keep these electrical connectors dry.

6.1.3 Recommended Volumes

Follow these instructions to use the transport/calibration cup for calibration procedures.

- ✓ Ensure that an o-ring is installed in the o-ring groove of the transport/calibration cup bottom cap, and that the bottom cap is securely tightened.

NOTE: Do not over-tighten as this could cause damage to the threaded portions.

- ✓ Remove the probe sensor guard, if it is installed.
- ✓ Remove the o-ring, if installed, from the probe module and inspect the installed o-ring on the probe module for obvious defects and, if necessary, replace it with the extra o-ring supplied.
- ✓ Some calibrations can be accomplished with the probe module upright or upside down. A separate clamp and stand, such as a ring stand, is required to support the probe module in the inverted position.
- ✓ To calibrate, follow the procedures in the next section, Calibration Procedures. The approximate volumes of the reagents are specified below for both the upright and upside down orientations.
- ✓ When using the Transport/Calibration Cup for dissolved oxygen % saturation calibration, make certain that the vessel is vented to the atmosphere by loosening the bottom cap or cup assembly and that approximately 1/8” of water is present in the cup.

| Sensor to Calibrate | Upright | Upside Down |
|---------------------|---------|-------------|
| Conductivity | 55ml | 55ml |
| pH/ORP | 30ml | 60ml |

Table 6.1 Calibration Volumes

6.2 Calibration Procedures

6.2.1 Accessing the Calibrate Screen

1. Press the **On/off** key to display the run screen.
2. Press the **Escape** key to display the main menu screen.
3. Use the arrow keys to highlight the **Calibrate** selection.

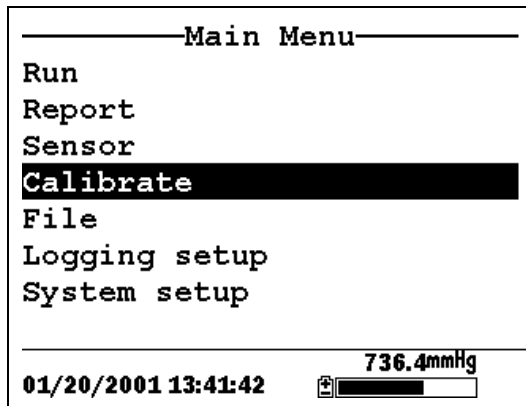


Figure 6.1 Main Menu

4. Press the **Enter** key. The Calibrate screen is displayed.

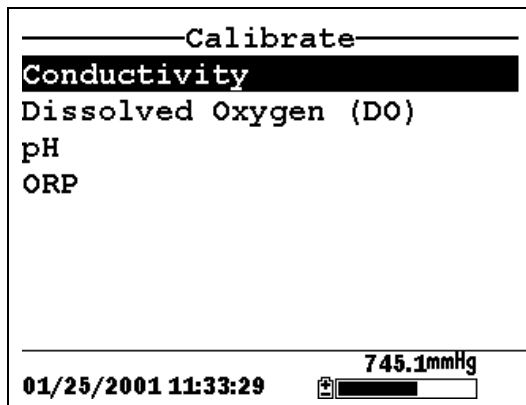


Figure 6.2 Calibrate Screen

6.2.2 Conductivity Calibration

This procedure calibrates specific conductance (recommended), conductivity and salinity. Calibrating any one option automatically calibrates the other two.

1. Go to the calibrate screen as described in Section 6.2.1 Accessing the Calibrate Screen.
2. Use the arrow keys to highlight the **Conductivity** selection. See Figure 6.2 Calibrate Screen.
3. Press **Enter**. The Conductivity Calibration Selection Screen is displayed.

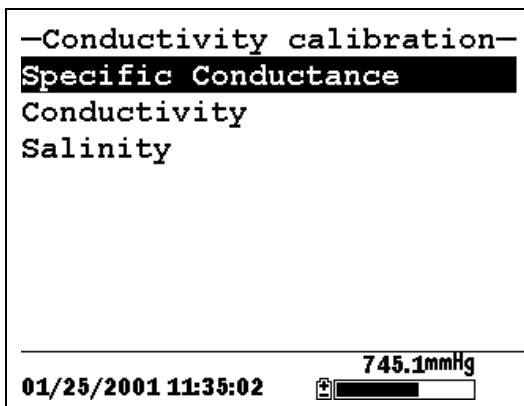


Figure 6.3 Conductivity Calibration Selection Screen

4. Use the arrow keys to highlight the Specific Conductance selection.
5. Press **Enter**. The Conductivity Calibration Entry Screen is displayed.

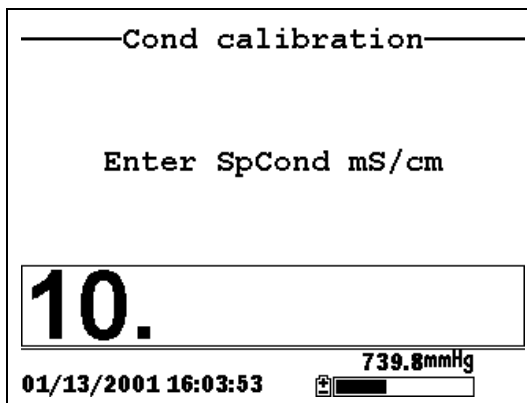


Figure 6.4 Conductivity Calibration Entry Screen

6. Place the correct amount of conductivity standard (see Table 6.1 Calibration Volumes) into a clean, dry or pre-rinsed transport/calibration cup.

⚠ WARNING: Calibration reagents may be hazardous to your health. See *Appendix D Health and Safety* for more information.

NOTE: For maximum accuracy, the conductivity standard you choose should be within the same conductivity range as the samples you are preparing to measure. However, we do not recommend using standards less than 1 mS/cm. For example:

- ✓ For fresh water use a 1 mS/cm conductivity standard.
- ✓ For brackish water use a 10 mS/cm conductivity standard.
- ✓ For seawater use a 50 mS/cm conductivity standard.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the conductivity sensor with a small amount of standard that can be discarded. Be certain that you avoid cross-contamination of solutions. Make certain that there are no salt deposits around the oxygen and pH/ORP sensors, particularly if you are employing standards of low conductivity.

7. Carefully immerse the sensor end of the probe module into the solution.
8. Gently rotate and/or move the probe module up and down to remove any bubbles from the conductivity cell.

NOTE: The sensor must be completely immersed past its vent hole. Using the recommended volumes from Table 6.1 Calibration Volumes, should ensure that the vent hole is covered.

9. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

NOTE: Do not overtighten as this could cause damage to the threaded portions.

10. Use the keypad to enter the calibration value of the standard you are using.

NOTE: Be sure to enter the value in **mS/cm at 25°C**.

11. Press **Enter**. The Conductivity Calibration Screen is displayed.

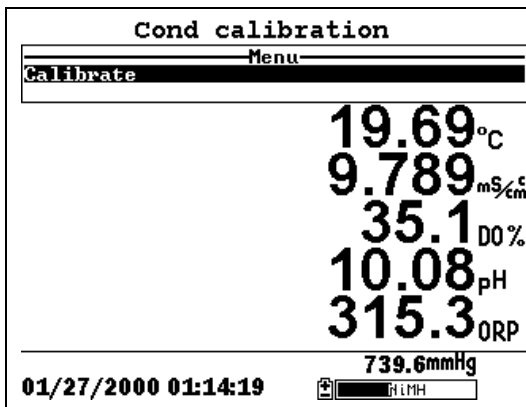


Figure 6.5 Conductivity Calibration Screen

12. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors

will appear on the screen and will change with time as they stabilize.

13. Observe the reading under Specific Conductance. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.

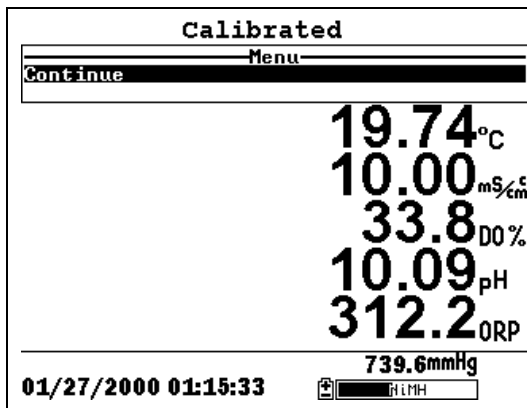


Figure 6.6 Calibrated

14. Press **Enter**. This returns you to the Conductivity Calibrate Selection Screen, See Figure 6.3 Conductivity Calibration Selection Screen.
15. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.
16. Rinse the probe module and sensors in tap or purified water and dry.

6.2.3 Dissolved Oxygen Calibration

This procedure calibrates dissolved oxygen. Calibrating any one option (% or mg/L) automatically calibrates the other.

1. Go to the calibrate screen as described in Section 6.2.1 *Accessing the Calibrate Screen*.

NOTE: The instrument must be on for at least 20 minutes to polarize the DO sensor before calibrating.

2. Use the arrow keys to highlight the **Dissolved Oxygen** selection. See Figure 6.2 Calibrate Screen.
3. Press **Enter**. The dissolved oxygen calibration screen is displayed.

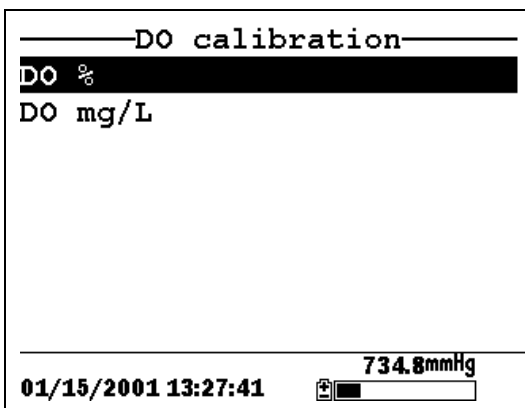


Figure 6.7 DO Calibration Screen

DO Calibration in % Saturation

1. Use the arrow keys to highlight the DO% selection.
2. Press **Enter**. The DO Barometric Pressure Entry Screen is displayed.

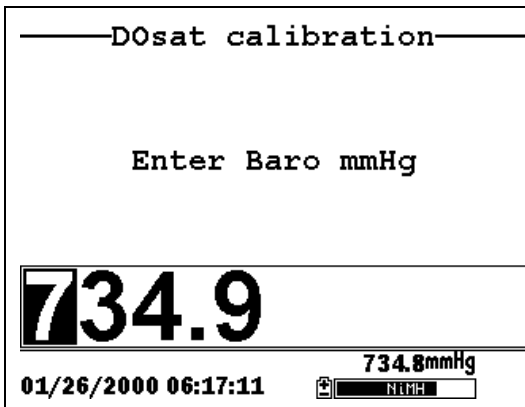


Figure 6.8 DO Barometric Pressure Entry Screen

3. Place approximately 3 mm (1/8 inch) of water in the bottom of the transport/calibration cup.
4. Place the probe module into the transport/calibration cup.

NOTE: Make sure that the DO and temperature sensors are **not** immersed in the water.

5. Engage only 1 or 2 threads of the transport/calibration cup to ensure the DO sensor is vented to the atmosphere.
6. Use the keypad to enter the current local barometric pressure.

NOTE: If the unit has the optional barometer, no entry is required.

NOTE: Barometer readings that appear in meteorological reports are generally corrected to sea level and must be uncorrected before use (refer to Section 10.10 *Calibrate Barometer, Step 2*).

7. Press **Enter**. The DO% saturation calibration screen is displayed.

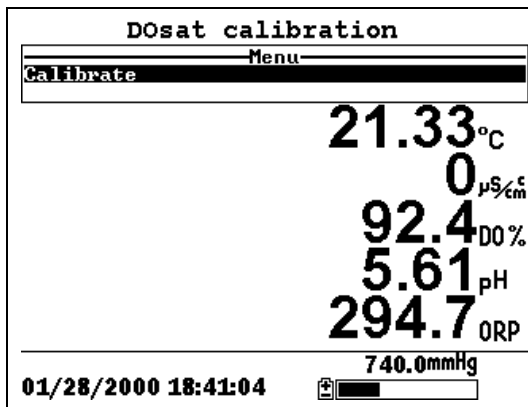


Figure 6.9 DO Sat Calibration Screen

8. Allow approximately ten minutes for the air in the transport/calibration cup to become water saturated and for

the temperature to equilibrate before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

- 9.** Observe the reading under DO %. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue. See Figure 6.6 Calibrated.
- 10.** Press **Enter**. This returns you to the DO calibration screen, See Figure 6.7 DO Calibration Screen.
- 11.** Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.
- 12.** Rinse the probe module and sensors in tap or purified water and dry.

DO Calibration in mg/L

DO calibration in mg/L is carried out in a water sample which has a known concentration of dissolved oxygen (usually determined by a Winkler titration).

- 1.** Go to the DO calibrate screen as described in Section 6.2.3 *Dissolved Oxygen Calibration*, steps 1 through 3.
- 2.** Use the arrow keys to highlight the **DO mg/L** selection.
- 3.** Press **Enter**. The DO mg/L Entry Screen is displayed.

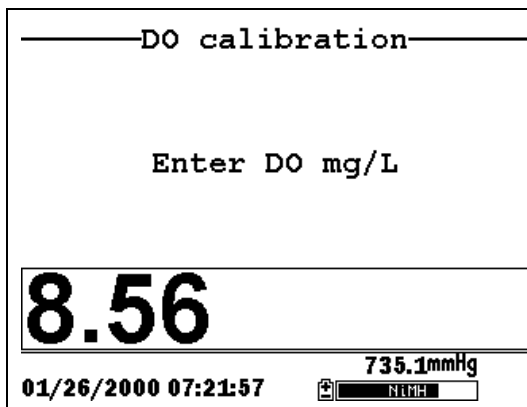


Figure 6.10 DO mg/L Entry Screen

4. Place the probe module in water with a known DO concentration.
- NOTE:** Be sure to completely immerse all the sensors.
5. Use the keypad to enter the known DO concentration of the water.
 6. Press **Enter**. The Dissolved Oxygen mg/L Calibration Screen is displayed.

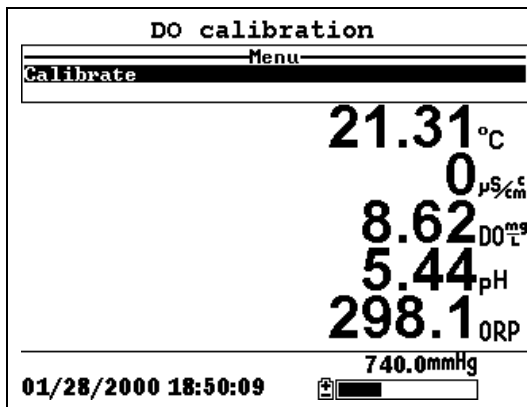


Figure 6.11 DO mg/L Calibration Screen

7. Stir the water with a stir bar, or by rapidly moving the probe module, to provide fresh sample to the DO sensor.
8. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
9. Observe the DO mg/L reading, when the reading is stable (shows no significant change for approximately 30 seconds), press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
10. Press **Enter**. This returns you to the DO calibration screen. See Figure 6.7 DO Calibration Screen.
11. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.
12. Rinse the probe module and sensors in tap or purified water and dry.

6.2.4 pH Calibration

1. Go to the calibrate screen as described in *Section 6.2.1 Accessing the Calibrate Screen*.
2. Use the arrow keys to highlight the **pH** selection. See Figure 6.2 Calibrate Screen.
3. Press **Enter**. The pH calibration screen is displayed.

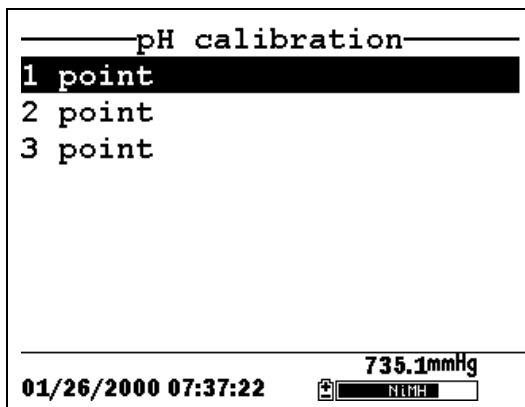


Figure 6.12 pH Calibration Screen

- Select the **1-point** option only if you are adjusting a previous calibration. If a 2-point or 3-point calibration has been performed previously, you can adjust the calibration by carrying out a one point calibration. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select only one pH buffer.
 - Select the **2-point** option to calibrate the pH sensor using only two calibration standards. Use this option if the media being monitored is known to be either basic or acidic. For example, if the pH of a pond is known to vary between 5.5 and 7, a two-point calibration with pH 7 and pH 4 buffers is sufficient. A three point calibration with an additional pH 10 buffer will not increase the accuracy of this measurement since the pH is not within this higher range.
 - Select the **3-point** option to calibrate the pH sensor using three calibration solutions. In this procedure, the pH sensor is calibrated with a pH 7 buffer and two additional buffers. The 3-point calibration method assures maximum accuracy when the pH of the media to be monitored cannot be anticipated. The procedure for this calibration is the same as for a 2-point calibration, but the software will prompt you to select a third pH buffer.
4. Use the arrow keys to highlight the **2-point** selection.
 5. Press **Enter**. The pH Entry Screen is displayed.

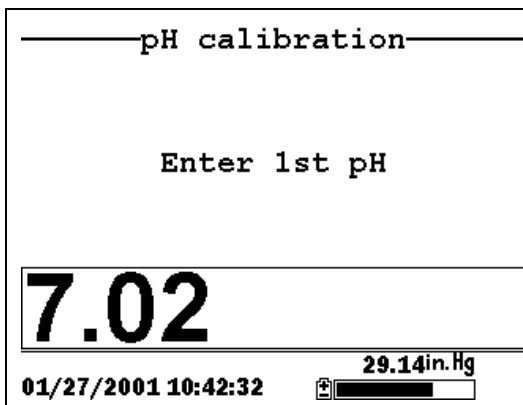


Figure 6.13 pH Entry Screen

6. Place the correct amount (see Table 6.1 Calibration Volumes) of pH buffer into a clean, dry or pre-rinsed transport/calibration cup.

⚠ WARNING: Calibration reagents may be hazardous to your health. See *Appendix D Health and Safety* for more information.

NOTE: For maximum accuracy, the pH buffers you choose should be within the same pH range as the water you are preparing to sample.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the pH sensor with a small amount of buffer that can be discarded. Be certain that you avoid cross-contamination of buffers with other solutions.

7. Carefully immerse the sensor end of the probe module into the solution.
8. Gently rotate and/or move the probe module up and down to remove any bubbles from the pH sensor.

NOTE: The sensor must be completely immersed. Using the recommended volumes from Table 6.1 Calibration Volumes, should ensure that the sensor is covered.

9. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

NOTE: Do not overtighten as this could cause damage to the threaded portions.

10. Use the keypad to enter the calibration value of the buffer you are using **at the current temperature**.

NOTE: pH vs. temperature values are printed on the labels of all YSI pH buffers.

11. Press **Enter**. The pH calibration screen is displayed.

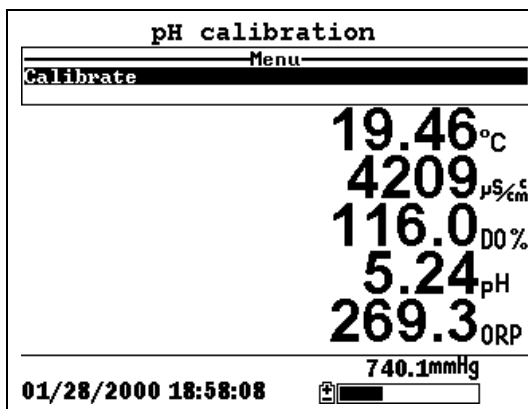


Figure 6.14 pH Calibration Screen

12. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
13. Observe the reading under pH, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
14. Press **Enter**. This returns you to the Specified pH Calibration Screen, See Figure 6.13 pH Entry Screen.

15. Rinse the probe module, transport/calibration cup and sensors in tap or purified water and dry.
16. Repeat steps 6 through 13 above using a second pH buffer.
17. Press **Enter**. This returns you to the pH Calibration Screen, See Figure 6.12 pH Calibration Screen.
18. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.
19. Rinse the probe module and sensors in tap or purified water and dry.

6.2.5 ORP Calibration

1. Go to the calibrate screen as described in Section 6.2.1 *Accessing the Calibrate Screen*.
2. Use the arrow keys to highlight the **ORP** selection. See Figure 6.2 Calibrate Screen.
3. Press **Enter**. The ORP calibration screen is displayed.

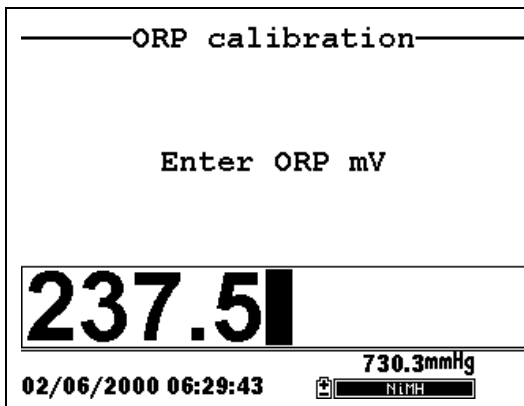



Figure 6.15 Specified ORP Calibration Screen

4. Place the correct amount (see Table 6.1 Calibration Volumes) of a known ORP solution (we recommend Zobell solution) into a clean, dry or pre-rinsed transport/calibration cup.

 **WARNING:** Calibration reagents may be hazardous to your health. See *Appendix D Health and Safety* for more information.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the ORP sensor with a small amount of solution that can be discarded. Be certain that you avoid cross-contamination with other solutions.

5. Carefully immerse the sensor end of the probe module into the solution.
6. Gently rotate and/or move the probe module up and down to remove any bubbles from the ORP sensor.

NOTE: The sensor must be completely immersed. Using the recommended volumes from Table 6.1 Calibration Volumes should ensure that the sensor is covered.

7. Screw the transport/calibration cup on the threaded end of the probe module and securely tighten.

NOTE: Do not overtighten as this could cause damage to the threaded portions.

8. Use the keypad to enter the correct value of the calibration solution you are using at the current temperature. Refer to Table 6.2 Zobel Solution Values.

| Temperature °C | Zobell Solution Value, mV |
|----------------|---------------------------|
| -5 | 270.0 |
| 0 | 263.5 |
| 5 | 257.0 |
| 10 | 250.5 |
| 15 | 244.0 |
| 20 | 237.5 |
| 25 | 231.0 |
| 30 | 224.5 |
| 35 | 218.0 |
| 40 | 211.5 |
| 45 | 205.0 |
| 50 | 198.5 |

Table 6.2 Zobel Solution Values

9. Press **Enter**. The ORP calibration screen is displayed.

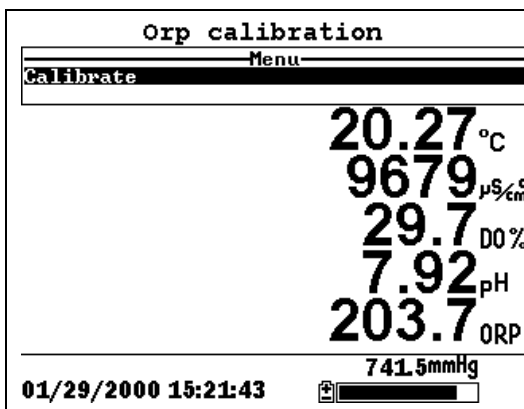


Figure 6.16 ORP Calibration Screen

10. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

NOTE: Verify that the temperature reading matches the value you used in Table 6.2 Zobel Solution Values.

11. Observe the reading under ORP, when the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt you to press **Enter** again to Continue.
12. Press **Enter**. This returns you to the Calibrate Screen. See Figure 6.2 Calibrate Screen.
13. Rinse the probe module and sensors in tap or purified water and dry.

6.3 Return to Factory Settings

1. Go to the calibrate screen as described in Section 6.2.1 *Accessing the Calibrate Screen*.
2. Use the arrow keys to highlight the **Conductivity** selection. See Figure 6.2 Calibrate Screen.

NOTE: We will use the Conductivity sensor as an example; however, this process will work for any sensor.

3. Press **Enter**. The Conductivity Calibration Selection Screen is displayed. See Figure 6.3 Conductivity Calibration Selection Screen.
4. Use the arrow keys to highlight the **Specific Conductance** selection.
5. Press **Enter**. The Conductivity Calibration Entry Screen is displayed. See Figure 6.4 Conductivity Calibration Entry Screen.
6. Press and hold the **Enter** key down and press the **Escape** key.

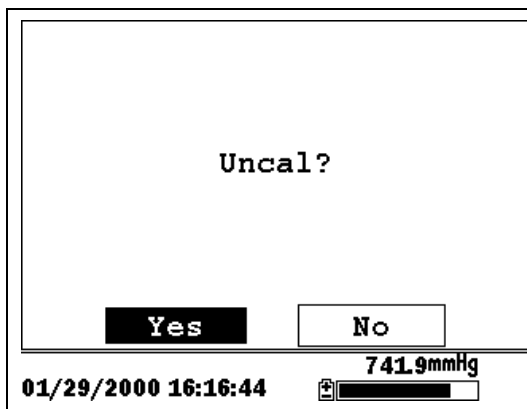


Figure 6.17 ORP Calibration Screen

7. Use the arrow keys to highlight the **YES** selection.

CAUTION: This returns a sensor to the factory settings. For example, in selecting to return specific conductance to the factory setting, salinity and conductivity will automatically return to their factory settings.

- 8.** Press **Enter**. This returns you to the Conductivity Calibrate Selection Screen, See Figure 6.3 Conductivity Calibration Selection Screen.
- 9.** Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

7. Run

The Run screen displays data from the sensors in real-time and allows the user to log sample data to memory for later analysis. Refer to Section 9 *Logging* for details on logging sample data.

7.1 Real-Time Data

NOTE: Before measuring samples you must prepare the probe module (refer to Section 3.4 *Preparing the Probe Module*), attach the probe module to the instrument (refer to Section 3.6 *Instrument/Cable Connection*) and calibrate the sensors (refer to Section 6 *Calibrate*).

1. Press the **On/off** key.

OR select Run from the main menu to display the run screen.

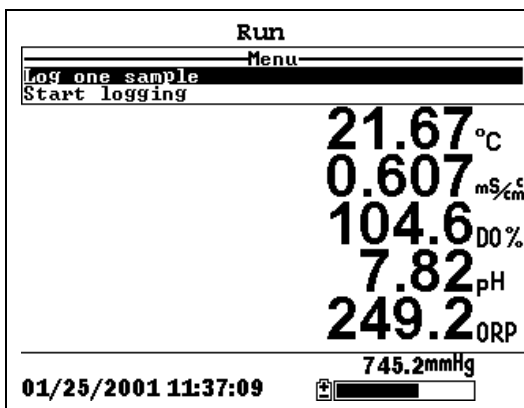


Figure 7.1 Run Screen

2. Make sure the probe sensor guard is installed.
3. Place the probe module in the sample. Be sure to completely immerse all the sensors.
4. Rapidly move the probe module through the sample to provide fresh sample to the DO sensor.
5. Watch the readings on the display until they are stable.

- 6.** Refer to Section 9 *Logging* for instructions on logging sample data.

8. File

The File menu allows the user to view, upload or delete sample data and calibration record files stored in the YSI 556 MPS.

8.1 Accessing the File Screen

1. Press the **On/off** key to display the run screen.
2. Press the **Escape** key to display the main menu screen.

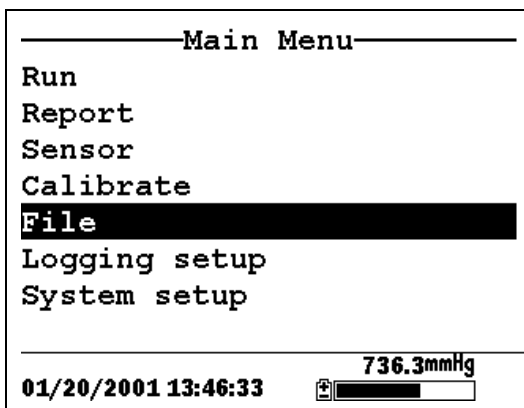


Figure 8.1 Main Menu Screen

3. Use the arrow keys to highlight the **File** selection.
4. Press the **Enter** key. The file screen is displayed.



Figure 8.2 File Screen

8.2 Directory

1. Go to the file screen as described in Section 8.1 *Accessing the File Screen*.
2. Use the arrow keys to highlight the **Directory** selection. See Figure 8.2 File Screen.
3. Press the **Enter** key. The file list screen is displayed.

NOTE: Files are listed in the order in which they are logged to memory. Sample Data files have the file extension **.dat**, while Calibration Record files have the file extension **.glp**.

| Filename | Samples | Bytes |
|----------------|---------|-------|
| RED.dat | 26 | 955 |
| CAT.dat | 63 | 2028 |
| OHIO.dat | 118 | 3623 |
| 00008004.glp | 6 | 130 |

736.8mmHg


01/20/2001 13:57:40 

Figure 8.3 File List Screen

4. Use the arrow keys to highlight a file.
5. Press the **Enter** key. The file details screen is displayed.

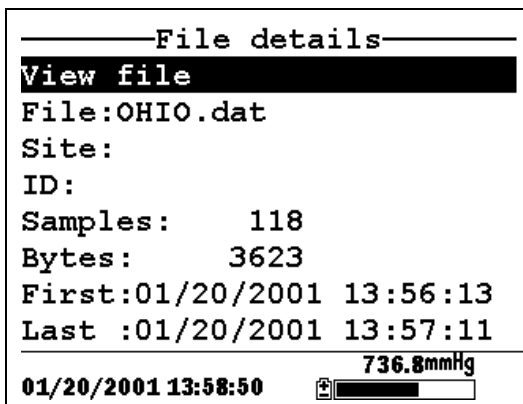


Figure 8.4 File Details Screen

6. Press the **Enter** key to view the file data. Refer to Section 8.3 *View File* for details.
7. Press the **Escape** key repeatedly to return to the main menu screen.

8.3 View File

1. Go to the file screen as described in Section 8.1 *Accessing the File Screen*. See Figure 8.2 File Screen.
2. Use the arrow keys to highlight the **View file** selection.
3. Press the **Enter** key. A list of files is displayed. See Figure 8.3 File List Screen.
4. Use the arrow keys to highlight an individual file.

NOTE: You may have to scroll down to see all the files.

5. Press the **Enter** key. The file data is displayed with the file name at the top of the display.

NOTE: If no file name was specified, the data is stored under the default name NONAME1.dat.

| OHIO.dat | | |
|------------|----------|-------|
| Date | Time | Temp |
| m/d/y | hh:mm:ss | C |
| 01/20/2001 | 13:56:13 | 22.54 |
| 01/20/2001 | 13:56:13 | 22.54 |
| 01/20/2001 | 13:56:14 | 22.54 |
| 01/20/2001 | 13:56:14 | 22.54 |
| 01/20/2001 | 13:56:15 | 22.54 |
| 01/20/2001 | 13:56:15 | 22.54 |
| 01/20/2001 | 13:56:16 | 22.54 |
| 01/20/2001 | 13:56:16 | 22.54 |
| 01/20/2001 | 13:56:17 | 22.54 |

736.7mmHg


01/20/2001 13:59:34 

Figure 8.5 File Data Screen

6. Use the arrow keys to scroll horizontally and/or vertically to view all the data.
7. Press the **Escape** key repeatedly to return to the main menu screen.

8.4 Upload to PC

EcoWatch™ for Windows™ must be used as the PC software interface to the YSI 556 MPS. Refer to *Appendix G EcoWatch* for more information. EcoWatch for Windows is available at no cost via a download from the YSI Web Site (www.ysi.com) or by contacting YSI Customer Support. Refer to *Appendix E Customer Service*.

8.4.1 Upload Setup

1. Disconnect the YSI 5563 Probe Module from the YSI 556 MPS instrument.
2. Connect the YSI 556 MPS to a serial (Comm) port of your computer via the 655173 PC Interface cable as shown in the following diagram:

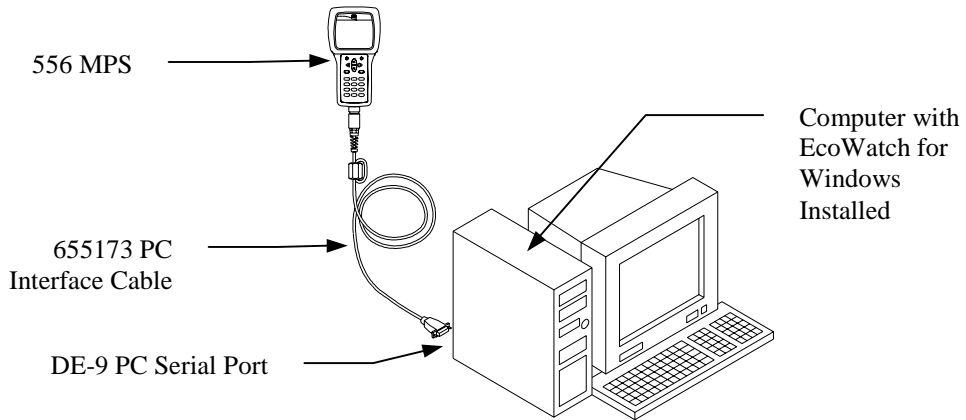

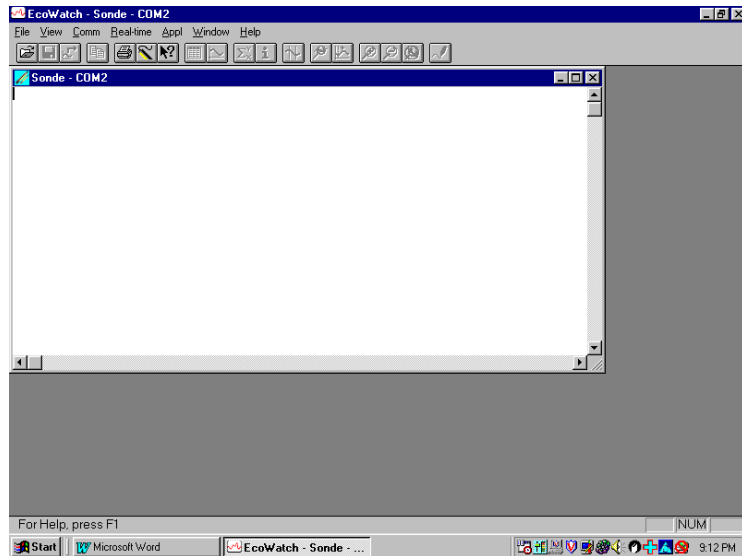


Figure 8.6 Computer/Instrument Interface

3. Open EcoWatch for Windows on your computer.
NOTE: See *Appendix G EcoWatch* for installation instructions.
4. Click on the sonde/probe icon  in the upper toolbar.
5. Set the Comm port number to match the port the YSI 556 MPS is connected to. After this setup procedure, the following screen will be present on your PC monitor:



8.4.2 Uploading a .DAT File

1. Setup the instrument as described in Section 8.4.1 *Upload Setup*.
2. Go to the YSI 556 MPS file screen as described in Section 8.1 *Accessing the File Screen*.
3. Use the arrow keys to highlight the **Upload to PC** selection. See Figure 8.2 File Screen.
4. Press the **Enter** key. The file list screen is displayed. See Figure 8.3 File List Screen.
5. Use the arrow keys to highlight the DAT file that you wish to transfer and press **Enter**, both the YSI 556 MPS and PC displays show the progress of the file transfer.

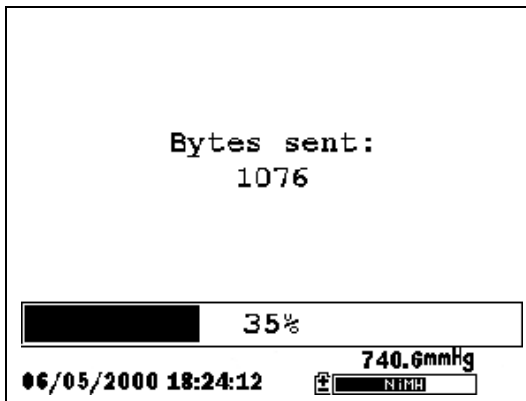
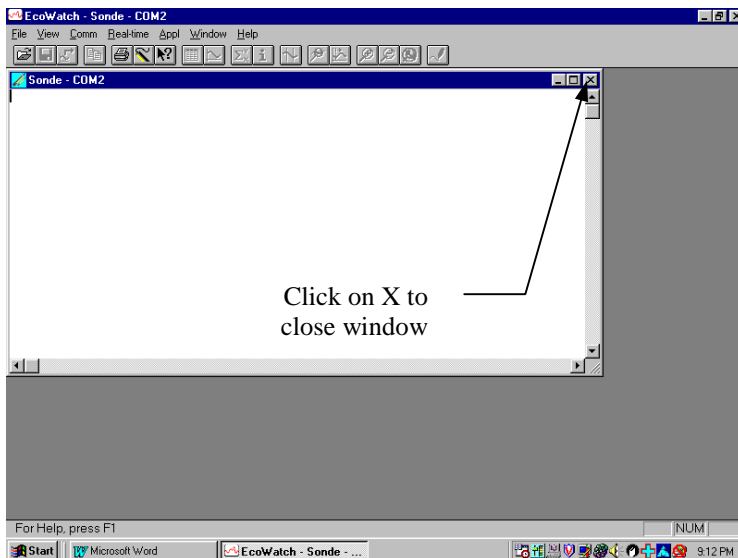


Figure 8.7 File Transfer Progress Screen

NOTE: After transfer, the file will be located in the C:\ECOWWIN\DATA folder of your PC, designated with a .DAT extension.

6. After the file transfer is complete, close the terminal window (small window on the PC) by clicking on the “X” at its upper right corner.



7. Press the **Escape** key on the YSI 556 MPS repeatedly to return to the main menu screen.

8.4.3 Uploading a Calibration Record (.glp) File

For more information on the calibration record, Refer to *Appendix H Calibration Record Information*.

1. Setup up the instrument as described in Section 8.4.1 *Upload Setup*.
2. Go to the YSI 556 MPS file screen as described in Section 8.1 *Accessing the File Screen*.
3. Use the arrow keys to highlight the **Upload to PC** selection. See Figure 8.2 File Screen.
4. Press the **Enter** key. The file list screen is displayed. See Figure 8.3 File List Screen.
5. Use the arrow keys to highlight the calibration record file that you wish to transfer and press **Enter**.
6. You will then be given a choice of uploading the file in three formats; **Binary, Comma & “” Delimited, and ASCII Text**.

NOTE: The binary format is reserved for future YSI software packages.

7. Choose an option and press **Enter**, both the YSI 556 and PC displays show the progress of the file transfer.

NOTE: After transfer, the file will be located in the C:\ECOWWIN\DATA folder of your PC, designated with the appropriate file extension.

NOTE: To view the Calibration Record data after upload, simply open the .txt file in a general text editor such as Wordpad or Notepad.

8. After the file transfer is complete, close the terminal window (small window on the PC) by clicking on the “X” at its upper right corner.
9. Press the **Escape** key repeatedly to return to the main menu screen.

8.5 File Memory

1. Go to the file screen as described in Section 8.1 *Accessing the File Screen*.
2. Use the arrow keys to highlight the **File memory** selection. See Figure 8.2 File Screen.
3. Press the **Enter** key. The file bytes used screen is displayed.


| File bytes used | |
|---|---------|
| Directory | 6400 |
| In files | 152832 |
| In deleted files | 0 |
| Free | 1413632 |
| Total | 1572864 |
| <hr/> <div style="display: flex; justify-content: space-between;"> 12/07/2000 16:39:19 737.0mmHg  </div> | |

Figure 8.8 File Bytes Used Screen

4. The amount of free memory is listed in line 4 of the file bytes used screen.

NOTE: If the amount of free memory is low, it may be time to delete all files (after first uploading all data to a PC). Refer to Section 8.6 *Delete All Files*.

5. Press the **Escape** key repeatedly to return to the main menu screen.

8.6 Delete All Files

NOTE: It is not possible to delete individual files in order to free up memory. The only way to free up memory is to delete ALL files present. Take care to transfer all files to your computer (refer to Section 8.4 *Upload to PC*) before deleting them.

1. Go to the file screen as described in Section 8.1 *Accessing the File Screen*.
2. Use the arrow keys to highlight the **Delete all files** selection. See Figure 8.2 File Screen.
3. Press the **Enter** key. The Delete all Files screen is displayed.

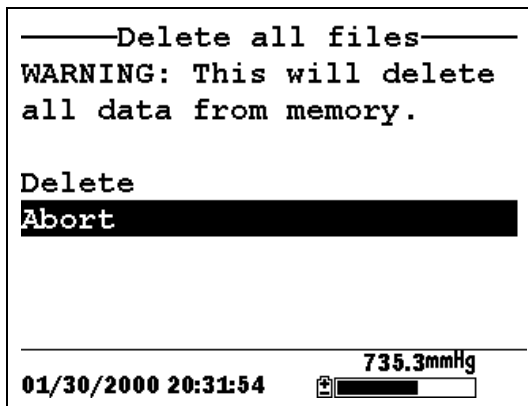


Figure 8.9 Delete All Files Screen

4. Use the arrow keys to highlight the **Delete** selection.
5. Press the **Enter** key.

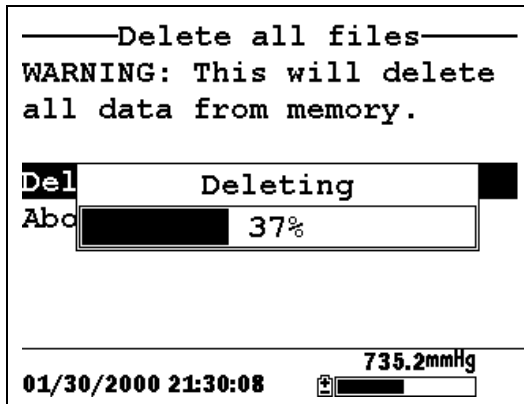


Figure 8.10 Deleting

The progress of file deletion is displayed in bar graph format.

NOTE: Deleting all files in the directory will not change any information in the site list.

6. Press the **Escape** key repeatedly to return to the main menu screen.

9. Logging

9.1 Accessing the Logging Setup Screen

1. Press the **On/off** key to display the run screen.
2. Press the **Escape** key to display the main menu screen.

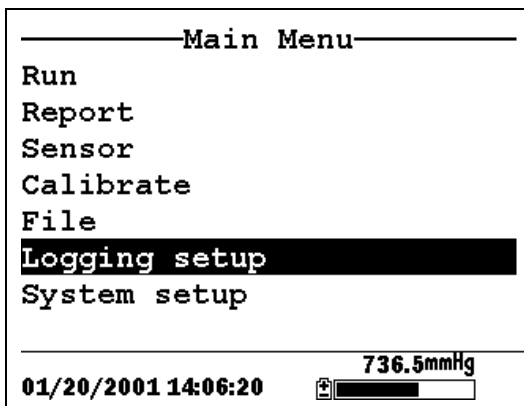


Figure 9.1 Main Menu

3. Use the arrow keys to highlight the **Logging setup** selection.
4. Press the **Enter** key. The logging setup screen is displayed.

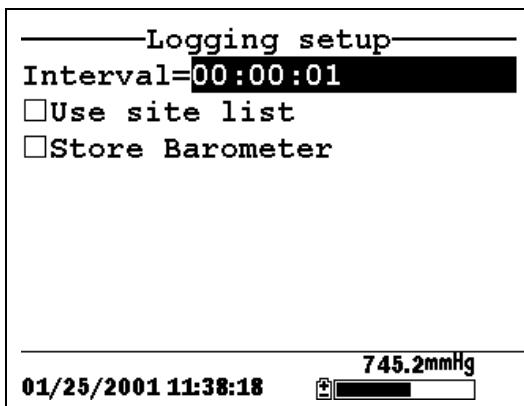


Figure 9.2 Logging Setup Screen

9.2 Setting Logging Interval

Follow steps below to set the interval for logging a data stream.

NOTE: If you do not specify an interval, the instrument will use a default interval setting of 1 second.

NOTE: It is not necessary to set a logging interval when logging a single sample.

1. Go to the logging setup screen as described in Section 9.1 *Accessing the Logging Setup Screen*.
2. Use the keypad to enter an interval between 1 second and 15 minutes. Refer to Section 2.9 *Keypad Use*.

NOTE: The interval field has hour, minute and second entry fields. Any entry over 15 minutes will change automatically to a 15-minute setting.

3. Press the **Enter** key. The data stream interval is set.
4. Press the **Escape** key repeatedly to return to the main menu screen.

9.3 Storing Barometer Readings

NOTE: The **Store barometer** option is only available on instruments that are equipped with the optional barometer.

1. Go to the logging setup screen as described in Section 9.1 *Accessing the Logging Setup Screen*.
2. Use the arrow keys to highlight the **Store barometer** selection. See Figure 9.2 Logging Setup Screen.
3. Press the **Enter** key until a check mark is entered in the box next to the store barometer selection if you want to log barometric readings.

OR press the **Enter** key until the box next to the barometer selection is empty if you do not want to log barometric readings.

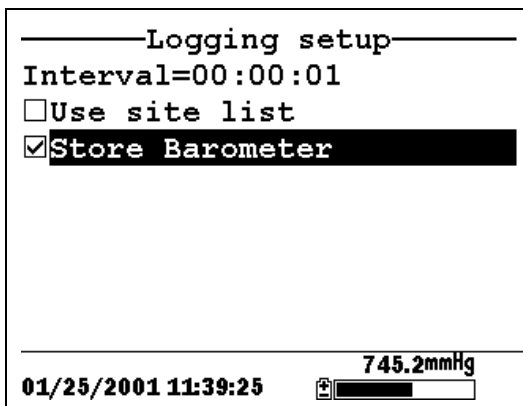


Figure 9.3 Store Barometer

4. Press the **Escape** key repeatedly to return to the main menu screen.

9.4 Creating a Site List

The site list option allows you to define file and site descriptions in the office or laboratory before moving to field logging studies. This is usually more convenient than entering the information at the site and is particularly valuable if you are visiting certain sites on a regular basis. The following section describes how to set up site lists which contain entries designated “Site Descriptions” that will be instantly available to the user in the field to facilitate the logging of data with pre-established naming of files and sites. There are two kinds of **Site Descriptions** available for use in Site lists:

- **Site Descriptions** associated with applications where data from a single site is always logged to a single file. This type is referred to as a “Single-Site Description” and is characterized by two parameters – a file name and a site name. Files logged to YSI 556 MPS memory under a **Single-Site Description** will be characterized primarily by the file name, but will also have the Site name attached, so that it is viewable in either the YSI 556 MPS **File directory** or in EcoWatch for Windows after upload to a PC

- Site Descriptions** associated with applications where data from multiple sites are logged to a single file. This type is referred to as a “Multi-site Description” and is characterized by three parameters – a file name, a site name, and a site number. Files logged to YSI 556 MPS memory under a **Multi-site Description** are characterized by a file name, but not a site name, since multiple sites are involved. However, each data point has a Site Number attached to it so that the user can easily determine the sampling site when viewing the data from the YSI 556 MPS **File** menu or processing the data in EcoWatch for Windows after upload to a PC.

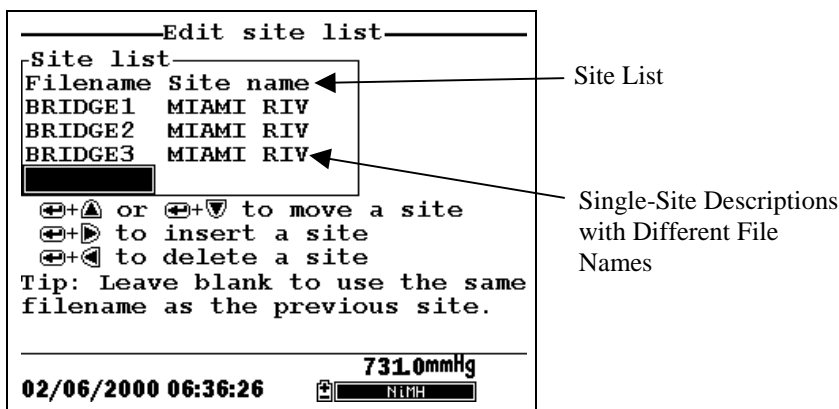


Figure 9.4 Single-Site Descriptions

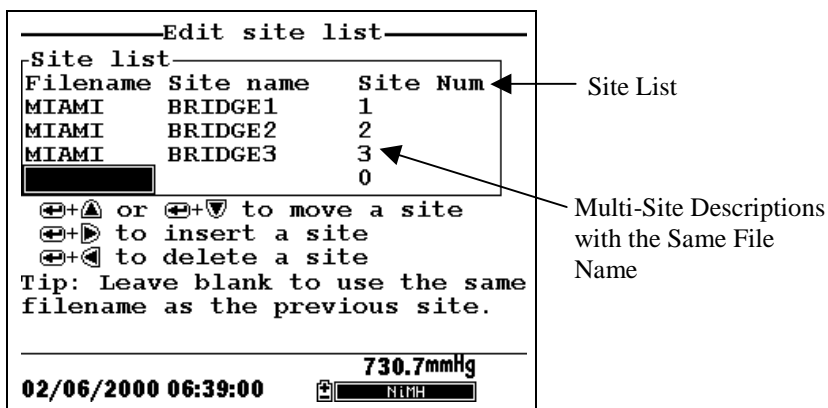


Figure 9.5 Multiple-Site Descriptions

NOTE: Site lists containing Single Site Descriptions are usually input with the designation **Store Site Number** INACTIVE in the YSI 556 MPS **Logging setup** menu. Thus, no site numbers appear in the first **Site list** example. Conversely, **Site lists** containing **Multi-Site Descriptions** MUST be input with the **Store Site Number** selection ACTIVE as shown in the second example.

To create a site list:

1. Go to the logging setup screen as described in Section 9.1 *Accessing the Logging Setup Screen*.
2. Use the arrow keys to highlight the **Use site list** selection.
3. Press the **Enter** key. A check mark is entered in the box next to the use site list selection *and* two new entries appear on the logging setup screen. See Figure 9.6 Logging Setup Screen.

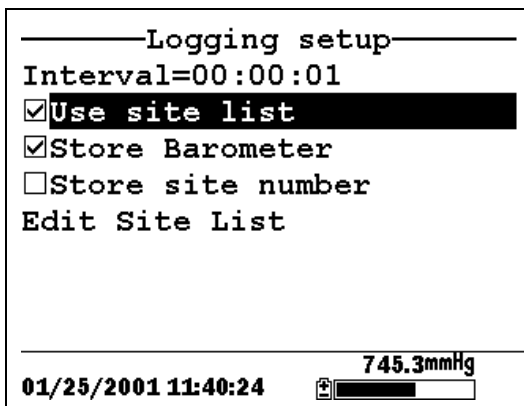


Figure 9.6 Logging Setup Screen

4. Use the arrow keys to highlight the **Store site number** selection.
5. If you are creating Multi-Site Descriptions (which require that the site **number** be stored in your data files), press the **Enter** key until a check mark appears in the box next to the store site number selection.

OR Press the **Enter** key until the box next to the store site number selection is empty, to create Single-Site Descriptions. The site **name** will be stored in the header of your data files.

6. Use the arrow keys to highlight the **Edit site list** selection.
7. Press the **Enter** key. The edit site list screen is displayed. See Figure 9.7 Edit Site List Screen. The **Filename** field is ready for input.

```

-----Edit site list-----
Site list
Filename Site name Site Num
[REDACTED]          0

←+▲ or ←+▼ to move a site
←+▶ to insert a site
←+◀ to delete a site
Tip: Leave blank to use the same
filename as the previous site.

-----
01/25/2001 11:42:21 745.3mmHg
[REDACTED]

```

Figure 9.7 Edit Site List Screen

8. Use the keypad to enter a filename up to 8 characters in length. Refer to Section 2.9 *Keypad Use*.
 9. Press the **Enter** key. The cursor moves to the right for the entry of a **Site name**.
 10. Use the keypad to enter a site name up to 11 characters in length. Refer to Section 2.9 *Keypad Use*.
- NOTE:** If the store site number selection is *not* checked, skip to Step 13.
11. Press the **Enter** key. The cursor moves to the site number entry position.

12. Use the keypad to enter a site number up to 7 characters in length. Refer to Section 2.9 *Keypad Use*.
13. Press **Enter**. The cursor moves to the next filename entry position.
14. Repeat Steps 8 to 13 until all filenames and sites have been entered.
15. Press **Escape** repeatedly to return to the main menu screen.

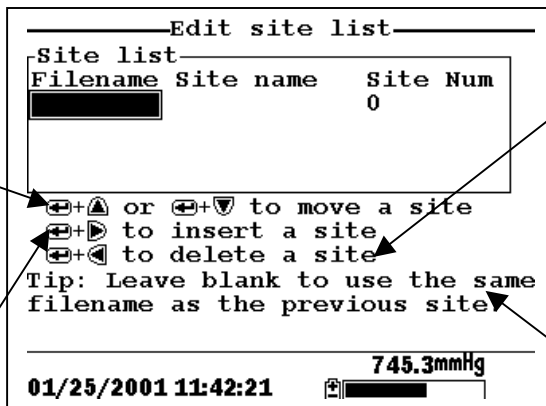
9.5 Editing a Site List

1. Go to the logging setup screen as described in Section 9.1 *Accessing the Logging Setup Screen*.
2. Use the arrow keys to highlight the **Edit Site List** selection. See Figure 9.6 Logging Setup Screen.
3. Press the **Enter** key. The edit site list screen is displayed.
4. Edit the site list using the keystrokes described below.

NOTE: Editing the site list will not have any effect on files stored in the instrument memory.

To MOVE a site:
 Use the arrow keys to highlight a site. Press the Up or Down arrow key while holding down the Enter key.

To INSERT a site above another site:
 Use the arrow keys to highlight the site. Press the Right arrow key while holding down the Enter key. Use keypad to input letters. Refer to Section 2.9 Keypad Use.



To DELETE a site:
 Use the arrow keys to highlight a site. Press the Left arrow key while holding down the Enter key.

To use the same file name as the previous site: Leave the filename blank.

Figure 9.8 Keystrokes for Editing Site List

9.6 Logging Data Without a Site List

1. Follow Steps 1 through 5 in Section 7.1 Real-Time Data.
2. Use the arrow keys to highlight the **Log one sample** selection on the run screen if only a single sample is being logged.

OR Use the arrow keys to highlight the **Start logging** selection on the run screen if a data stream is being logged.

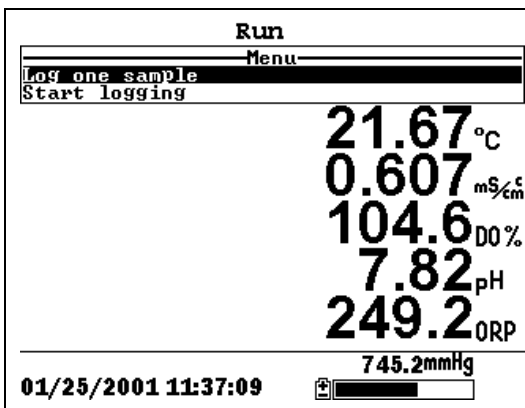


Figure 9.9 Run Screen

3. Press the **Enter** key. The Enter information screen is displayed.

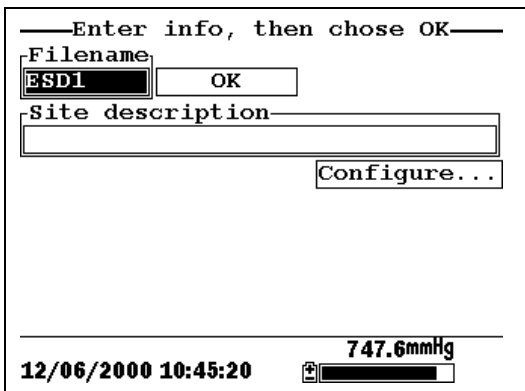


Figure 9.10 Enter Information Screen

NOTE: The last filename used will be displayed.

4. Use the keypad to enter a file name. Refer to Section 2.9 *Keypad Use*.

NOTE: The instrument will assign a default file name of NONAME if no file name is specified.

5. Press the **Enter** key to input the file name.
6. Use the arrow keys to highlight the **Site description** field in the enter information screen.

NOTE: Entering a Site Description is optional. You may leave the Site Description blank and skip to Step 9.

7. Use the keypad to enter a site description name. Refer to Section 2.9 *Keypad Use*.

8. Press the **Enter** key to input the site description.

NOTE: If you want to change the logging setup, such as sampling interval or storing the barometer reading, use the arrow keys to highlight the **Configure** field, press the **Enter** key, then refer to Section 9.2 *Setting Logging Interval* or 9.3 *Storing Barometer Readings* for details.

9. Use the arrow keys to highlight the **OK** field in the center of the information screen.

10. Press the **Enter** key to start logging.

NOTE: If the parameter mismatch screen is displayed, refer to Section 9.8 *Adding Data to Existing Files*.

11. If a single point is being logged, the header on the run screen changes momentarily from **Menu** to **Sample logged** to confirm that the point was successfully logged. Skip to Step 13.

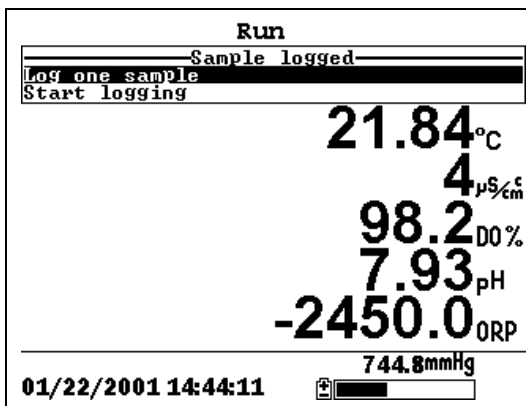


Figure 9.11 Sample Logged Screen

If a continuous stream of points is being logged, the start logging entry in the run screen changes from **Start logging** to **Stop logging**.

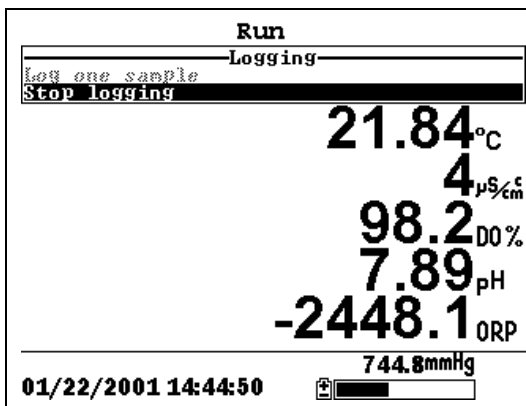


Figure 9.12 Logging Screen

12. At the end of the logging interval, press **Enter** to stop logging.
13. Refer to Section 8.3 *View File* to view the data on the instrument display.

9.7 Logging Data With a Site List

1. If you have not already created a site list, refer to Section 9.4 *Creating a Site List*.
2. Follow Steps 1 through 5 in Section 7.1 Real-Time Data.
3. Use the arrow keys to highlight the **Log one sample** selection on the run screen if only a single sample is being logged.

OR Use the arrow keys to highlight the **Start logging** selection on the run screen if a data stream is being logged. See Figure 9.9 Run Screen.

4. Press the **Enter** key. The Pick a site screen is displayed.

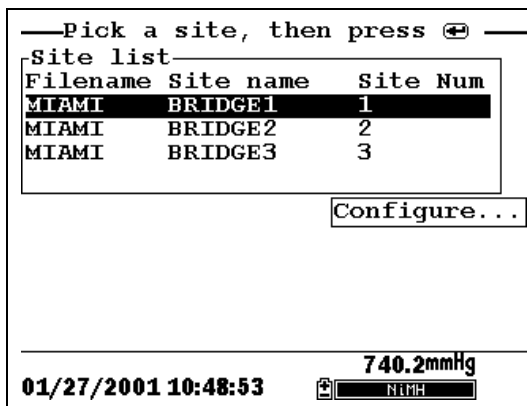


Figure 9.13 Pick a Site Screen

5. Use the arrow keys to highlight the **site** of your choice.

NOTE: If the site of your choice is grayed out in the site list, refer to Section 9.8 *Adding Data to Existing Files*.

NOTE: Refer to Section 9.5 *Editing a Site List* if you want to edit the site list.

6. Press the **Enter** key to start logging.

NOTE: If the parameter mismatch screen is displayed, refer to Section 9.8 *Adding Data to Existing Files*.

7. If a single point is being logged, the header on the run screen changes momentarily from **Menu** to **Sample logged** to confirm that the point was successfully logged. See Figure 9.11 Sample Logged Screen. Skip to Step 9.

If a continuous stream of points is being logged, the start logging entry in the run screen changes from **Start logging** to **Stop logging**. See Figure 9.12 Logging Screen.

8. At the end of the logging interval, press **Enter** to stop logging.
9. Refer to Section 8.3 *View File* to view the data on the instrument display.

9.8 Adding Data to Existing Files

In order to add new data to an existing file, the current logging and sensor setup must be *exactly* the same as when the file was created. The following settings must be the same:

- **Sensors enabled** (refer to Section 4 *Sensors*)
- **Store Barometer** (refer to Section 9.3 *Storing Barometer Readings*)
- **Store Site Number** (refer to Section 9.4 *Creating a Site List*)

If the current logging setup is not exactly the same as when the file was created, a parameter mismatch screen is displayed.

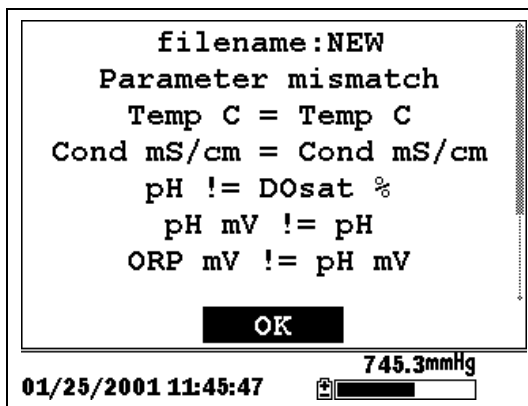


Figure 9.14 Parameter Mismatch Screen

NOTE: The right column shows parameters used when the file was created. The left column shows current parameters.

1. Press the **Down Arrow** key to scroll down and find the mismatch(es).
2. Use the following chart to resolve the mismatch(es).

| Mismatch | Action | Reference |
|---|---------------------------------------|---|
| Sensor(s) missing from left column | Enable the missing sensor(s) | Section 4 <i>Sensors</i> |
| Extra sensor(s) listed in left column | Disable the extra sensor(s) | Section 4 <i>Sensors</i> |
| Barometer missing from left column, but present in right column | Enable the Store Barometer setting | Section 9.3 <i>Storing Barometer Readings</i> |
| Barometer present in left column, but missing from right column | Disable the Store Barometer setting | Section 9.3 <i>Storing Barometer Readings</i> |
| Store Site Number missing from left column, but present in right column | Enable the Store Site Number setting | Section 9.4 <i>Creating a Site List</i> |
| Store Site Number present in left column, but missing from right column | Disable the Store Site Number setting | Section 9.4 <i>Creating a Site List</i> |

- 3.** Return to Section *9.6 Logging Data Without a Site List* or *9.7 Logging Data With a Site List*.

10. System Setup

The YSI 556 MPS has a number of features that are user-selectable or can be configured to meet the user's preferences. Most of these choices are found in the **System setup** menu.

10.1 Accessing the System Setup Screen

1. Press the **On/off** key to display the run screen. See Figure 2.1 Front View of YSI 556 MPS.
2. Press the **Escape** key to display the main menu screen.
3. Use the arrow keys to highlight the **System setup** selection.

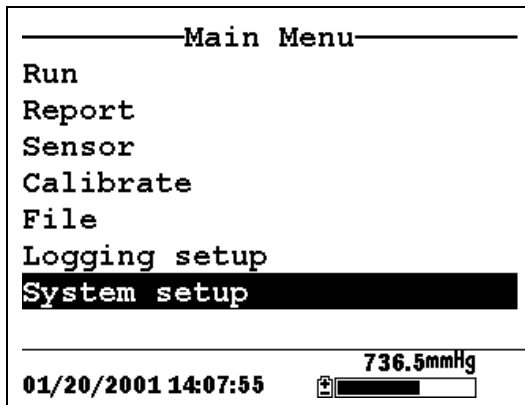


Figure 10.1 Main Menu

4. Press the **Enter** key. The system setup screen is displayed.

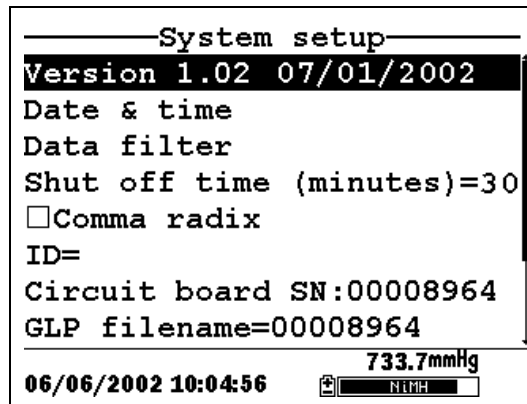


Figure 10.2 System Setup Screen

NOTE: The first line of the **System setup** menu shows the current software version of your YSI 556 MPS. As software enhancements are introduced, you will be able to upgrade your YSI 556 MPS from the YSI Web site. Refer to Section 11.2 *Upgrading YSI 556 MPS Software* for details.

10.2 Date and Time Setup

1. Go to the system setup screen as described in Section 10.1 *Accessing the System Setup Screen*.
2. Use the arrow keys to highlight the **Date & time** selection on the system setup screen. See Figure 10.2 System Setup Screen.
3. Press **Enter**. The date and time setup screen is displayed.

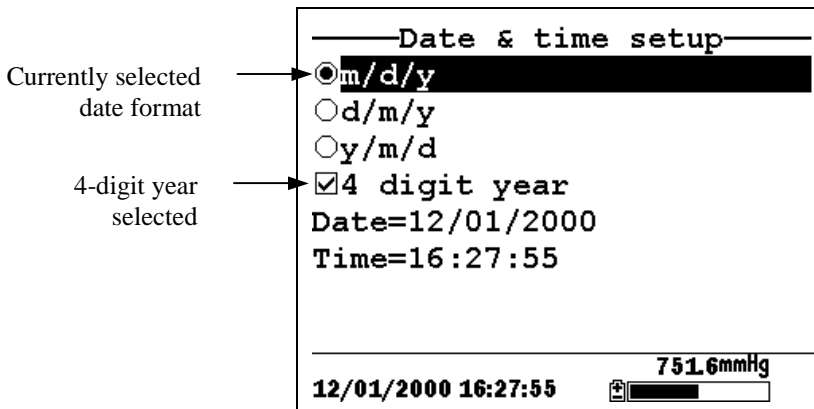


Figure 10.3 Date Setup Screen

NOTE: A black dot to the left of a date format indicates that format is selected.

4. Use the arrow keys to highlight your desired date format.
5. Press **Enter**.
6. Use the arrow keys to highlight the 4-digit year selection.
7. Press **Enter**. A check mark appears in the check box next to the 4-digit year selection.

NOTE: If unchecked, a 2-digit year is used.

8. Use the arrow keys to highlight the **Date** selection.
9. Press **Enter**. A cursor appears over the first number in the date.
10. Enter the proper number from the keypad for the highlighted date digit. The cursor moves automatically to the next date digit. Refer to Section 2.9 *Keypad Use* for more keypad information.
11. Repeat Step 10 until all date digits are correct.

- 12.** Press **Enter** to input the specified date.
- 13.** Use the arrow keys to highlight the **Time** selection.
- 14.** Press **Enter**. A cursor appears over the first number in the time selection.
- 15.** Enter the proper number from the keypad for the highlighted time digit. The cursor moves automatically to the next time digit.

NOTE: Use military format when entering time. For example, 2:00 PM is entered as 14:00.
- 16.** Repeat Step 15 until all time digits are correct.
- 17.** Press **Enter** to input the correct time.
- 18.** Press the **Escape** key repeatedly to return to the Main menu screen.

10.3 Data Filter

The Data Filter is a software filter that eliminates sensor noise and provides more stable readings.

NOTE: YSI recommends using the default values for the data filter for most field applications.

However, users who are primarily interested in a fast response from their dissolved oxygen sensor should consider a change of the default time constant setting of 8 seconds to one of 2 seconds. This change can be made according to the instructions in Section *10.3.1 Changing the Data Filter Settings* below. The disadvantage of lowering the time constant is that field pH readings may appear somewhat noisy if the cable is in motion.

10.3.1 Changing the Data Filter Settings

- 1.** Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.

2. Use the arrow keys to highlight the **Data filter** selection. See Figure 10.1 Main Menu.
3. Press the **Enter** key. The Data filter setup screen is displayed.

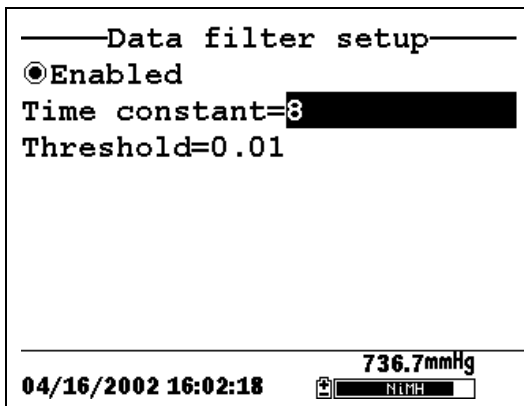


Figure 10.4 Data Filter Screen

4. With Enabled highlighted, press the **Enter** key to Enable or Disable the data filter. A black dot to the left of the selection indicates the data filter is enabled.
5. Use the arrow keys to highlight the **Time constant** field.

NOTE: This value is the time constant in seconds for the software data filter. Increasing the time constant will result in greater filtering of the data, but will also slow down the apparent response of the sensors.
6. Use the keypad to enter a value. The default value is 8 and this value is ideal for most 556 field applications. As described in Section 10.3 *Data Filter* above, users who wish to decrease the response time of the DO readings at the expense of some noise for the pH readings determined concurrently, should change the Time Constant to a value of 2.
7. Press the **Enter** key to enter the time constant.

8. Use the arrow keys to highlight the **Threshold** field.

NOTE: This value determines when the software data filter will engage/disengage, speeding the response to large changes in a reading. When the difference between two consecutive readings is larger than the threshold, then the reading is displayed unfiltered. When the difference between two consecutive readings drops below the threshold, readings will be filtered again.

9. Use the keypad to enter a value. The default value is 0.01.
10. Press the **Enter** key to enter the threshold.
11. Press the **Escape** key repeatedly to return to the Main menu screen.

10.4 Shutoff Time

The YSI 556 MPS shuts off automatically after 30 minutes of inactivity. The shut off time may be changed as described below.

1. Go to the system setup screen as described in Section 10.1 *Accessing the System Setup Screen*.
2. Use the arrow keys to highlight the **Shutoff time** selection on the system setup screen. See Figure 10.2 System Setup Screen.
3. Use the keypad to enter a value from 0 to 60 minutes. The default value is 30.

NOTE: To disable the automatic shutoff feature, enter a zero (0).

4. Press the **Enter** key to enter the correct shutoff time.
5. Press the **Escape** key repeatedly to return to the main menu screen.

10.5 Comma Radix

The user can toggle between a period (default) and comma for the radix mark by selecting this item and pressing the **Enter** key as follows:

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.
2. Use the arrow keys to highlight the **Comma radix** selection on the system setup screen. See Figure 10.2 System Setup Screen.
3. Press the **Enter** key. A check mark appears in the check box next to the comma radix selection indicating that the radix mark is a comma.

10.6 ID

This selection allows you to enter an identification name/number for your YSI 556 MPS. This ID name/number is logged in the header of each file.

1. Go to the system setup screen as described in Section *10.1 Accessing the System Setup Screen*.
2. Use the arrow keys to highlight the **ID** selection. See Figure 10.1 Main Menu.
3. Use the keypad to enter an alphanumeric ID up to 15 characters in length. Refer to Section *2.9 Keypad Use*.
4. Press the **Enter** key to enter the ID.
5. Press the **Escape** key repeatedly to return to the main menu screen.

10.7 GLP Filename

This selection allows you to enter a different filename for the YSI 556 MPS Calibration Record file.

NOTE: The default filename is the “556 PC board Serial Number.glp.”

6. Go to the system setup screen as described in Section 10.1 *Accessing the System Setup Screen*.
7. Use the arrow keys to highlight the **GLP Filename** selection. See Figure 10.1 Main Menu.
8. Use the keypad to enter a filename up to 8 characters in length. Refer to Section 2.9 *Keypad Use*.
9. Press the **Enter** key to enter the new filename.

Press the **Escape** key repeatedly to return to the main menu screen.

10.8 TDS Constant

This selection allows you to set the constant used to calculate Total Dissolved Solids (TDS). TDS in g/L is calculated by multiplying this constant times the specific conductance in mS/cm.

10.8.1 Changing the TDS Constant

1. Go to the system setup screen as described in Section 10.1 *Accessing the System Setup Screen*.
2. Use the arrow keys to highlight the **TDS Constant** selection. See Figure 10.1 Main Menu.
3. Use the keypad to enter a value. Refer to Section 2.9 *Keypad Use*. The default value is 0.65.
4. Press the **Enter** key to enter the correct TDS constant.
5. Press the **Escape** key repeatedly to return to the main menu screen.

10.9 Barometer Units

The following information is only for instruments with the barometer option.

1. Go to the system setup screen as described in Section 10.1 *Accessing the System Setup Screen*.
2. Use the arrow keys to highlight the **Barometer units** selection on the system setup screen. See Figure 10.2 System Setup Screen.
3. Press the **Enter** key. The Barometer units screen will appear.

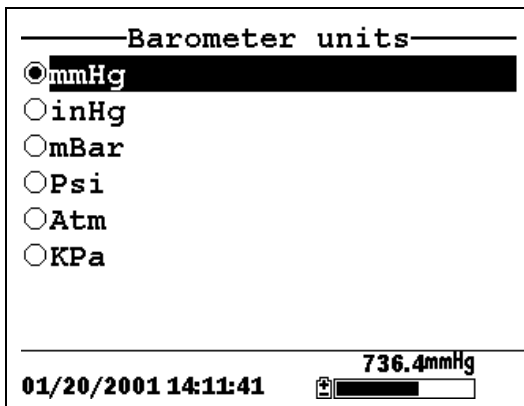


Figure 10.5 Barometer Units Screen

A black dot indicates the currently selected units.

4. Use the arrow keys to highlight your desired barometric unit.
5. Press the **Enter** key to select your choice. A black dot will appear in the circle next to your selected units.
6. Press the **Escape** key repeatedly to return to the main menu screen.

10.10 Calibrate Barometer

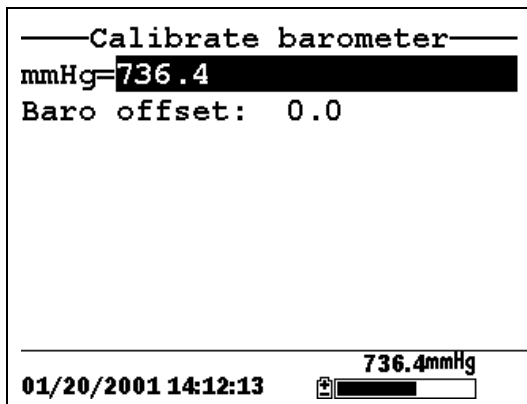
The optional barometer has been factory calibrated to provide accurate readings. However, some sensor drift may occur over time, requiring occasional calibration by the user, as follows:

1. Determine your local barometric pressure from an independent laboratory barometer or from your local weather service.
2. If the barometric pressure (BP) reading is from your local weather station, reverse the equation that corrects it to sea level.

NOTE: For this equation to be accurate, the barometric pressure units must be in mm Hg.

$$\text{True BP} = (\text{Corrected BP}) - [2.5 * (\text{Local Altitude}/100)]$$

3. Go to the system setup screen as described in Section 10.1 *Accessing the System Setup Screen*.
4. Use the arrow keys to highlight the **Calibrate barometer** selection on the system setup screen. See Figure 10.2 System Setup Screen.
5. Press the **Enter** key. The Calibrate Barometer screen is displayed.



- 6.** Use the keypad to input the known barometric pressure value as determined in Step 2.
- 7.** Press the **Enter** key. The new barometer reading is displayed as well as the approximate offset from the factory reading.

NOTE: To return the sensor to the factory setting, subtract the offset amount from the current setting and repeat Steps 5 to 7.

- 8.** Press the **Escape** key repeatedly to return to the main menu screen.

11. Maintenance

11.1 Sensor Care and Maintenance

Once the sensors have been properly installed, remember that periodic cleaning and DO membrane changes are required.

11.1.1 DO Sensor

For best results, we recommend that the KCl solution and the membrane cap be changed at least once every 30 days.

1. It is important to recognize that oxygen dissolved in the sample is consumed during sensor operation. It is therefore essential that the sample be continuously stirred at the sensor tip. If stagnation occurs, your readings will be artificially low. Stirring may be accomplished by mechanically moving the sample around the sensor tip, or by rapidly moving the sensor through the sample. The rate of stirring should be at least 1 foot per second.
2. Membrane life depends on usage. Membranes will last a long time if installed properly and treated with care. Erratic readings are a result of loose, wrinkled, damaged, or fouled membranes, or from large (more than 1/8" diameter) bubbles in the electrolyte reservoir. If erratic readings or evidence of membrane damage occurs, you should replace the membrane and the electrolyte solution. The average replacement interval is two to four weeks.
3. If the membrane is coated with oxygen consuming (e.g. bacteria) or oxygen producing organisms (e.g. algae), erroneous readings may occur.
4. Chlorine, sulfur dioxide, nitric oxide, and nitrous oxide can affect readings by behaving like oxygen at the sensor. If you suspect erroneous readings, it may be necessary to determine if these gases are the cause.
5. Avoid any environment that contains substances that may attack the probe module and sensor materials. Some of these substances are concentrated acids, caustics, and strong

solvents. The sensor materials that come in contact with the sample include FEP Teflon, acrylic plastic, EPR rubber, stainless steel, epoxy, polyetherimide and the PVC cable covering.

6. It is possible for the silver anode, which is the entire silver body of the sensor, to become contaminated. This will prevent successful calibration. To restore the anode, refer to Section *11.1.1 DO Sensor, Silver Anode Cleaning*.
7. For correct sensor operation, the gold cathode must always be bright. If it is tarnished (which can result from contact with certain gases), or plated with silver (which can result from extended use with a loose or wrinkled membrane), the gold surface must be restored. To restore the cathode, refer to Section *11.1.1 DO Sensor, Gold Cathode Cleaning*.
8. To keep the electrolyte from drying out, store the sensor in the transport/calibration cup with at least 1/8" of water.

Silver Anode Cleaning

After extended use, a thick layer of AgCl builds up on the silver anode reducing the sensitivity of the sensor. The anode must be cleaned to remove this layer and restore proper performance. The cleaning can be chemical or mechanical:

Chemical Cleaning: Remove the membrane cap and soak the entire anode section in a 14% ammonium hydroxide solution for 2 to 3 minutes, followed by a thorough rinsing with distilled or deionized water. The anode should then be thoroughly wiped with a wet paper towel to remove the residual layer from the anode.

Mechanical Cleaning: Sand off the dark layer from the silver anode with 400 grit wet/dry sandpaper. Wrap the sandpaper around the anode and twist the sensor. Rinse the anode with clean water after sanding, followed by wiping thoroughly with a wet paper towel.

NOTE: After cleaning, a new membrane cap must be installed. Refer to Section *3.4.3 Membrane Cap Installation*.

Turn the instrument on and allow the system to stabilize for at least 30 minutes. If, after several hours, you are still unable to calibrate, contact your dealer or YSI Customer Service. Refer to *Appendix E Customer Service*.

Gold Cathode Cleaning

For correct sensor operation, the gold cathode must be textured properly. It can become tarnished or plated with silver after extended use. The gold cathode can be cleaned by using the adhesive backed sanding disc and tool provided in the YSI 5238 Probe Reconditioning Kit.

Using the sanding paper provided in the YSI 5238 Probe Reconditioning Kit, wet sand the gold with a twisting motion about 3 times or until all silver deposits are removed and the gold appears to have a matte finish. Rinse the cathode with clean water after sanding, followed by wiping thoroughly with a wet paper towel. If the cathode remains tarnished, contact your dealer or YSI Customer Service. Refer to *Appendix E Customer Service*.

NOTE: After cleaning, a new membrane cap must be installed. Refer to Section 3.4.3 *Membrane Cap Installation*.

11.1.2 DO Sensor Replacement

1. Remove the probe sensor guard.



CAUTION: Thoroughly dry the sensor so that no water enters the probe module sensor port when the sensor is removed.

2. Insert the long end of the hex key wrench into the small hole in the side of the probe module bulkhead. Turn the wrench counterclockwise and remove the screw. (You do not have to remove the screw all the way to release the sensor.)
3. Pull the old DO sensor module straight out of the probe module body.

NOTE: The DO sensor is not threaded, it is keyed, so it cannot be removed by twisting.

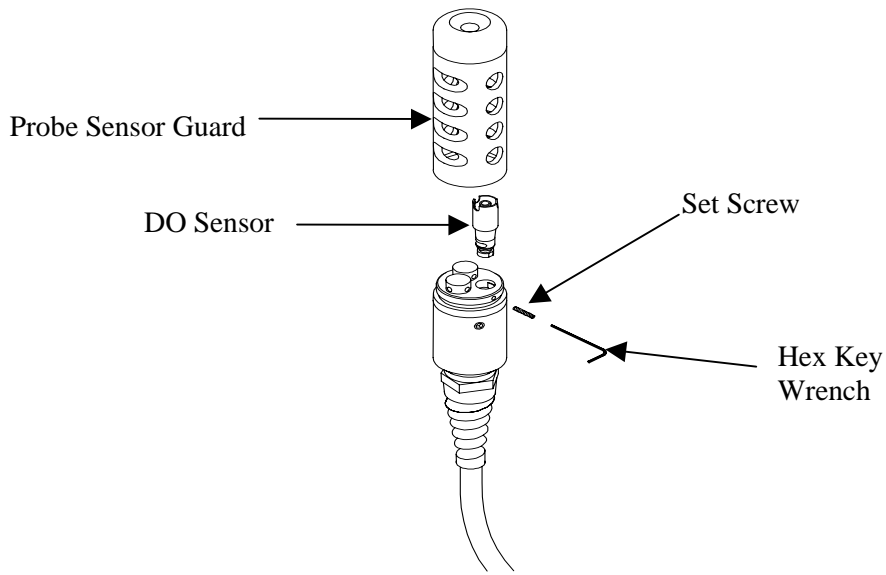


Figure 11.1 DO Sensor Replacement

4. Insert the new DO sensor module. Make sure that the inside of the probe module sensor port and the o-ring on the sensor are clean, with no contaminants, such as grease, dirt, or hair. The DO sensor is keyed, or has a flat side, so that it cannot be aligned improperly.

NOTE: Make sure the DO sensor bottoms out before the set screw is inserted.

5. Insert the set screw into the small hole in the side of the probe module bulkhead, and turn clockwise to rethread.

⚠ CAUTION: Make sure that you do not cross-thread the set screw. Use the hex key wrench to tighten the screw in properly, making sure that the screw does not stick out of the side of the probe module bulkhead. The probe sensor guard will not thread


on properly and damage may result if the screw is allowed to stick out.

NOTE: The YSI 5563 DO sensor is shipped dry. A shipping membrane was installed to protect the electrode. A new membrane cap must be installed before the first use. Refer to Section 3.4.1 *Sensor Installation*.

11.1.3 YSI 5564 pH and 5565 Combination pH/ORP Sensor Cleaning

Cleaning is required whenever deposits or contaminants appear on the glass and/or platinum surfaces of these sensors or when the response of the sensor becomes slow.

1. Remove the sensor from the probe module.
2. Initially, simply use clean water and a soft clean cloth, lens cleaning tissue, or cotton swab to remove all foreign material from the glass bulb (YSI 5564 and YSI 5565) and platinum button (YSI 5565). Then use a moistened cotton swab to carefully remove any material that may be blocking the reference electrode junction of the sensor.

 **CAUTION:** When using a cotton swab with the YSI 5564 or YSI 5565, be careful NOT to wedge the swab tip between the guard and the glass sensor. If necessary, remove cotton from the swab tip, so that the cotton can reach all parts of the sensor tip without stress.

NOTE: If good pH and/or ORP response is not restored by the above procedure, perform the following additional procedure:

1. Soak the sensor for 10-15 minutes in clean water containing a few drops of commercial dishwashing liquid.
2. GENTLY clean the glass bulb and platinum button by rubbing with a cotton swab soaked in the cleaning solution.
3. Rinse the sensor in clean water, wipe with a cotton swab saturated with clean water, and then re-rinse with clean water.

NOTE: If good pH and/or ORP response is still not restored by the above procedure, perform the following additional procedure:

1. Soak the sensor for 30-60 minutes in one molar (1 M) hydrochloric acid (HCl). This reagent can be purchased from most distributors. Be sure to follow the safety instructions included with the acid.
2. GENTLY clean the glass bulb and platinum button by rubbing with a cotton swab soaked in the acid.
3. Rinse the sensor in clean water, wipe with a cotton swab saturated with clean water, and then re-rinse with clean water. To be certain that all traces of the acid are removed from the sensor crevices, soak the sensor in clean water for about an hour with occasional stirring.

NOTE: If biological contamination of the reference junction is suspected or if good response is not restored by the above procedures, perform the following additional cleaning step:

1. Soak the sensor for approximately 1 hour in a 1 to 1 dilution of commercially available chlorine bleach.
2. Rinse the sensor with clean water and then soak for at least 1 hour in clean water with occasional stirring to remove residual bleach from the junction. (If possible, soak the sensor for period of time longer than 1 hour in order to be certain that all traces of chlorine bleach are removed.) Then re-rinse the sensor with clean water and retest.

11.1.4 Temperature/Conductivity Sensor Cleaning

The single most important requirement for accurate and reproducible results in conductivity measurement is a clean cell. A dirty cell will change the conductivity of a solution by contaminating it. The small cleaning brush included in the YSI 5511 Maintenance Kit is ideal for this purpose.

To clean the conductivity cell:

1. Dip the brush in clean water and insert it into each hole 15-20 times.
2. Rinse the cell thoroughly in deionized or clean tap water.

NOTE: In the event that deposits have formed on the electrodes, perform the following additional procedure:

1. Use a mild detergent solution in combination with the brush. Dip the brush in the solution and insert it into each hole 15-20 times.
2. Rinse the cell thoroughly in deionized or clean tap water.

NOTE: After cleaning, check the response and accuracy of the conductivity cell with a calibration standard.

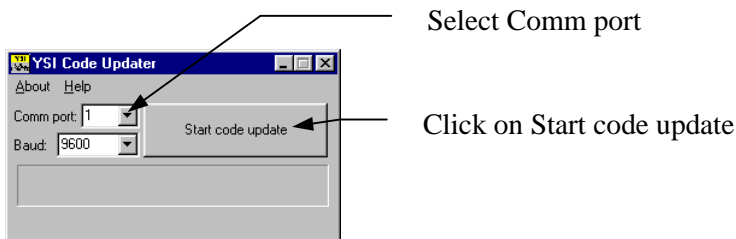
NOTE: If this procedure is unsuccessful, or if sensor performance is impaired, it may be necessary to return the sensor to a YSI authorized service center for service. Refer to *Appendix E Customer Service*.

The temperature portion of the sensor requires no maintenance.

11.2 Upgrading YSI 556 MPS Software

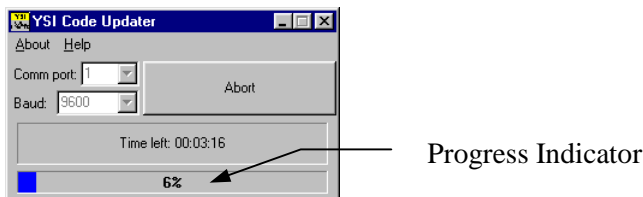
1. Access the YSI Environmental Software Downloads page as described in *Appendix G EcoWatch* Step 1 through 3.
2. Click on the **YSI Instruments Software Updates** link (or scroll down until you see YSI 556 MPS).
3. Click on the file icon to the right of the **YSI 556 MPS** listing and save the file to a temporary directory on your computer.
4. After the download is complete, run the file (that you just downloaded) and follow the on screen instructions to install the YSI Code Updater on your computer. If you encounter difficulties, contact YSI customer service for advice. Refer to *Appendix E Customer Service*.

5. If necessary, disconnect the YSI 5563 Probe Module from the YSI 556 MPS instrument.
6. Connect the YSI 556 MPS to a serial port of your computer via the 655173 PC interface cable. See Figure 8.6 Computer/Instrument Interface.
7. Press the **On/off** key on the YSI 556 MPS to display the run screen.
8. Run the YSI Code Updater software that you just installed on your computer. The following window will be displayed:

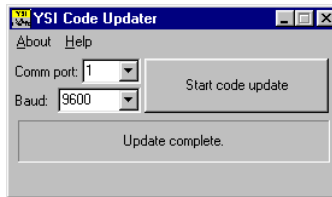


9. Set the Comm port number to match the port that you connected the 655173 PC Interface Cable to, then click on the **Start Code Update** button.

The YSI 556 MPS screen will blank out and a progress indicator will be displayed on the PC.



When the update is finished (indicated on the PC screen), the YSI 556 MPS will return to the Run screen. See Figure 7.1 Run Screen.



- 10.** Close the YSI Code Updater window (on the PC) by clicking on the "X" in the upper right corner of the window.

- 11.** Disconnect the YSI 556 MPS from the 655173 PC interface cable and reconnect it to the YSI 5563 Probe Module. Refer to Section 3.6 *Instrument/Cable Connection*.

12. Storage

Proper storage between periods of usage will not only extend the life of the sensors, but will also ensure that the unit will be ready to use as quickly as possible in your next application.

12.1 General Recommendations for Short Term Storage

No matter what sensors are installed in the instrument, it is important to keep them moist without actually immersing them in liquid. Immersing them could cause some of them to drift or result in a shorter lifetime.

YSI recommends that short term storage of all multi-parameter instruments be done by placing approximately 1/2 inch of tap water in the transport/calibration cup that was supplied with the instrument, and by placing the probe module with all of the sensors installed into the cup. The use of a moist sponge instead of a 1/2 inch of tap water is also acceptable, as long as its presence does not compromise the attachment of the cup to the probe module. The transport/calibration cup should be sealed to prevent evaporation.

NOTE: Ensure that an o-ring is installed in the o-ring groove on the threaded end of the probe module body. See Figure 3.7 Transport/Calibration Cup Installation.



CAUTION: The water level has to be low enough so that none of the sensors are actually under water. Check the transport/calibration cup periodically to make certain that the water is still present or the sponge is still moist.

NOTE: If the storage water (tap water) is accidentally lost during field use, environmental water can be used.


12.2 General Recommendations for Long Term Storage

12.2.1 Probe Module Storage

1. Remove the pH or pH/ORP sensor from the probe module and store according to the individual sensor storage instructions found in Section 12.2.2 *Sensor Storage*.
2. Seal the empty port with the provided port plug.

NOTE: Leave the conductivity/temperature sensor and dissolved oxygen sensor, with membrane cap still on, in the probe module.

3. Place 1/2" of water, deionized, distilled or tap, in the transport/calibration cup.

 **CAUTION:** The water level has to be low enough so that none of the sensors are actually under water. Check the transport/calibration cup periodically to make certain that the water is still present or the sponge is still moist.

4. Insert the probe module into the cup.

NOTE: Ensure that an o-ring is installed in the o-ring groove on the threaded end of the probe module body. See Figure 3.7 Transport/Calibration Cup Installation.

12.2.2 Sensor Storage

Temperature/Conductivity Sensor

No special precautions are required. Sensor can be stored dry or wet, as long as solutions in contact with the thermistor and conductivity electrodes are not corrosive (for example, chlorine bleach). However, it is recommended that the sensor be cleaned with the provided brush prior to long term storage. Refer to Section 11.1.4 *Temperature/Conductivity Sensor Cleaning*.

pH and Combination pH/ORP Sensor

The key to sensor storage is to make certain that the reference electrode junction does not dry out. Junctions which have been allowed to dry out due to improper storage procedures can usually be rehydrated by soaking the sensor for several hours (overnight is recommended) in a solution which is 2 molar in potassium chloride. If potassium chloride solution is not available, soaking the sensor in tap water or commercial pH buffers may restore sensor function. However in some cases the sensor may have been irreparably damaged by the dehydration and will require replacement.



CAUTION: Do not store the sensor in distilled or deionized water as the glass sensor may be damaged by exposure to this medium.

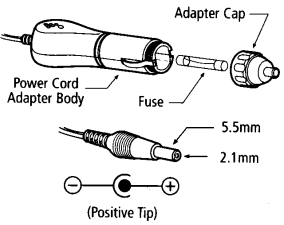
1. Remove the pH or pH/ORP sensor from the probe module.
2. Seal the empty port with the provided port plug.
3. Place the sensor in the storage vessel (plastic boot or bottle) which was on the sensor at delivery. The vessel should contain a solution which is 2 molar in potassium chloride.

NOTE: Make certain that the vessel is sealed to prevent evaporation of the storage solution.

13. Troubleshooting

The following sections describe problems you may encounter when using the YSI 556 MPS and provides suggestions to overcome the symptom.

| PROBLEM | POSSIBLE SOLUTION |
|--|---|
| Display Problems | |
| No display is visible after pressing the on/off key. | If C cells are used, make certain that they are installed properly with regard to polarity and that good batteries are used. If a rechargeable battery pack is used, place the pack in the instrument and charge for 30 minutes. |
| Instrument software appears to be locked up as evidenced by no response to keypad entries or display not changing. | First, attempt to reset the instrument by simply turning off and then on again. If this fails, remove battery power from the instrument for 30 seconds and then reapply power. When using C cells, remove the battery lid and one of the batteries; when using the rechargeable battery pack, remove the pack completely from the instrument. After 30 seconds replace the battery or battery pack and check for instrument function. |
| The 556 display flashes and the instrument speaker makes a continuous clicking sound. | The battery voltage is low. Change to new C cells or recharge the 6117 battery pack. |
| Water Damage to Instrument | |
| Leakage detected in battery compartment when using C cells | Dispose of batteries properly. Dry the battery compartment using compressed air if possible. If corrosion is present on battery terminals, contact YSI Customer Service. |
| Water has contacted rechargeable battery pack | Remove battery pack immediately. Send battery pack to YSI Product Service for evaluation. CAUTION: DO NOT REUSE BATTERY PACK UNTIL YSI PRODUCT SERVICE HAS EVALUATED IT. |
| Leakage suspected into the main cavity of the instrument case | Remove the batteries immediately. Return the instrument to YSI Product Service. |

| PROBLEM | POSSIBLE SOLUTION |
|---|---|
| Optional Cigarette Lighter Charger | |
| <p>Power cord fuse blown</p>  <p>Adapter Cap Power Cord Adapter Body Fuse 5.5mm 2.1mm (Positive Tip)</p> | <ol style="list-style-type: none"> 1. Unscrew adapter’s cap, remove tip and pull out fuse. 2. Replace fuse with a new 2-amp fast-blow fuse from an electronics store such as Radio Shack. 3. Reassemble the adapter and securely screw the cap back onto the adapter body. |
| File Problems | |
| <p>Upload of files from YSI 556 MPS to PC fails</p> | <ol style="list-style-type: none"> 1. Make sure that cable is connected properly to both 556 and PC. 2. Make certain that the proper Comm port is selected in EcoWatch for Windows. |
| <p>Barometer data is not stored with sensor data file.</p> | <p>Make sure Store barometer is active in the 556 Logging setup menu.</p> |
| <p>Site Descriptions in the Site List are “grayed-out” and not available for appending files with additional data.</p> | <p>There is a parameter mismatch between the current 556 setup and that initially used. Change the current logging and sensor setup to match the setup that was initially used to create the file.</p> |
| Sensor Problems | |
| <p>Dissolved Oxygen reading unstable or inaccurate. Out of Range message appears during calibration.</p> | <p>Sensor not properly calibrated. Follow DO cal procedures.</p> |
| | <p>Membrane not properly installed or may be punctured. Replace membrane cap.</p> |
| | <p>DO sensor electrodes require cleaning. Follow DO cleaning procedure. Use 5511 Maintenance kit.</p> |
| | <p>Water in sensor connector. Dry connector; reinstall sensor.</p> |
| | <p>Algae or other contaminant clinging to DO sensor. Rinse DO sensor with clean water.</p> |
| | <p>Barometric pressure entry is incorrect. Repeat DO cal procedure.</p> |
| | <p>Calibrated at extreme temperature. Recalibrate at (or near) sample temperature.</p> |
| | <p>DO sensor has been damaged. Replace sensor. Internal failure. Return probe module for service.</p> |

| PROBLEM | POSSIBLE SOLUTION |
|---|--|
| Sensor Problems | |
| pH or ORP readings are unstable or inaccurate. Out of Range message appears during calibration. | Sensor requires cleaning. Follow sensor cleaning procedure. |
| | Sensor requires calibration. Follow cal procedures. |
| | pH sensor reference junction has dried out from improper storage. Soak sensor in tap water or buffer until readings become stable. |
| | Water in sensor connector. Dry connector; reinstall sensor. |
| | Sensor has been damaged. Replace sensor. |
| | Calibration solutions out of spec or contaminated with other solution. Use new calibration solutions. |
| | ORP fails Zobell check. Take into account temperature dependence of Zobell solution readings. |
| | Internal failure. Return probe module for service. |
| Conductivity unstable or inaccurate. Out of Range message appears during calibration. | Conductivity improperly calibrated. Follow calibration procedure. |
| | Conductivity sensor requires cleaning. Follow cleaning procedure. |
| | Conductivity sensor damaged. Replace sensor. |
| | Calibration solution out of spec or contaminated. Use new calibration solution. |
| | Internal failure. Return probe module for service. |
| | Calibration solution or sample does not cover entire sensor. Immerse sensor fully. |
| Temperature, unstable or inaccurate | Water in connector. Dry connector; reinstall sensor. |
| | Sensor has been damaged. Replace the 5560 sensor. |
| Installed sensor has no reading | The sensor has been disabled. Enable sensor. |
| | Water in sensor connector. Dry connector; reinstall sensor. |
| | Sensor has been damaged. Replace the sensor. |
| | Report output improperly set up. Set up report output. |
| | Internal failure. Return probe module for service. |

If these guidelines and tips fail to correct your problem or if any other symptoms occur, contact YSI Customer Service for Advice. Refer to *Appendix E Customer Service*.

14. Appendix A YSI 556 MPS Specifications

14.1 Sensor Specifications

| Dissolved Oxygen | |
|--|--|
| Sensor Type | Steady state polarographic |
| Range: % air sat'n mg/L | <ul style="list-style-type: none"> ▪ 0 to 500% air saturation ▪ 0 to 50 mg/L |
| Accuracy: % air sat'n mg/L | <ul style="list-style-type: none"> ▪ 0 to 200% air saturation: ±2% of the reading or 2% air saturation; whichever is greater ▪ 200 to 500% air saturation: ±6% of the reading ▪ 0 to 20 mg/L: ±2% of the reading or 0.2 mg/L; whichever is greater ▪ 20 to 50 mg/L: ±6% of the reading |
| Resolution: % air sat'n mg/L | <ul style="list-style-type: none"> ▪ 0.1% air saturation ▪ 0.01 mg/L |
| Temperature | |
| Sensor Type: | YSI Precision™ thermistor |
| Range: | -5 to 45°C |
| Accuracy: | ±0.15°C |
| Resolution: | 0.01°C |
| Conductivity | |
| Sensor Type: | 4-electrode cell with auto-ranging |
| Range: | 0 to 200 mS/cm |
| Accuracy: | ±0.5% of reading or ±0.001 mS/cm; whichever is greater—4 meter cable ±1.0% of reading or ±0.001 mS/cm; whichever is greater—20 meter cable |
| Resolution: | 0.001 mS/cm to 0.1 mS/cm (range-dependent) |
| Salinity | |
| Sensor Type: | Calculated from conductivity and temperature |
| Range: | 0 to 70 ppt |
| Accuracy: | ±1.0% of reading or 0.1 ppt; whichever is greater |
| Resolution: | 0.01 ppt |

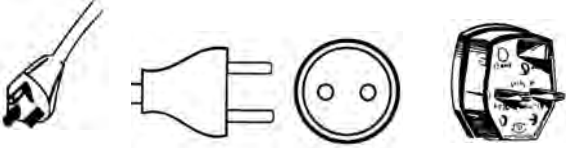
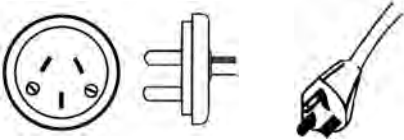
| | |
|------------------------------|-----------------------------|
| <i>pH (optional)</i> | |
| Sensor Type: | Glass combination electrode |
| Range: | 0 to 14 units |
| Accuracy: | ±0.2 units |
| Resolution: | 0.01 units |
| <i>ORP (optional)</i> | |
| ORP Sensor Type: | Platinum button |
| Range: | -999 to +999 mV |
| Accuracy: | ±20 mV |
| Resolution: | 0.1 mV |

| | |
|------------------------------------|--|
| <i>Barometer (optional)</i> | |
| Range: | 500 to 800 mm Hg |
| Accuracy: | ±3 mm Hg within ±15°C temperature range from calibration point |
| Resolution: | 0.1 mm Hg |

14.2 Instrument Specifications

| | |
|-------------------------------|---|
| Memory Size: | 1.5 MB Flash Memory 49,000 data sets (@ 6 parameters per set plus time stamp) 100 Sites |
| Size: | 11.9 cm width x 22.9 cm length (4.7 in. x 9 in.) |
| Weight with batteries: | 0.92 kg (2.1 lbs) |
| Power: | 4 alkaline C-cells; optional rechargeable pack |
| Cables: | 4, 10, and 20 m (13.1, 32.8, 65.6 ft.) lengths |
| Warranty: | 3-Years for the instrument; 1-Year for the probe modules and cable |

15. Appendix B Instrument Accessories

| ITEM # | ACCESSORY |
|---------|--|
| 5563-4 | 4m Cable with DO/temp/conductivity |
| 5563-10 | 10m Cable with DO/temp/conductivity |
| 5563-20 | 20m Cable with DO/temp/conductivity |
| 5564 | pH Kit |
| 5565 | pH/ORP Kit |
| 6118 | Rechargeable Battery Pack Kit for use in US |
| 5094 | Rechargeable Battery Pack Kit with universal charger and three adapter cables for use in international applications  |
| 5095 | Rechargeable Battery Pack Kit with universal charger and two adapter cables for use in international applications  |
| 5083 | Flow Cell – probe module is secured in the flow cell and groundwater is pumped through it |
| 616 | Charger, Cigarette Lighter – used to power up the instrument from a car's cigarette lighter |
| 4654 | Tripod |
| 614 | Ultra Clamp, C Clamp –used to clamp the instrument to a table top or car dashboard |
| 6081 | Large Carrying Case, Hard-sided |
| 5085 | Hands-free Harness |
| 5065 | Carrying Case, Form-fitted, for use in the field – has a clear vinyl window, shoulder strap, belt loop strap and hand strap |

16. Appendix C Required Federal Communications Notice

The Federal Communications Commission defines this product as a computing device and requires the following notice.

This equipment generates and uses radio frequency energy and if not installed and used properly, may cause interference to radio and television reception. It has been type tested and found to comply with the limits for a Class A or Class B computing device in accordance with the specification in Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient the receiving antenna
- Relocate the computer with respect to the receiver
- Move the computer away from the receiver
- Plug the computer into a different outlet so that the computer and receiver are on different branch circuits.

If necessary, the user should consult the dealer or an experienced radio/television technician for additional suggestions. The user may find the following booklet, prepared by the Federal Communications Commission, helpful: "How to Identify and Resolve Radio-TV Interference Problems". This booklet is available from the U.S. Government Printing Office, Washington, D.C. 20402, Stock No.0004-000-00345-4.

17. Appendix D Health and Safety

YSI Conductivity solutions: 3161, 3163, 3165, 3167, 3168, 3169

INGREDIENTS:

- Iodine
- Potassium Chloride
- Water

WARNING: INHALATION MAY BE FATAL.

 **CAUTION: AVOID INHALATION, SKIN CONTACT, EYE CONTACT OR INGESTION. MAY EVOLVE TOXIC FUMES IN FIRE.**

Harmful if ingested or inhaled. Skin or eye contact may cause irritation. Has a corrosive effect on the gastro-intestinal tract, causing abdominal pain, vomiting, and diarrhea. Hyper-sensitivity may cause conjunctivitis, bronchitis, skin rashes etc. Evidence of reproductive effects.

FIRST AID:

INHALATION: Remove victim from exposure area. Keep victim warm and at rest. In severe cases seek medical attention.

SKIN CONTACT: Remove contaminated clothing immediately. Wash affected area thoroughly with large amounts of water. In severe cases seek medical attention.

EYE CONTACT: Wash eyes immediately with large amounts of water, (approx. 10 minutes). Seek medical attention immediately.

INGESTION: Wash out mouth thoroughly with large amounts of water and give plenty of water to drink. Seek medical attention immediately.

YSI pH 4.00, 7.00, and 10.00 Buffer Solutions: 3821, 3822, 3823**pH 4 INGREDIENTS:**

- Potassium Hydrogen Phthalate
- Formaldehyde
- Water

pH 7 INGREDIENTS:

- Sodium Phosphate, Dibasic
- Potassium Phosphate, Monobasic
- Water

pH 10 INGREDIENTS:

- Potassium Borate, Tetra
- Potassium Carbonate
- Potassium Hydroxide
- Sodium (di) Ethylenediamine Tetraacetate
- Water



CAUTION - AVOID INHALATION, SKIN CONTACT, EYE CONTACT OR INGESTION. MAY AFFECT MUCOUS MEMBRANES.

Inhalation may cause severe irritation and be harmful. Skin contact may cause irritation; prolonged or repeated exposure may cause Dermatitis. Eye contact may cause irritation or conjunctivitis. Ingestion may cause nausea, vomiting and diarrhea.

FIRST AID:

INHALATION - Remove victim from exposure area to fresh air immediately. If breathing has stopped, give artificial respiration. Keep victim warm and at rest. Seek medical attention immediately.

SKIN CONTACT - Remove contaminated clothing immediately. Wash affected area with soap or mild detergent and large amounts of water (approx. 15-20 minutes). Seek medical attention immediately.

EYE CONTACT - Wash eyes immediately with large amounts of water (approx. 15-20 minutes), occasionally lifting upper and lower lids. Seek medical attention immediately.

INGESTION - If victim is conscious, immediately give 2 to 4 glasses of water and induce vomiting by touching finger to back of throat. Seek medical attention immediately.

YSI Zobell Solution: 3682**INGREDIENTS:**

- Potassium Chloride
- Potassium Ferrocyanide Trihydrate
- Potassium Ferricyanide



CAUTION - AVOID INHALATION, SKIN CONTACT, EYE CONTACT OR INGESTION. MAY AFFECT MUCOUS MEMBRANES.

May be harmful by inhalation, ingestion, or skin absorption. Causes eye and skin irritation. Material is irritating to mucous membranes and upper respiratory tract. The chemical, physical, and toxicological properties have not been thoroughly investigated.

Ingestion of large quantities can cause weakness, gastrointestinal irritation and circulatory disturbances.

FIRST AID:

INHALATION - Remove victim from exposure area to fresh air immediately. If breathing has stopped, give artificial respiration. Keep victim warm and at rest. Seek medical attention immediately.

SKIN CONTACT - Remove contaminated clothing immediately. Wash affected area with soap or mild detergent and large amounts of water (approx. 15-20 minutes). Seek medical attention immediately.

EYE CONTACT - Wash eyes immediately with large amounts of water (approx. 15-20 minutes), occasionally lifting upper and lower lids. Seek medical attention immediately.

INGESTION - If victim is conscious, immediately give 2 to 4 glasses of water and induce vomiting by touching finger to back of throat. Seek medical attention immediately.

18. Appendix E Customer Service

For information on Authorized Service Centers, refer to *Authorized Service Centers* in this appendix.

Equipment exposed to biological, radioactive, or toxic materials must be cleaned and disinfected before being returned or presented for service. A cleaning certificate must accompany the equipment. Refer to *18.2 Cleaning Instructions* in this appendix.

18.1 YSI Environmental Authorized Service Centers

For information on the nearest authorized service center, please contact:

YSI Technical Support • 1725 Brannum Lane
Yellow Springs, Ohio • 45387 • Phone: +1 (937) 767-7241
Phone: 800-897-4151 (US) • Email: environmental@ysi.com

or visit our website for the most current information:

www.ysi.com

18.2 Cleaning Instructions

Equipment exposed to biological, radioactive, or toxic materials must be cleaned and disinfected before being serviced.

Biological contamination is presumed for any instrument, probe, or other device that has been used with body fluids or tissues, or with wastewater. Radioactive contamination is presumed for any instrument, probe or other device that has been used near any radioactive source.

If an instrument, probe, or other part is returned or presented for service without a Cleaning Certificate, and if in our opinion it represents a potential biological or radioactive hazard, our service personnel reserve the right to withhold service until appropriate cleaning, decontamination, and certification has been completed. We will contact the sender for instructions as to the disposition of the equipment. Disposition costs will be the responsibility of the sender.

When service is required, either at the user's facility or at a YSI Service Center, the following steps must be taken to ensure the safety of service personnel.

- In a manner appropriate to each device, decontaminate all exposed surfaces, including any containers. 70% isopropyl alcohol or a solution of 1/4-cup bleach to 1-gallon tap water is suitable for most disinfecting. Instruments used with wastewater may be disinfected with .5% Lysol if this is more convenient to the user.
- The user shall take normal precautions to prevent radioactive contamination and must use appropriate decontamination procedures should exposure occur.
- If exposure has occurred, the customer must certify that decontamination has been accomplished and that no radioactivity is detectable by survey equipment.
- Any product being returned to the YSI Repair Center should be packed securely to prevent damage.
- Cleaning must be completed and certified on any product before returning it to YSI.

18.3 Packing Procedure

- Clean and decontaminate items to ensure the safety of the handler.
- Complete and include the Cleaning Certificate.
- Place the product in a plastic bag to keep out dirt and packing material.
- Use a large carton, preferably the original, and surround the product completely with packing material.
- Insure for the replacement value of the product.

18.4 Cleaning Certificate

| |
|---|
| Organization _____ |
| Department _____ |
| Address _____ |
| City _____ State __ Zip _____ |
| Country _____ Phone _____ |
| Model No. of Device __ Lot Number _____ |
| Contaminant (if known) _____ |
| Cleaning Agent(s) used _____ |
| Radioactive Decontamination Certified? (Answer only if there has been radioactive exposure) _____ Yes _____ No |
| Cleaning Certified By _____ |
| Name Date |

18.5 Warranty

The instrument is warranted for three years against defects in workmanship and materials when used for its intended purposes and maintained according to instructions. The probe module and cables are warranted for one year. The dissolved oxygen, temperature/conductivity, pH, and pH/ORP combination sensors are warranted for one year. Damage due to accidents, misuse, tampering, or failure to perform prescribed maintenance is not covered. The warranty period for chemicals and reagents is determined by the expiration date printed on their labels. Within the warranty period, YSI will repair or replace, at its sole discretion, free of charge, any product that YSI determines to be covered by this warranty.

To exercise this warranty, write or call your local YSI representative, or contact YSI Customer Service in Yellow Springs, Ohio. Send the product and proof of purchase, transportation prepaid, to the Authorized Service Center selected by YSI. Repair or replacement will be made and the product returned transportation prepaid. Repaired or replaced products are warranted for the balance of the original warranty period, or at least 90 days from date of repair or replacement.

Limitation of Warranty

This Warranty does not apply to any YSI product damage or failure caused by (i) failure to install, operate or use the product in accordance with YSI's written instructions, (ii) abuse or misuse of the product, (iii) failure to maintain the product in accordance with YSI's written instructions or standard industry procedure, (iv) any improper repairs to the product, (v) use by you of defective or improper components or parts in servicing or repairing the product, or (vi) modification of the product in any way not expressly authorized by YSI.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. YSI'S LIABILITY UNDER THIS WARRANTY IS LIMITED TO REPAIR OR REPLACEMENT OF THE PRODUCT, AND THIS SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY. IN NO EVENT SHALL YSI BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES RESULTING FROM ANY DEFECTIVE PRODUCT COVERED BY THIS WARRANTY.

19. Appendix F Ferrite Bead Installation

⚠ WARNING: If you are using your YSI 556 in a European Community (CE) country or in Australia or New Zealand, you must attach a ferrite bead to the 655173 PC Interface Cable and the YSI 6117 Charger Adapter Cable in order to comply with the Residential, Commercial and Light Industrial Class B Limits for radio-frequency emissions specified in EN55011 (CISPR11) for Industrial, Scientific and Medical laboratory equipment. These ferrite assemblies are supplied as part of cable kits.

1. Make a small loop (approximately 5 cm in diameter) in the cable near the YSI 556 MS-19 connector.
2. Lay the open ferrite bead assembly under the loop with the cable cross-over position within the cylinder of the ferrite bead.

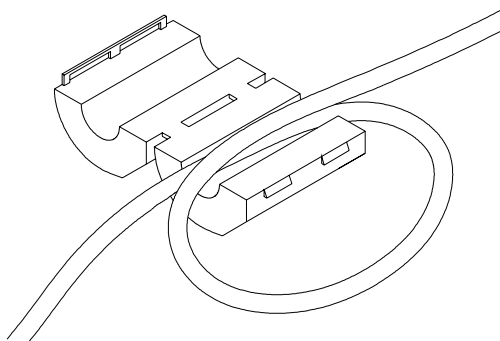


Figure 19.1 Ferrite Bead Installation

3. Snap the two pieces of the bead together making certain that the tabs lock securely.
4. When the installation is complete, the 655173 and YSI 6117 cables should resemble the following drawings.

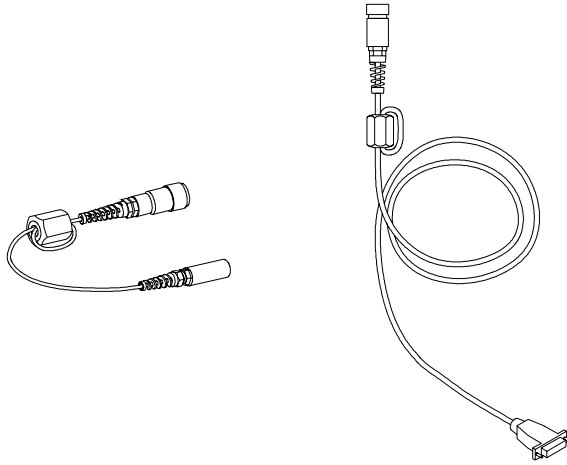


Figure 19.2 Cables with Ferrite Beads

20. Appendix G EcoWatch

EcoWatch™ for Windows™ must be used as the PC software interface to the YSI 556 MPS. EcoWatch is a powerful tool that can also be used with YSI 6-series sondes. Many features of the software will only be utilized by advanced users or are not relevant to the 556 MPS at all. This section is designed in tutorial format to familiarize you with the commonly used features of EcoWatch so that it will be possible to:

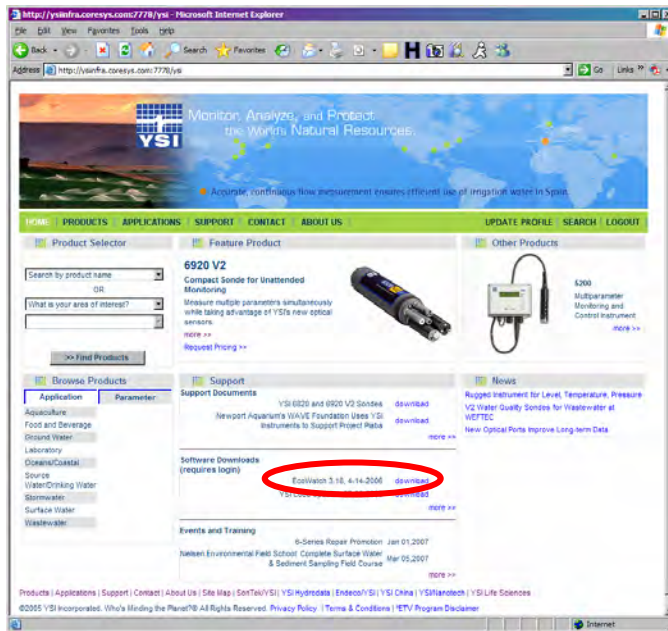
- Upload data from a 556 MPS to a PC
- Assemble plots and reports of your data
- Zoom in on certain segments of the plots of your data to facilitate analysis
- Show statistical data for your studies
- Export data in spreadsheet-compatible formats
- Print plots and reports

The advanced features of EcoWatch can be explored by downloading a 6-series manual from the YSI Web Site (www.y.si.com), purchasing a hard copy of the manual through YSI Customer Service (Item # 069300), or utilizing the on-line help feature of the software.

20.1 Installing EcoWatch for Windows

EcoWatch for Windows is available at no cost via a download from the YSI Web Site.

1. Access the YSI Web Site at www.y.si.com.
2. Click on the **Login** link and login (or register if you have not previously registered).



3. Click on the EcoWatch link and save the file to a directory on your computer.

4. After the download is complete, run the EcoWatch file (that you just downloaded) and follow the on screen instructions to install the software on your computer.

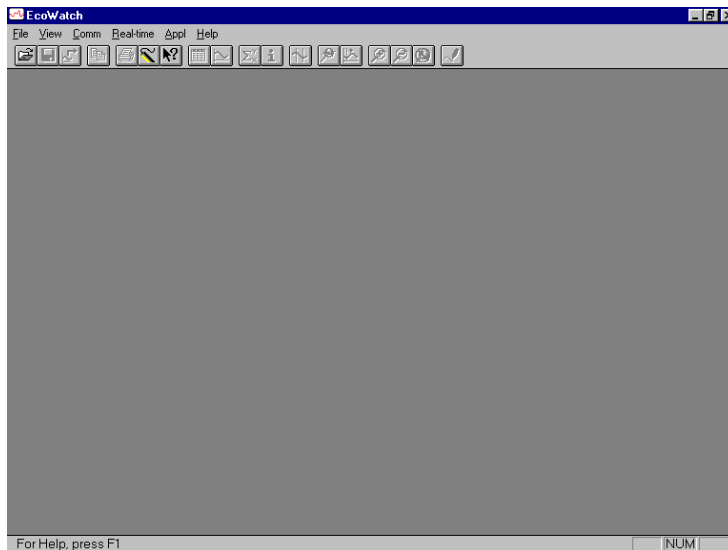
If you encounter difficulties in the download procedure, contact YSI Customer Service. Refer to *Appendix E Customer Service*. Alternatively, you may purchase the software on CD ROM (Item #006075) by contacting YSI Customer Service.

20.2 EcoWatch Tutorial

This EcoWatch tutorial is designed to teach you the commonly used operations associated with the software when used with your 556 MPS.

After you have uploaded a file, Refer to Section [8.4 Upload to PC](#), you will see two files in the C:\ECOWWIN\DATA directory; the file you transferred and a file supplied by YSI designated SAMPLE.DAT. This SAMPLE.DAT file is referred to in the remainder of this tutorial section. After following the instructions below for the analysis of SAMPLE.DAT, you apply the same analysis to the data file which was uploaded from your 556 MPS to assure that you are familiar with the basic features and capabilities of EcoWatch for Windows.

To start the analysis of the SAMPLE.DAT file, note that a shortened menu bar is visible and many of the tools in the toolbar appear dimmed or “grayed out” before any file is opened (see below).

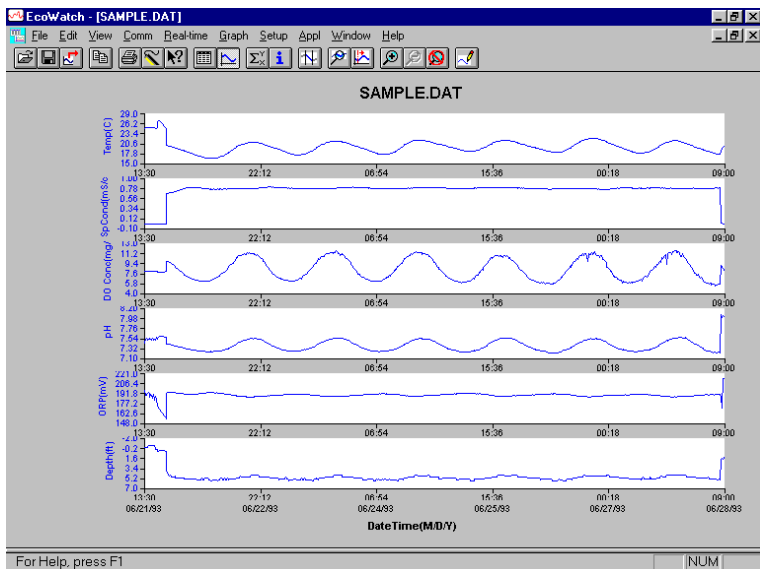


Full activation of EcoWatch features will be realized after a file is opened.




To open the sample data file:

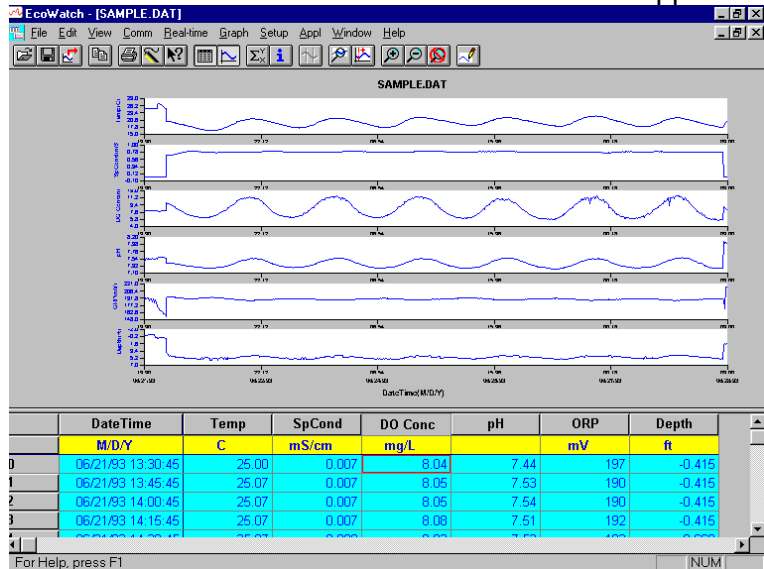
5. 1. Click the **File** menu  button in the toolbar.
6. 2. Select the **SAMPLE.DAT** file.
7. 3. Click **OK** to open the file.




The following display will appear:

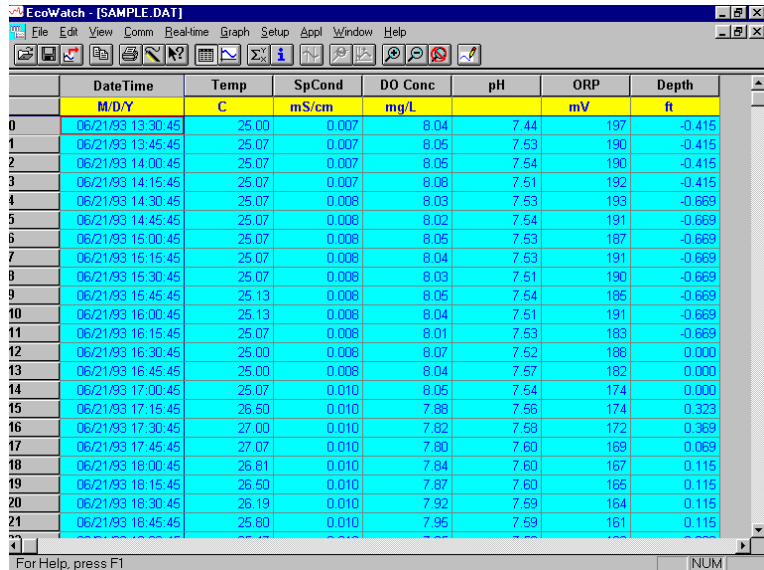


Note that the data in this file appears as a graph of temperature, specific conductance, dissolved oxygen, pH, ORP, and depth, all versus time. The graphs are scaled automatically so that all data fits comfortably on the computer screen. Note also that this data file was obtained with a 6-series sonde for which a depth sensor is available. Depth is NOT a current parameter for the 556 MPS.

The **Table**  and **Graph**  buttons on the toolbar are on/off switches that are used to display or hide the graph and table pages respectively. When displaying a graph and a table at the same time, you can control the relative size of the two pages by placing the cursor over the small bar that separates them and then dragging it to the desired location. Click the **Table**  button to generate the following dual display of data.



Now click the **Graph**  button (turn it off) to display only a report of your data as shown below. Note that the size of the report can be varied by clicking on the  and  buttons in the Toolbar.



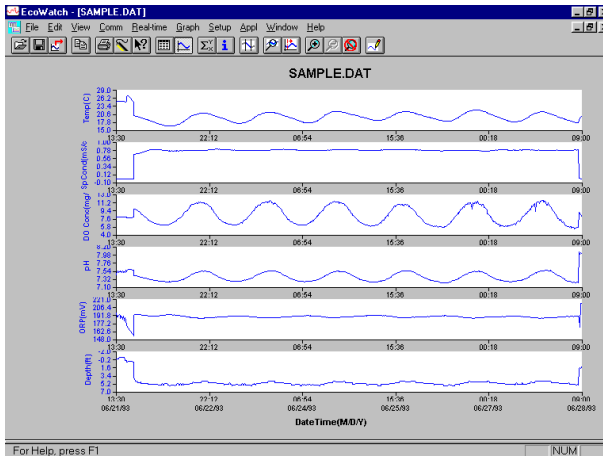
Now return to the original graphic display by toggling the **Table**



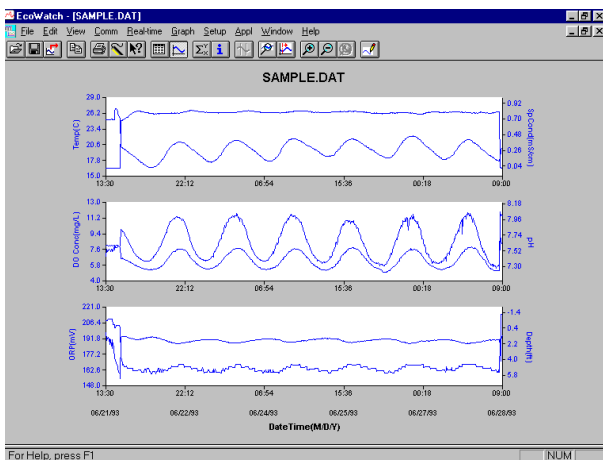
button “off” and **Graph**



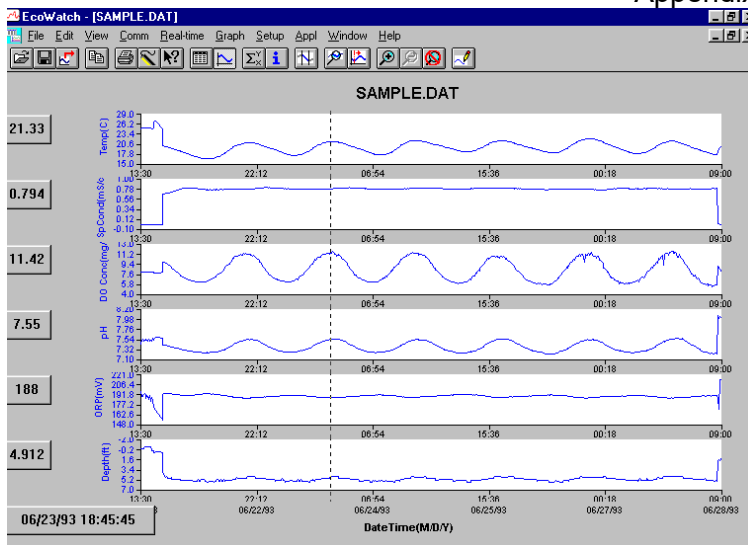
button “on”.




From the **Setup** menu, click **Graph**. Click **2 Traces per Graph** and notice that the parameters are now graphed in pairs for easy comparison of parameters.

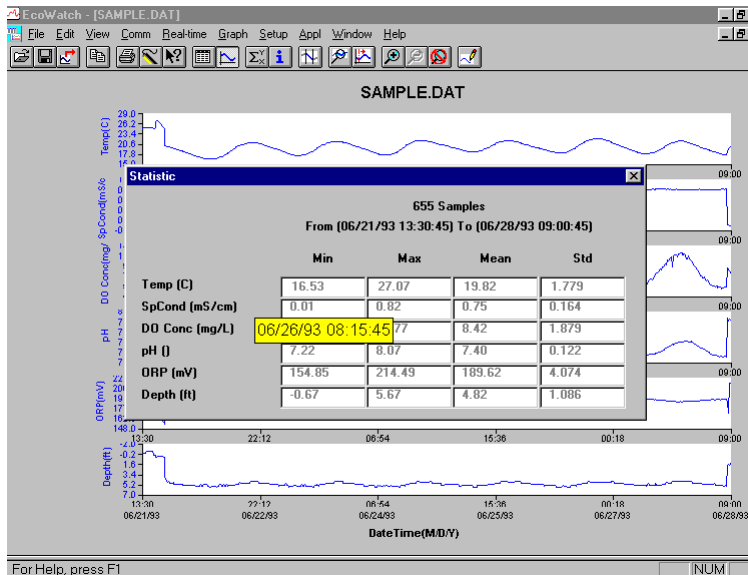


Click **1 Trace per Graph** to return the display to the original setting. Move the cursor to any position in the graph, then click and hold the right mouse button.




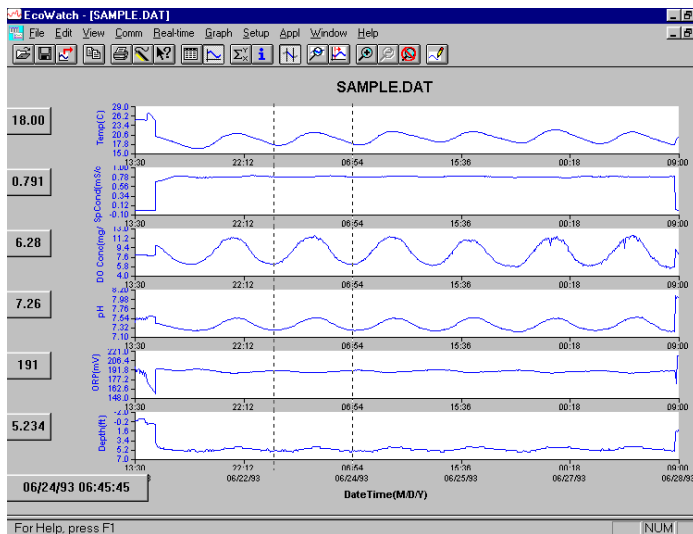
Note that the exact measurements for this point in time are displayed to the left of the graph. While holding down the right mouse button, move to another area on the graph. Notice how the measurements change as you move. When you release the mouse button, the display returns to normal.

To view statistical information for the study, click the **Statistics**  button on the toolbar. On the statistics window, click on any min or max value to display the time when it occurred.

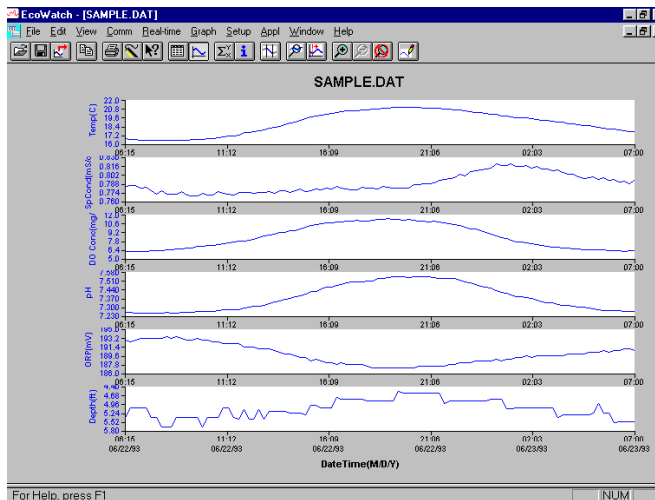


After viewing statistics, click the “x” at the upper right to close the window and return to the normal display.


Now click on the delimiter  icon in the toolbar and then move the displayed icon to the graph. Click at the two points shown by dotted lines in the display below, being sure that the first click is to the left of the second.

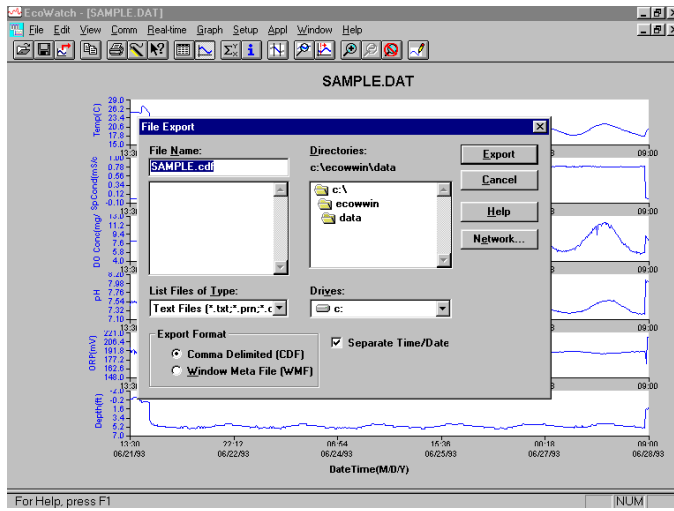



The data between the two selected points will then be graphed in higher resolution as shown below.

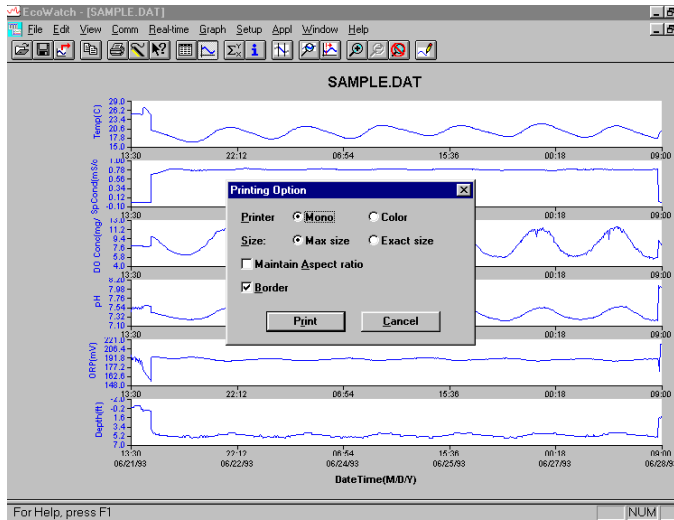


To return to the complete data set, select **Graph** from the toolbar and then click **Cancel Limits**.

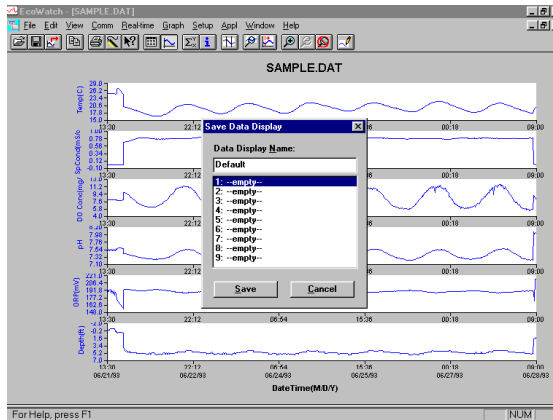
Now select the  icon from the Toolbar to create a new data file which will allow your data to be imported into spreadsheets. Select the default export settings for a Comma Delimited File (.CDF) and click OK. A new spreadsheet-importable file (SAMPLE.CDF) is now present in the same folder as the SAMPLE.DAT file.



Now select the  icon from the toolbar to print the plot. Accept the default settings and click OK to complete the printing operation.



Finally, end the tutorial by saving the **Data Display** in the format shown. From the **File** menu, click **Save Data Display**.



Then type “Default” for the file name and click **Save**. The parameters, colors, format, and x-axis time interval associated with the current display are now saved and can be accessed any time in the future. Nine different data displays may be saved for any data file. You can easily switch between various displays of the data. The data files can be accessed by clicking **Load Data Display** from the file menu and then selecting the desired presentation.

20.2.1 Summary of Toolbar Capability

The EcoWatch toolbar includes buttons for some of the most common commands in EcoWatch, such as **File Open**. To display or hide the toolbar, open the **View** menu and click on the **Toolbar** command. A check mark appears next to the menu item when the toolbar is displayed.


















The toolbar is displayed across the top of the application window, below the menu bar.



Click To:



Open an existing data file (.DAT). EcoWatch displays the **Open** dialog box, in which you can locate and open the desired file.

-  Save the working Data Display of the active data file. EcoWatch displays the **Save Data Display** dialog box in which you can overwrite existing Data Display or save to a new one.
-  Export data as a graph in Window Meta File (.WMF) format or as data in Comma Delimited (.CDF) format.
-  Copy the whole graph page or data from the selection on the table to the clipboard.
-  Print the active graph page or table page depending on which one is currently active.
-  Open a new terminal window to communicate with the sonde.
-  Access context sensitive help (Shift+F1).
-  Toggle table window during file processing.
-  Toggle graph window during file processing.
-  Display study statistics.
-  Display study info.
-  Limit the data to be processed in a study.
-  Enlarge a selective portion of graph.
-  Center the graph under the cursor.
-  Enlarge graph or table 20%.
-  Reduce graph or table 20%.
-  Return graph or table to its normal state (unzoom)
-  Redraw the graph.

20.2.2 Other Capabilities

The above tutorial and function list for the toolbar provide basic information to allow you to view and analyze the field data which was stored in your 556 MPS. Some of the other commonly used capabilities of EcoWatch which the user may want to explore are listed below:

- Customize the units for each parameter, e.g., report $\mu\text{S}/\text{cm}$ instead of mS/cm for conductivity.
- Customize the order of parameters in each plot or report.
- Customize the colors and fonts of each data display.
- Manually scale the y-axis sensitivity for each parameter.
- Merging of two or more data files with compatible parameter formats
- View information about the study such as number of points, instrument serial number, etc. which was stored in the 556 with the data.
- Print data reports in different statistical formats.
- Create plots of parameter vs. parameter rather than parameter vs. time.

These additional features of EcoWatch for Windows are explained in detail in the YSI 6-series manual (which can be downloaded at no cost from the YSI Web Site as described above) and the Help selection in the EcoWatch menubar. To purchase a hard copy of the 6-series manual, contact YSI Customer Service using the contact information in *Appendix E Customer Service*.

21. Appendix H Calibration Record Information

When your YSI 556 MPS sensors are initially calibrated, relevant information about the sensors will be stored in a separate file in the YSI 556 MPS memory.

NOTE: This file, by default, will have the name “556 Circuit Board Serial Number.glp.” The circuit board serial number is assigned at the factory and has a hexadecimal format such as 000080A4. Thus the default calibration record file would be designated 00080A4.glp. Refer to Section 10.7 *GLP Filename* to change the filename.

The information in the calibration record will track the sensor performance of your instrument and should be particularly useful for programs operating under Good Laboratory Practices (GLP) protocols.

21.1 Viewing the Calibration Record (.glp) File

NOTE: Make certain that you have performed a calibration on at least one of the sensors associated with your YSI 556 MPS.

1. Follow the procedures outlined in Section 8.3 *View File*.

21.2 Uploading the Calibration Record (.glp) File

NOTE: Make certain that you have performed a calibration on at least one of the sensors associated with your YSI 556 MPS.

1. Follow the procedures outlined in Section 8.4 *Upload to PC*.

21.3 Understanding the Calibration Record (.glp) File

1. Open a calibration record file. Refer to Section 8.3 *View File*.
2. Use the arrow keys to scroll horizontally and/or vertically to view all the data.

| 00008003 .glp | | |
|---------------|----------|----------|
| m/d/y | hh:mm:ss | S/N |
| 01/24/2001 | 08:17:51 | 00008003 |
| 01/24/2001 | 08:17:51 | 00008003 |
| 01/24/2001 | 08:17:51 | 00008003 |
| 01/24/2001 | 08:17:51 | 00008003 |
| 01/24/2001 | 08:17:51 | 00008003 |
| 01/24/2001 | 08:17:51 | 00008003 |
| 01/24/2001 | 08:17:51 | 00008003 |
| 01/24/2001 | 08:17:51 | 00008003 |
| 01/24/2001 | 08:25:40 | 00008003 |
| 01/24/2001 | 08:25:40 | 00008003 |

735.9mmHg

01/24/2001 08:39:53

Figure 21.1 Calibration Record Screen 1

| 00008003 .glp | | |
|----------------------|------|----------|
| | Type | Value |
| Conductivity gain | | 1.000000 |
| DO gain | | 1.000000 |
| pH gain (pH-7) *K/mV | | -5.05833 |
| pH offset (pH-7) *K | | 0.000000 |
| ORP offset mV | | 0.000000 |
| TDS constant | | 0.650000 |
| Barometer offset PSI | | 0.000000 |
| DO gain | | 1.110250 |
| pH gain (pH-7) *K/mV | | -5.05833 |
| pH offset (pH-7) *K | | -12.2899 |

735.9mmHg

01/24/2001 08:39:19

Figure 21.2 Calibration Record Screen 2

NOTE: Each sensor (not parameter) is characterized by either 1 line (Conductivity, Dissolved Oxygen, ORP, TDS, or Barometer (Optional)) or 2 lines (pH) of calibration documentation.

The left hand portion of each calibration entry shows the date and time that a calibration of a particular sensor was performed. In addition, each calibration entry is characterized by the instrument serial number, as defined by YSI. See Figure 21.1 Calibration Record Screen 1. The right hand portion shows the YSI designation of the calibration constants and their values after their calibration has been performed. A more detailed description of the calibration constants is provided below:

- **Conductivity Gain** – A relative number which describes the sensitivity of the sensor. Basically, the value represents the calculated cell constant divided by the typical value of the cell constant (5 cm^{-1}).
- **DO Gain** – A relative number which describes the sensitivity of the sensor. Basically, the value represents the sensor current at the time of calibration divided by the typical value of the sensor current (15 μA).
- **pH Gain** – A number which basically represents the sensitivity of the pH sensor. To remove the effect of temperature on the slope of the relationship of probe output in mv versus pH, the value of pH/mv is multiplied by the temperature in degrees Kelvin (K).
- **pH Offset** – A number which basically represents the offset (or intercept) of the relationship of probe output in mv versus pH, the value of pH is multiplied by the temperature in degrees Kelvin (K).

Anytime you perform a calibration, information concerning the calibration constants will be logged to the Calibration Record file (.glp file). However, if the **Delete All Files** command is used, Refer to Section 8.6 *Delete All Files*, the Calibration Record file will also be lost. It is critical that this file should be uploaded to your PC prior to issuing a **Delete All Files** command. Refer to Section 8.4 *Upload to PC*.



YSI incorporated

YSI Environmental
1700/1725 Brannum Lane
Yellow Springs, OH
45387 USA
937.767.7241
937.767.9353 fax
environmental@YSI.com

www.YSI.com

©2004 YSI Incorporated

A655279C
655279Web
January 2004

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

I. Purpose and Scope

This SOP presents general guidelines for the collection of groundwater samples from monitoring wells using low-flow purging and sampling procedures.

II. Equipment and Materials

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

III. Procedures and Guidelines

A. Setup and Purging

1. Obtain information on well location, diameter(s), depth, and screen interval(s), and the method for disposal of purged water.
2. Calibrate instruments according to manufacturer's instructions.

3. Record well number, site, date, and condition in the field logbook.
4. Place plastic sheeting on the ground surrounding well head. All decontaminated equipment to be used in sampling will be placed only on the plastic sheeting until after the sampling has been completed. Do not let any downhole equipment touch the ground.
5. Open the well and begin screening breathing zone with air monitoring device until sampling is complete, in accordance with the HASP.
6. All sampling equipment and any other equipment to be placed in the well must be cleaned and decontaminated before sampling in accordance with SOP *Decontamination of Personnel and Equipment*.
7. Water level measurements are collected in accordance with the *Water Level Measurements* SOP. **Do not measure the depth to the bottom of the well at this time**; this reduces the possibility that any accumulated sediment in the well will be disturbed. Obtain depth to bottom information from well construction log.
7. Attach and secure the tubing to the pump. Lower the pump slowly into the well and set it at approximately the middle of the screen, or wetted screen interval, and at least two feet above the bottom of the well to avoid disturbance of sediment. Submersible pumps should be lowered by the suspension cable rather than the discharge tubing.
8. Insert the water quality measurement probes into the flow-through cell and place in a shaded area. The purged groundwater must enter the flow through the cell by the lower port and exit via the upper port. Wrap exposed tubing and the flow through cell in aluminum foil to minimize heat loss/gain due to environmental conditions.
9. Generators and fuel, if used, must be located at least 30 feet downwind from the well to avoid exhaust fumes contaminating the samples.
10. Begin purging the well at 0.2 to 0.5 liters per minute. Avoid surging. Purging rates for more transmissive formations could be started at 0.5-liter to 1 liter per minute. The initial field parameters of pH, specific conductance, dissolved oxygen, ORP, turbidity, and temperature of water are measured and recorded in the field logbook.
11. Contain purged water for placement in labeled 55-gallon drum or tank, as appropriate.
12. The water level should be monitored frequently during purging, and, ideally, the purge rate should equal the well recharge rate so that there is little or no drawdown in the well (i.e., less than 0.3-foot). The water level should stabilize for the specific purge rate. There should be at least 1 foot of water over the pump intake so there is no risk of the pump suction being broken, or entrainment of air in the sample. Record adjustments in the purge rate and changes in depth to water in the logbook. Purge rates should, if needed, be decreased to the

minimum capabilities of the pump (0.1- to 0.2-liter per minute) to minimize water level drawdown.

13. During purging, the field parameters must be measured frequently (every 5 minutes) until the parameters have stabilized. Field parameters are considered stable when measurements meet the following criteria:
 - pH: within 0.1 pH units
 - Specific conductance: within 3 percent
 - Dissolved oxygen: within 10 percent
 - Turbidity: within 10 percent for values greater than 5 NTU; if 3 turbidity values are less than 5 NTU, consider the values as stabilized
 - ORP: within 10 mV
 - Temperature: within 3 percent

B. Sample Collection

Once purging is complete the well is ready to sample. The pump should be allowed to operate at the same rate as the purge cycle until sampling begins, whereupon the discharge should be reduced to 0.1 L/m.

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

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

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

1. The cap is removed from the sample bottle, and the bottle is tilted slightly.
2. The sample is slowly poured so that it runs down the inside of the sample bottle with a minimum of splashing. The pumping rate should be reduced to approximately 100 ml per minute when sampling VOCs.
3. Inorganics, including metals, may be collected and preserved in the filtered form as well as the unfiltered form. Disposable in-line filters (0.45 micron filter), connected to the end of the sample tubing, are typically used for field filtration. Samples are field filtered as the water is being placed into the sample container.
4. Adequate space is left in the bottle to allow for expansion, except for VOC vials, which are filled to the top with a positive meniscus. VOC vials should be capped slowly to prevent introduction of air bubbles in

the sample. Once capped, the VOC vial should be inverted and tapped to detect the presence of air bubbles.

5. Immediately upon collection, all samples for chemical analysis are to be labeled and placed on ice.
6. Re-usable equipment must be cleaned and decontaminated in accordance with the *Decontamination of Personnel and Equipment* SOP.

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

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

C. Additional remarks

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

IV. Attachments

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

V. Key Checks and Preventative Maintenance

- The drawdown in the well should be minimized as much as possible (preferably no more than 0.5-foot to 1 foot) so that natural groundwater-flow conditions are maintained as closely as possible.
- The highest purging rate should not exceed 1 liter per minute. This is to keep the drawdown minimized.
- Stirring up of sediment in the well should be avoided so that turbidity containing adsorbed chemicals is not suspended in the well and taken in by the pump.

- Overheating of the pump should be avoided to minimize the potential for losing VOCs through volatilization. Submersible pumps used in large diameter wells should be equipped with a shroud to force water flow across the pump motor to dissipate heat build-up.
- Keep the working space clean with plastic sheeting and good housekeeping.
- Maintain field equipment in accordance with the manufacturer's recommendations. This will include, but is not limited to:
 - Inspect sampling pump regularly and replace as warranted
 - Inspect quick-connects regularly and replace as warranted
 - Verify battery charge, calibration, and proper working order of field measurement equipment prior to initial mobilization and daily during field efforts

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

White Paper on Low-Flow Sampling

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

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

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

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

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

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

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

Water-Level Measurements

I. Purpose and Scope

The purpose of this procedure is to provide a guideline for the measurement of the depth to groundwater in piezometers and monitoring wells, even where a second phase of floating liquid (e.g., gasoline) is encountered, and on staff gages in surface-water bodies. This SOP includes guidelines for discrete measurements of static water levels and does not cover the use of continuously recording loggers (see SOP *Use of Data Loggers and Pressure Transducers*).

II. Equipment and Materials

- Electronic water-level meter (Solinst® or equivalent) with a minimum 100-foot tape; the tape should have graduations in increments of 0.01 feet or less
- Interface probe (Solinst® Model 122 Interface Meter or equivalent)

III. Procedures and Guidelines

Verify that the unit is turned on and functioning properly. Slowly lower the probe on its cable into the piezometer or well until the probe just contacts the water surface; the unit will respond with a tone or light signal. Note the depth from a reference point indicated on the piezometer or well riser. Typically this is the top of the PVC casing. If no reference is clearly visible, measure the depth to water from the northern edge of the PVC casing. If access to the top of the PVC casing is difficult, sight across the top of the locking casing adjacent to the measuring point, recording the position of the cable when the probe is at the water surface.

Measure the distance from this point to the closest interval marker on the tape, and record the water level reading in the logbook. Water levels will be measured to the nearest 0.01-foot. Also when specified in the project plans, measure and record the depth of the piezometer or well. The depth of the piezometer or well may be measured using the water-level probe with the instrument turned off.

Free product light or dense nonaqueous phase liquid may be present in the piezometer or well. If the presence of free product is suspected, the thickness of the product should be determined using appropriate equipment (e.g., Solinst® Model 122 Interface Meter). The depth to water also is determined with this equipment and the water-level meter should not be used in the piezometer or well as long as product is present. Typically, a constant sound is emitted from the device when free product is encountered and an alternating on/off beep sound is emitted when water is encountered.

The apparent elevation of the water level in the well or piezometer is determined by measuring both the apparent depth to water and the thickness of free product. The corrected water-level elevation is calculated by the following equation:

$$WL_c = WL_a + (\text{Free-product thickness} \times 0.80)$$

Where WL_c = Corrected water-level elevation

WL_a = Apparent water-level elevation

0.80 = Typical value for the density of petroleum hydrocarbon products.

If free product is detected on the surface of the water in the piezometer or well, the value of sampling should be reconsidered because of the potential for contaminating the sampling equipment.

Staff gages may be installed in some surface-water bodies. These facilities typically are constructed by attaching a calibrated, marked staff gage to a wood or metal post, driving the post into the bottom of the surface-water body, and surveying the elevation of the top of the post to a resolution or 0.01-foot. The elevation of the water in the surface-water body then can be determined by reading off the distance the water level is from the top of the post. A shield or other protection may be needed to calm the fluctuations in water level if the gage is installed at a location exposed to wind or wave.

IV. Attachments

None.

V. Key Checks

- Before each use, verify that the battery is charged by pressing the test button on the water-level meter.
- Verify that the unit is operating correctly by testing the probe in distilled or de-ionized water. Leave the unit turned off when not in use.

General Guidance for Monitoring Well Installation

I. Purpose

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

II. Scope

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

III. Equipment and Materials

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

IV. Procedures and Guidelines

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

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

Monitoring Well Installation

- 2" monitoring wells in unconsolidated materials will be installed in at least 6-inch-diameter boreholes to accommodate well completion materials in designated locations.
- All monitoring wells penetrating a confining layer will be surface-cased from the ground surface to approximately 5 feet into the confining layer. Exceptions to this may be allowed under certain circumstances (e.g., evidence of significant natural gaps in the confining layer).
- Monitoring wells in unconsolidated materials will be constructed of 2-inch-diameter, factory manufactured, flush-jointed, Schedule 40 PVC (or stainless steel) screen with threaded bottom plug and riser.
- Screens will be filter packed with a properly sized and graded, thoroughly washed, sound, durable, well-rounded basalt or siliceous sand. When using hollow-stem augers, the filter pack will be installed by slowly pouring the sand into the annular space while simultaneously raising the augers and using a weighted tape to sound for the sand surface. For rotary-drilled wells, the height of the sand pack also will be sounded with a weighted tape.
- The primary filter sand pack (typically Morie #00 or DSI #1 for a 10-slot screen) will extend from 1 to 2 feet below the base to 2 feet above the top of the screen; filter pack will be allowed to settle before final measurement is taken. For wells deeper than 30 feet, the filter pack will be placed using a tremie pipe and flowing water.

| Screen Size Opening (Inches) | Screen Size Slot Number | Typical Sand Pack Mesh Size (U.S. Standard Sieve Number) |
|------------------------------|-------------------------|--|
| 0.005 | 5 | 100 |
| 0.010 | 10 | 20 to 40 |
| 0.020 | 20 | 10 to 20 |
| 0.030 | 30 | 10 to 20 |

- A secondary filter sand pack (typically a fine sand seal) 1-foot thick may be placed above the primary sand pack.
- Annular well seals will consist of 2 feet of pelletized, chip, or granular bentonite clay placed above the filter pack. If necessary the pellets will be hydrated using potable water. For wells installed using hollow-stem augers, the bentonite will be poured into the annular space while slowly raising the augers and sounding for the top of the bentonite with a weighted tape. A

high-solids bentonite slurry using powdered bentonite introduced with a side-discharging tremie pipe will be used for the bentonite seals in wells greater than 30 feet deep. For rotary-drilled wells, the height of the well seal also will be sounded with a weighted tape. High-solids slurries will have solids content of at least 20 percent.

- The top of the annular seal will be measured after the bentonite seal has been allowed to hydrate and before the grout is applied. The seal will be allowed to hydrate for at least 30 minutes before work in the well continues.
- The annular space above the bentonite seal will be filled to grade with a bentonite-cement slurry grout mixture.
- The grout mixture consists of 6 to 8 gallons of water per 94-pound bag of Portland cement; 3 to 6 pounds of bentonite added per bag of cement to reduce shrinkage. A grout density scale is recommended for determining the correct density. See attached grout volume and weights chart for calculation of grout volume.
- The grout mix will be carefully applied to avoid disturbing the bentonite seal; the method of grout placement must force grout from the top of the bentonite seal to ground surface.
- After allowing the grout to settle and set up overnight, additional grout will be added to maintain grade.
- A protective steel casing equipped with keyed alike locking caps will be grouted in place for each new well; the casing will extend at least 2 feet above grade and 3 feet below grade, and will be painted a bright color.

Well Development

- New monitoring wells will be developed after the well has been completely installed and the grout has hardened (at least 24 hours)
- The well will be developed by surging and pumping.
- Equipment placed in the well will be decontaminated before use.
- If information is available, begin developing in the least-contaminated well first.
- Development will include surging the well by either abruptly stopping flow and allowing water in the well column to fall back into the well or through the use of a surge block that is slightly smaller in diameter than the well casing inner diameter.
- Pipes and pumps must not be fitted with foot valves or other devices that might inhibit the return flow of water to the well.
- Surging should continue throughout the development process.

- The air-lift method may be used to pump materials out of the well. The air compressor will be fitted with filters to remove all oil and the air lift hose used will be made of inert materials.
- Well development will continue until the water produced is free of turbidity, sand, and silt. A Horiba-U22 meter, YSI meter with separate Hanna turbidity meter, or equivalent should be used to determine when the turbidity is low and parameters have stabilized.
- Development water will be considered hazardous and placed in sealed 55-gallon U.S. DOT approved steel drums. CH2M HILL will label and date the drums as pending analysis, and transport the drums to a designated site for storage.

V. Attachments

Grout Volume and Weights Chart

VI. Key Check and Items

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

Installation of Shallow Monitoring Wells

I. Purpose and Scope

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

II. Equipment and Materials

Drilling

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

Well Riser/Screen and Associated Materials

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

Sand

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

Bentonite

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

Protective Casing

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

Well Development

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

III. Procedures and Guidelines

A. Drilling Method

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

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

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

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

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

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

B. Monitoring-Well Installation

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

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

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

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

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

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

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

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

C. Well Completion

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

Guard posts may be installed in high-traffic areas for additional protection. Four steel guard posts will be installed around the protective casing. Guard posts would be concrete-filled, at least 2 inches in diameter, and would extend at least 2 feet into the ground and 3 feet above the ground. The protective casing and guard posts will be painted with an epoxy paint to prevent rust.

For monitoring wells with flush-mount completions, Morrison 9-inch or 12-inch 519 manhole cover or equivalent, with a rubber-sealed cover and drain will be installed. The top of the manhole cover will be positioned approximately 1 inch above grade. A square concrete pad, approximately 2 feet per side (unless otherwise specified in the project plans), will be installed as a concrete collar surrounding the road box cover, and will slope uniformly downward to the adjacent grade. The road box and installation thereof will be of sufficient strength to withstand normal vehicular traffic.

Concrete pads installed at all wells will be a minimum of 6 inches below grade. The concrete pad will be 12 inches thick at the center and taper to 6-inch thick at the edge. The surface of the pad should slope away from the protective casing to prevent water from pooling around the casing. Protective casing, guard posts, and flush mounts will be installed into this concrete.

Each well will be properly labeled on the exterior of the locking cap or protective casing with a metal stamp indicating the permanent well number.

D. Well Development

Well development will be accomplished using a combination of surging throughout the well screen and pumping, until the physical and chemical parameters of the discharge water that are measured in the field have stabilized and the turbidity of the discharge water is substantially reduced. Fine-grained materials in the surficial aquifer at the site may not allow low turbidity results to be achieved.

The surging apparatus will include a surge block. Well development will begin by surging the well screen, starting at the bottom of the screen and proceeding upwards, throughout the screened zone. Following surging, the well will be pumped to remove the fine materials that have been drawn into the well. During pumping, measurements of pH, temperature, and specific conductance will be recorded.

Development will continue by alternately surging and pumping until the discharge water is free from sand and silt, the turbidity is substantially reduced, and the pH, temperature, and specific conductance have stabilized at regional background levels, based on historical data. Development will continue for a minimum of 30 minutes and until the water removed from the well is as clear of turbidity as practicable.

Well development equipment will be decontaminated prior to initial use and after the development of each well. Decontamination procedures are detailed in SOP *Decontamination of Personnel and Equipment*. Water generated during well development will be contained and managed as detailed in the SOP *Disposal of Waste Fluids and Solids* and the Investigation Derived Waste Management Plan.

IV. Attachments

Schematic diagram of shallow monitoring-well construction (MWSingleDiag.xls)

Aquifer Slug Testing

I. Purpose and Scope

The purpose of this procedure is to outline the equipment and methods that will be used to perform variable-head tests (“slug” tests) on piezometers and monitoring wells. The guidance covers use of both air and solid displacement methods.

II. Equipment and Materials

- In-Situ data loggers or equivalent
- Well-testing assembly
 - packer
 - fittings for pressure transducers
 - fittings for air supply
 - release valve
- Compressed air
- Computer and associated equipment
- Solid displacement device with rope

III. Procedures and Guidelines

The tests to be performed are rising head tests. The tests are accomplished by lowering the head of water in the well and monitoring the recovery of the water level to the static water level. The water level will be lowered by one of two methods. One method is the use of an air displacement device. Alternatively, a solid displacement device removed from the well will be used.

The air displacement apparatus consists of a packer assembly, fittings to accommodate transducers and air pressurization, and a pressure-release valve. The packer is lowered into the upper portion of the monitoring well, secured in place and inflated, providing a seal between the apparatus and the inside of the well. Two fittings are provided for pressure transducers: one transducer is fed through the inside of the device and positioned below the water surface and the other is inserted to measure the air pressure inside the assembly. A third fitting is connected to the pressurized air supply, a compressed air tank.

The datalogger will be programmed to display the air pressure in units of head, the head measured by the submerged transducer, and the difference between the two. The difference between the two pressure transducers is the height of the water column on the submerged transducer. The readings are recorded in a field notebook, and then the assembly is pressurized. The air pressure applied will be equivalent to 3 to 7 feet

of head. The pressures are allowed to stabilize. The pressure of the air should not lower the water level to below the base of the bentonite seal installed in the well.

Each test is started by releasing the air pressure inside the assembly and allowing the water level to rise to the static water level. When the datalogger perceives a change in water level in the well above a preset trigger amount, it automatically begins to record the water levels and elapsed time. Alternatively, the datalogger can be started manually just prior to injection of air. Each test will be terminated when the water level has recovered to at least 90 percent of the original equilibrium level before pressurization. Note that the test method cannot be used if the well is screened across or near the water table.

An alternate method of lowering the water level is to use a solid displacement device. A single transducer will be installed in the well below the water table. A weighted solid displacement device is added to the well and the water level allowed to stabilize at the original static water level. The test is started by rapidly removing the displacement device, which causes a drop in the water level. The data logger begins recording the water level and elapsed time when the preset trigger amount is reached. Readings are taken as above, and the test stopped when the well has recovered to 90 percent of the original level.

At least two valid tests will be performed in each well. Additional tests will be required if there is some evidence that any of the tests were unacceptable.

At the end of each test, the test results will be transferred to a laptop and the data downloaded and checked for preliminary completeness.

IV. Attachments

None.

V. Key Checks and Preventive Maintenance

- Check that the packer assembly is in good condition and not leaking. Provide a repair kit including tape and clamps. Take additional packer assembly and other spare parts.
- Check the batteries for the datalogger and computer. Check that the computer disks containing the programs for the datalogger are packed.
- Check the datalogger calculation of the well hydraulic conductivity at the end of each test to determine if these are consistent with expectations.

Appendix C
DoD ELAP Letter



SCOPE OF ACCREDITATION TO ISO/IEC 17025:2005

VISTA ANALYTICAL LABORATORY
 1104 Windfield Way
 El Dorado Hills, CA 95762
 Martha Maier Phone: 916-673-1520
 mmaier@vista-analytical.com

ENVIRONMENTAL

Valid To: September 30, 2017

Certificate Number: 3091.01

In recognition of the successful completion of the A2LA evaluation process, (including an assessment of the laboratory's compliance with ISO IEC 17025:2005, the 2009 NELAC Standard, and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in version 5.0 of the DoD Quality Systems Manual for Environmental Laboratories) accreditation is granted to this laboratory to perform recognized EPA methods using the

following testing technologies and in the analyte categories identified below:

Testing Technologies

High Resolution Gas Chromatography / Mass Spectrometry

| Parameter/Analyte | Potable Water | Nonpotable Water | Solid Hazardous Waste | Tissue |
|--|---------------|------------------|-----------------------|----------------|
| <u>Dioxins/Furans</u> | | | | |
| 2,3,7,8-Tetrachlorodibenzo-p-dioxin | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| 1,2,3,7,8-Pentachlorodibenzo-p-dioxin | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| 1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| 1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| 1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| 1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| 1,2,3,4,6,7,8,9-Octachlorodibenzo-p-dioxin | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| 2,3,7,8-Tetrachlorodibenzofuran | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| 1,2,3,7,8-Pentachlorodibenzofuran | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| 2,3,4,7,8-Pentachlorodibenzofuran | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| 1,2,3,4,7,8-Hexachlorodibenzofuran | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| 1,2,3,6,7,8-Hexachlorodibenzofuran | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| 2,3,4,6,7,8-Hexachlorodibenzofuran | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| 1,2,3,7,8,9-Hexachlorodibenzofuran | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| 1,2,3,4,6,7,8-Heptachlorodibenzofuran | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| 1,2,3,4,7,8,9-Heptachlorodibenzofuran | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| 1,2,3,4,6,7,8,9-Octachlorodibenzofuran | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |

| Parameter/Analyte | Potable Water | Nonpotable Water | Solid Hazardous Waste | Tissue |
|-----------------------------------|---------------|------------------|-----------------------|-----------------|
| Total Tetrachlorodibenzo-p-dioxin | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| Total Pentachlorodibenzo-p-dioxin | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| Total Hexachlorodibenzo-p-dioxin | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| <u>Dioxins/Furans</u> | | | | |
| Total Heptachlorodibenzo-p-dioxin | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| Total Tetrachlorodibenzofuran | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| Total Pentachlorodibenzofuran | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| Total Hexachlorodibenzofuran | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| Total Heptachlorodibenzofuran | ----- | EPA 1613B/8290 | EPA 1613B/8290 | EPA 1613B/8290 |
| <u>PCBs</u> | | | | |
| 2-Chlorobiphenyl (1) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3-Chlorobiphenyl (2) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 4-Chlorobiphenyl (3) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2'-Dichlorobiphenyl (4) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3-Dichlorobiphenyl (5) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3'-Dichlorobiphenyl (6) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,4-Dichlorobiphenyl (7) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,4'-Dichlorobiphenyl (8) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,5-Dichlorobiphenyl (9) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,6-Dichlorobiphenyl (10) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,3'-Dichlorobiphenyl (11) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,4-Dichlorobiphenyl (12) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,4'-Dichlorobiphenyl (13) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,5-Dichlorobiphenyl (14) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 4,4'-Dichlorobiphenyl (15) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3-Trichlorobiphenyl (16) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',4-Trichlorobiphenyl (17) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',5-Trichlorobiphenyl (18) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',6-Trichlorobiphenyl (19) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3'-Trichlorobiphenyl (20) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |

| Parameter/Analyte | Potable Water | Nonpotable Water | Solid Hazardous Waste | Tissue |
|------------------------------------|---------------|--------------------|-----------------------|--------------------|
| 2,3,4-Trichlorobiphenyl (21) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,4'-Trichlorobiphenyl (22) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,5-Trichlorobiphenyl (23) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,6-Trichlorobiphenyl (24) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3',4-Trichlorobiphenyl (25) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3',5-Trichlorobiphenyl (26) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3',6-Trichlorobiphenyl (27) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,4,4'-Trichlorobiphenyl (28) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,4,5-Trichlorobiphenyl (29) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,4,6-Trichlorobiphenyl (30) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,4',5-Trichlorobiphenyl (31) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,4',6-Trichlorobiphenyl (32) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2',3,4-Trichlorobiphenyl (33) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2',3,5-Trichlorobiphenyl (34) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,3',4-Trichlorobiphenyl (35) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,3',5-Trichlorobiphenyl (36) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,4,4'-Trichlorobiphenyl (37) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,4,5-Trichlorobiphenyl (38) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,4',5-Trichlorobiphenyl (39) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3'-Tetrachlorobiphenyl (40) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4-Tetrachlorobiphenyl (41) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4'-Tetrachlorobiphenyl (42) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,5-Tetrachlorobiphenyl (43) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,5'-Tetrachlorobiphenyl (44) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,6-Tetrachlorobiphenyl (45) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |

| Parameter/Analyte | Potable Water | Nonpotable Water | Solid Hazardous Waste | Tissue |
|-------------------------------------|---------------|--------------------|-----------------------|--------------------|
| 2,2',3,6'-Tetrachlorobiphenyl (46) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',4,4'-Tetrachlorobiphenyl (47) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',4,5'-Tetrachlorobiphenyl (48) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',4,5'-Tetrachlorobiphenyl (49) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',4,6'-Tetrachlorobiphenyl (50) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',4,6'-Tetrachlorobiphenyl (51) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',5,5'-Tetrachlorobiphenyl (52) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',5,6'-Tetrachlorobiphenyl (53) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',6,6'-Tetrachlorobiphenyl (54) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4'-Tetrachlorobiphenyl (55) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4'-Tetrachlorobiphenyl (56) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',5'-Tetrachlorobiphenyl (57) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',5'-Tetrachlorobiphenyl (58) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',6'-Tetrachlorobiphenyl (59) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,4,4'-Tetrachlorobiphenyl (60) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,4,5'-Tetrachlorobiphenyl (61) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,4,6'-Tetrachlorobiphenyl (62) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,4,5'-Tetrachlorobiphenyl (63) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,4,6'-Tetrachlorobiphenyl (64) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,5,6'-Tetrachlorobiphenyl (65) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3',4,4'-Tetrachlorobiphenyl (66) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3',4,5'-Tetrachlorobiphenyl (67) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3',4,5'-Tetrachlorobiphenyl (68) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3',4,6'-Tetrachlorobiphenyl (69) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3',4',5'-Tetrachlorobiphenyl (70) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |

| Parameter/Analyte | Potable Water | Nonpotable Water | Solid Hazardous Waste | Tissue |
|--------------------------------------|---------------|--------------------|-----------------------|--------------------|
| 2,3',4',6-Tetrachlorobiphenyl (71) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3',5,5'-Tetrachlorobiphenyl (72) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3',5',6-Tetrachlorobiphenyl (73) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,4,4',5-Tetrachlorobiphenyl (74) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,4,4',6-Tetrachlorobiphenyl (75) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2',3,4,5-Tetrachlorobiphenyl (76) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,3',4,4'-Tetrachlorobiphenyl (77) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,3',4,5-Tetrachlorobiphenyl (78) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,3',4,5'-Tetrachlorobiphenyl (79) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,3',5,5'-Tetrachlorobiphenyl (80) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,4,4',5-Tetrachlorobiphenyl (81) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4-Pentachlorobiphenyl (82) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',5-Pentachlorobiphenyl (83) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',6-Pentachlorobiphenyl (84) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,4'-Pentachlorobiphenyl (85) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,5-Pentachlorobiphenyl (86) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,5'-Pentachlorobiphenyl (87) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,6-Pentachlorobiphenyl (88) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,6'-Pentachlorobiphenyl (89) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4',5-Pentachlorobiphenyl (90) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4',6-Pentachlorobiphenyl (91) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,5,5'-Pentachlorobiphenyl (92) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,5,6-Pentachlorobiphenyl (93) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,5,6'-Pentachlorobiphenyl (94) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,5',6-Pentachlorobiphenyl (95) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |

| Parameter/Analyte | Potable Water | Nonpotable Water | Solid Hazardous Waste | Tissue |
|---------------------------------------|---------------|--------------------|-----------------------|--------------------|
| 2,2',3,6,6'-Pentachlorobiphenyl (96) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3',4,5-Pentachlorobiphenyl (97) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3',4,6-Pentachlorobiphenyl (98) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',4,4',5-Pentachlorobiphenyl (99) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',4,4',6-Pentachlorobiphenyl (100) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',4,5,5'-Pentachlorobiphenyl (101) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',4,5,6'-Pentachlorobiphenyl (102) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',4,5,6-Pentachlorobiphenyl (103) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',4,6,6'-Pentachlorobiphenyl (104) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4,4'-Pentachlorobiphenyl (105) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4,5-Pentachlorobiphenyl (106) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4',5-Pentachlorobiphenyl (107) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4,5'-Pentachlorobiphenyl (108) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4,6-Pentachlorobiphenyl (109) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4',6-Pentachlorobiphenyl (110) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',5,5'-Pentachlorobiphenyl (111) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',5,6-Pentachlorobiphenyl (112) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',5',6-Pentachlorobiphenyl (113) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,4,4',5-Pentachlorobiphenyl (114) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,4,4',6-Pentachlorobiphenyl (115) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,4,5,6-Pentachlorobiphenyl (116) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,4',5,6-Pentachlorobiphenyl (117) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3',4,4',5-Pentachlorobiphenyl (118) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3',4,4',6-Pentachlorobiphenyl (119) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3',4,5,5'-Pentachlorobiphenyl (120) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |

| Parameter/Analyte | Potable Water | Nonpotable Water | Solid Hazardous Waste | Tissue |
|---|---------------|--------------------|-----------------------|--------------------|
| 2,3',4,5,'6-Pentachlorobiphenyl (121) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2',3,3',4,5-Pentachlorobiphenyl (122) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2',3,4,4',5-Pentachlorobiphenyl (123) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2',3,4,5,5'-Pentachlorobiphenyl (124) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2',3,4,5,6'-Pentachlorobiphenyl (125) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,3',4,4',5-Pentachlorobiphenyl (126) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,3',4,5,5'-Pentachlorobiphenyl (127) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,4'-Hexachlorobiphenyl (128) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,5-Hexachlorobiphenyl (129) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,5'-Hexachlorobiphenyl (130) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,6-Hexachlorobiphenyl (131) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,6'-Hexachlorobiphenyl (132) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',5,5'-Hexachlorobiphenyl (133) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',5,6-Hexachlorobiphenyl (134) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',5,6'-Hexachlorobiphenyl (135) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',6,6'-Hexachlorobiphenyl (136) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,4',5-Hexachlorobiphenyl (137) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,4',5'-Hexachlorobiphenyl (138) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,4',6-Hexachlorobiphenyl (139) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,4',6'-Hexachlorobiphenyl (140) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,5,5'-Hexachlorobiphenyl (141) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,5,6-Hexachlorobiphenyl (142) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,5,6'-Hexachlorobiphenyl (143) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,5',6-Hexachlorobiphenyl (144) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,6,6'-Hexachlorobiphenyl (145) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |

| Parameter/Analyte | Potable Water | Nonpotable Water | Solid Hazardous Waste | Tissue |
|--|---------------|--------------------|-----------------------|--------------------|
| 2,2',3,4',5,5'-Hexachlorobiphenyl (146) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4',5,6-Hexachlorobiphenyl (147) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4',5,6'-Hexachlorobiphenyl (148) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4',5',6-Hexachlorobiphenyl (149) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4',6,6'-Hexachlorobiphenyl (150) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,5,5',6-Hexachlorobiphenyl (151) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,5,6,6'-Hexachlorobiphenyl (152) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',4,4',5,5'-Hexachlorobiphenyl (153) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',4,4',5',6-Hexachlorobiphenyl (154) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',4,4',6,6'-Hexachlorobiphenyl (155) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4,4',5-Hexachlorobiphenyl (156) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4,4',5'-Hexachlorobiphenyl (157) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4,4',6-Hexachlorobiphenyl (158) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4,5,5'-Hexachlorobiphenyl (159) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4,5,6-Hexachlorobiphenyl (160) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4,5',6-Hexachlorobiphenyl (161) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4',5,5'-Hexachlorobiphenyl (162) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4',5,6-Hexachlorobiphenyl (163) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4',5',6-Hexachlorobiphenyl (164) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',5,5',6-Hexachlorobiphenyl (165) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,4,4',5,6-Hexachlorobiphenyl (166) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3',4,4',5,5'-Hexachlorobiphenyl (167) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3',4,4',5',6-Hexachlorobiphenyl (168) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 3,3',4,4',5,5'-Hexachlorobiphenyl (169) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,4',5-Heptachlorobiphenyl (170) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |

| Parameter/Analyte | Potable Water | Nonpotable Water | Solid Hazardous Waste | Tissue |
|--|---------------|--------------------|-----------------------|--------------------|
| 2,2',3,3',4,4',6-Heptachlorobiphenyl (171) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,5,5'-Heptachlorobiphenyl (172) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,5,6-Heptachlorobiphenyl (173) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,5,6'-Heptachlorobiphenyl (174) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,5',6-Heptachlorobiphenyl (175) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,6,6'-Heptachlorobiphenyl (176) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4',5,6-Heptachlorobiphenyl (177) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',5,5',6-Heptachlorobiphenyl (178) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',5,6,6'-Heptachlorobiphenyl (179) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,4',5,5'-Heptachlorobiphenyl (180) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,4',5,6-Heptachlorobiphenyl (181) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,4',5,6'-Heptachlorobiphenyl (182) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,4',5',6-Heptachlorobiphenyl (183) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,4',6,6'-Heptachlorobiphenyl (184) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,5,5',6-Heptachlorobiphenyl (185) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,5,6,6'-Heptachlorobiphenyl (186) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4',5,5',6-Heptachlorobiphenyl (187) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4',5,6,6'-Heptachlorobiphenyl (188) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4,4',5,5'-Heptachlorobiphenyl (189) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4,4',5,6-Heptachlorobiphenyl (190) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4,4',5',6-Heptachlorobiphenyl (191) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4,5,5',6-Heptachlorobiphenyl (192) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4',5,5',6-Heptachlorobiphenyl (193) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,4',5,5'-Octachlorobiphenyl (194) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,4',5,6-Octachlorobiphenyl (195) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |

| Parameter/Analyte | Potable Water | Nonpotable Water | Solid Hazardous Waste | Tissue |
|--|---------------|--------------------|---------------------------|---------------------------|
| 2,2',3,3',4,4',5,6'-Octachlorobiphenyl (196) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,4',6,6'-Octachlorobiphenyl (197) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,5,5',6-Octachlorobiphenyl (198) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,5,5',6'-Octachlorobiphenyl (199) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,5,6,6'-Octachlorobiphenyl (200) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,5',6,6'-Octachlorobiphenyl (201) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',5,5',6,6'-Octachlorobiphenyl (202) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,4',5,5',6-Octachlorobiphenyl (203) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,4,4',5,6,6'-Octachlorobiphenyl (204) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,3,3',4,4',5,5',6-Octachlorobiphenyl (205) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (206) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,4',5,6,6'-Nonachlorobiphenyl (207) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| 2,2',3,3',4,5,5',6,6'-Nonachlorobiphenyl (208) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| Decachlorobiphenyl (209) | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| Monochlorobiphenyl, Total | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| Dichlorobiphenyl, Total | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| Trichlorobiphenyl, Total | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| Tetrachlorobiphenyl, Total | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| Pentachlorobiphenyl, Total | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| Hexachlorobiphenyl, Total | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| Heptachlorobiphenyl, Total | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| Octachlorobiphenyl, Total | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| Nonachlorobiphenyl, Total | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| Decachlorobiphenyl, Total | ----- | EPA 1668A/1668C | EPA 1668A/1668C | EPA 1668A/1668C |
| Per- and Poly-fluorinated compounds | | | | |
| Perfluorobutanesulfonic acid (PFBS) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |

| Parameter/Analyte | Potable Water | Nonpotable Water | Solid Hazardous Waste | Tissue |
|--|---------------|------------------|------------------------|------------------------|
| Perfluoroheptanoic acid (PFHpA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| Perfluorohexanesulfonic acid (PFHxS) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| Perfluorooctanesulfonic acid (PFOS) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| Perfluorooctanoic acid (PFOA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| Perfluorononaic acid (PFNA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| Perfluoroheptanesulfonate (PFHpS) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| Perfluorodecanesulfonate (PFDS) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| Perfluoropentanoic acid (PFPeA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| Perfluoroundecanoic acid (PFUdA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| Perfluorodecanoic acid (PFDA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| Perfluorododecanoic acid (PFDoA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| Perfluorotridecanoic acid (PFTrDA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| Perfluorotetradecanoic acid (PFTeDA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| Perfluorohexadecanoic acid (PFHxDA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| Perfluorobutanoic acid (PFBA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| Perfluorohexanoic acid (PFHxA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| 6:2 Fluorotelomer sulfanate (6:2 FTS) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| 8:2 Fluorotelomer sulfanate (8:2 FTS) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| N-methylperfluoro-1-octanesulfonamide (N-MeFOSA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| N-ethylperfluoro-1-octanesulfonamide (N-EtFOSA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| Perfluorooctane sulfonamide (PFOSA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| N-methylperfluoro-1-octanesulfonamido ethanol (N-MeFOSE) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| N-ethylperfluoro-1-octanesulfonamido ethanol (N-EtFOSE) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| N-ethyl perfluorooctanesulfonamidoacetic acid (N-EtFOSAA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |
| N-methyl perfluorooctanesulfonamidoacetic acid (N-MeFOSAA) | EPA 537 mod | EPA 537 mod | EPA 537 mod (VAL-PFAS) | EPA 537 mod (VAL-PFAS) |

| Parameter/Analyte | Potable Water | Nonpotable Water | Solid Hazardous Waste | Tissue |
|--------------------|---------------|------------------|-----------------------|--------|
| 1,4-Dioxane | | | | |
| 1,4-Dioxane | ----- | EPA 522 mod | ----- | ----- |

Appendix D
Vista Analytical Laboratory SOP 49

| | | |
|---|--------------------|----------------------|
| SOP 49 | Revision: 7 | Supersedes: 6 |
| PREPARATION AND ANALYSIS FOR THE DETERMINATION OF PER and POLY-FLUORINATED COMPOUNDS | | |
| Analyst Review: <i>Alison Clarke</i> | | |
| Management: <i>Mattho Maier</i> | | |
| Quality Assurance: <i>Mojdeh Fiti</i> | | |
| Effective Date: 7 March 2016 | | |

| Revision | Description of Revision |
|-----------------|---|
| 1 | Section 1.1: Removed aqueous matrix, Section 4.3: Modification from 537 method regarding peak symmetry, Section 8: Addition of equipment used for Soil/Tissue method, Section 13.2: Addition of the Soil/Tissue digestion and extraction, Section 13.5: Final volume modified, Section 14.1: Changed the Desolvation Temperature, deleted Section 14.3.2.1.3: following EPA 537 limits, Section 15: Calculations modified, Section 19.2: Soil/Tissue method reference, Table 1A and B: ICAL concentrations changed, Table 3A-C: Addition of table for the Acceptance Criteria for Performance Tests for Aqueous (A), Soil (B) and Tissue (C), Table 4: Table added (reporting limits) |
| 2 | Added Section 4.5: Modification of detection limit calculation |
| 3 | Deleted Table 3C. Combined Soil and Tissue into Table 3B. Updated IS recoveries in Table 3B. |
| 4 | Added Section 4.6: Modification from 537 method regarding forcing ICAL through zero, Added Section 4.7: Maintaining the OPR at a static, mid-level concentration. Section, Added Section 4.8: Modification from 537 method regarding rotating of CCAL points, Section 11.2.1: Changed 10 samples per batch to 20. Section 11.3: Removed section on rotating OPR between low, medium, and high concentrations. Section 11.4: Added MS/MSD per client request, Section 11.5: Duplicate preformed every sample batch, Section 11.4 and 11.5: Perform duplicate samples instead of MS/MSD, Section 11.6: FRB per client request, Section 11.7.1: Updated to reflect that a Second Source is run with every calibration curve, Added section 13.1.3: Aqueous samples with high particulate section, Section 13.5: Modification for the adjustment to final volume, Section 14.4.1: signal to noise modified, 14.5.2: natives within 0.1 min of IS retention time, Section 15.1 added sample weight to calculation, Added Table 3, Table 4A-B: Updated percent recoveries |

| | |
|---|--|
| 5 | <p>Section 2: Added N-EtFOSAA and N-MeFOSAA to compound list, changed FOSA to PFOSA. Updated section 4.1. Added sections 4.2-4.5 in method modifications. Deleted section 4.6 in Method Modifications, as the calibration is now forced through zero. Added Sections 8.20 – 8.22 for new instrument. Added Section 9.2.7: Isopropyl Alcohol. Updated section 11.5 to only perform duplicates per request. Section 13.1.2 changed 250mL to 125mL. Section 13.2.1.1.3: Added vortexing step. Added Section 13.3.2 with volumes used for 100mg/3mL cartridge. 13.4.1: Added spiking of RS. Section 13.5.2: Changed final volume from 0.5mL to 1mL. Section 14.2.1: Changed the Ical to specify quadratic fit and forcing through zero. Sections 14.2.4 and 14.2.5: Added Coefficient of Determination and RSD requirements. Section 14.3.1: All CCCs at midlevel concentration. Added Section 14.5.6: Totals Added section 15.1 quantitation for natives using quadratic regression. Tables: Added N-EtFOSAA, N-MeFOSAA, d₅-N-EtFOSAA, d₃-N-MeFOSAA, 13C₃-PFPeA to appropriate tables, changed FOSA to PFOSA where required. Updated OPR, IPR and sample recovery limits. Updated curve concentrations. Table 3: Updated masses monitored where appropriate. Table 4: Updated recoveries to reflect only reporting those ISs in EPA methods.</p> |
| 6 | <p>Added Section 4.9: Two PFOS transitions are monitored for. Added Section 4.14: Using EDL to check sensitivity. Added Section 14.5.7: Estimated Detection Limits.</p> |
| 7 | <p>Section 13.3: Updated wash solvent</p> |

1. PURPOSE

- 1.1 This SOP outlines and describes the preparative and analytical techniques used for the determination of per and poly-fluorinated compounds (PFAS).

2. SCOPE

- 2.1 All differences between EPA 537, ISO 25101 and actual laboratory techniques have been developed to reduce interference and increase sensitivity.
- 2.2 Data determined to be out-of-control from criteria stated within this SOP, is handled according to procedures addressed within the applicable section.

| Compound | CAS Registry No.* |
|--|--------------------------|
| Perfluorobutanesulfonic acid (PFBS) | 375-73-5 |
| Perfluoroheptanoic acid (PFHpA) | 375-85-9 |
| Perfluorohexanesulfonic acid (PFHxS) | 355-46-4 |
| Perfluorohexanoic acid (PFHxA) | 307-24-4 |
| Perfluorooctanesulfonic acid (PFOS) | 1763-23-1 |
| Perfluorooctanoic acid (PFOA) | 355-67-1 |
| Perfluorobutanoic acid (PFBA) | 375-22-4 |
| Perfluoroheptanesulfonate (PFHpS) | 60270-55-5 |
| Perfluorodecanesulfonate (PFDS) | 13419-61-9 |
| Perfluoropentanoic acid (PFPeA) | 2706-90- |
| Perfluorononaic acid (PFNA) | 375-95-1 |
| Perfluoroundecanoic acid (PFUdA) | 2058-94-8 |
| Perfluorodecanoic acid (PFDA) | 335-76-2 |
| Perfluorododecanoic acid (PFDoA) | 307-55-1 |
| Perfluorotridecanoic acid (PFTrDA) | 72629-94-8 |
| Perfluorotetradecanoic acid (PFTeDA) | 376-06-7 |
| Perfluorohexadecanoic acid (PFHxDA) | 67905-19-5 |
| Perfluorooctadecanoic acid (PFODA) | 16517-11-6 |
| 6:2 Fluorotelomer sulfanate (6:2 FTS) | 27619-97-2 |
| 8:2 Fluorotelomer sulfanate (8:2 FTS) | 39108-34-4 |
| N-methylperfluoro-1-octanesulfonamide (N-MeFOSA) | 31506-32-8 |
| N-ethylperfluoro-1-octanesulfonamide (N-EtFOSA) | 4151-50-2 |
| Perfluorooctane sulfonamide (PFOSA) | 754-91-6 |
| N-methylperfluoro-1-octanesulfonamido ethanol (N-MeFOSE) | 24448-09-7 |
| N-ethylperfluoro-1-octanesulfonamido ethanol (N-EtFOSE) | 1691-99-2 |
| N-ethyl perfluorooctanesulfonamidoacetic acid (N-EtFOSAA) | - |
| N-methyl perfluorooctanesulfonamidoacetic acid (N-MeFOSAA) | - |

*Chemical Abstract Service

3. SUMMARY OF METHOD

- 3.1 This procedure uses ultra performance liquid chromatography/tandem mass

spectrometry (UPLC/MS/MS) for detection and quantitation of per and poly-fluorinated compounds, commonly referred to as PFAS.

- 3.2 All differences between the method and actual laboratory techniques have been developed to reduce interferences and increase sensitivity.
- 3.3 Detection limits are sample-specific and congener-specific.

4. MODIFICATIONS

- 4.1 Calibration standards made using methanol and water.
- 4.2 The extraction volume for aqueous samples is 125mLs.
- 4.3 The internal standard (IS) is not spiked directly into the sample bottle. The IS is spiked into a test tube containing methanol. Then the test tube is poured into the sample bottle.
- 4.4 Drinking water samples follow the IS recovery limits set in EPA Method 537; version 1.1, September 2009. IS recovery limits from all other matrices are derived from the EPA Draft Sludge Method, December 2011.
- 4.5 MS/MSDs and Duplicates performed by client request only.
- 4.6 Additional ISs were added to improve native quantitation. Only the recoveries of ISs listed in EPA methods will be reported.
- 4.7 SPE extracts are concentrated to near dryness and reconstituted in H₂O.
- 4.8 Symmetry of peaks not calculated due to the greatly improved chromatography of UPLC versus HPLC.
- 4.9 Two transitions of PFOS are monitored for and data sets are evaluated to decide which transition is appropriate.
- 4.10 The SPE cartridge used is a polymeric weak anion cartridge and therefore requires the reagents used in the SPE procedure.
- 4.11 The calculation of the detection limit, SOP Section 15.2, differs from Section 9.2.7 in EPA Method 537, version 1.1, September 2009.
- 4.12 The OPR is spiked at a static, mid-level concentration.
- 4.13 Continuing calibration standards are not rotated between a mid and a high concentration.
- 4.14 Section 10.3.2 in EPA Method 537; version 1.1, September 2009 states that absolute areas of ISs must be compared to the most recent ICAL and CCAL. Vista utilizes embedded Estimated Detection Limits (EDL) on a per analyte basis to qualify system sensitivity as well as quantitation by isotope dilution.

5. CONTAMINATION AND INTERFERENCES

- 5.1 Solvents, reagents, glassware and other sample processing hardware may yield discrete artifacts or elevated baselines that may cause misinterpretation of the chromatographic data. All of these materials must be demonstrated to be free from interfering substances under the conditions of analysis by performing laboratory method blanks. Analysts should avoid using materials containing PTFE, where possible.
- 5.2 All differences between EPA 537, ISO 25101 and actual laboratory techniques have been developed to reduce interference and increase sensitivity.
- 5.3 The use of high purity reagents and solvents helps to minimize interference problems.
- 5.4 Interferants co-extracted from the sample will vary considerably from matrix to matrix.

6. DEFINITIONS

- 6.1 Definitions are presented in the Glossary.

7. SAFETY

- 7.1 Procedures shall be carried out in a manner that protects the health and safety of all Vista employees.
- 7.2 Each chemical compound should be treated as a potential health hazard. Exposure to these compounds should be reduced to the lowest possible level. All compounds or reagents should be handled only by highly trained personnel thoroughly familiar with handling and cautionary procedures and the associated risks.
- 7.3 Additional health and safety information can be obtained from material safety data sheets (MSDSs) available to all personnel involved in these analyses.
- 7.4 In the event of a known or potential compromise to the health and safety of a Vista associate, all work must stop and the incident reported immediately to management.
- 7.5 Contamination of the laboratory will be minimized by conducting most of the manipulations in a hood
- 7.6 The toxicity or carcinogenicity of each chemical used in this method has not been precisely determined; however, each compound should be treated as a potential health hazard. Exposure to these compounds 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 MSDS should also be made available to all

personnel involved in these analyses.

8. APPARATUS AND MATERIALS

Note: All materials used should be suitable for LC work, and comparable brand materials can be substituted where specific brands are mentioned.

- 8.1 Analytical Balances, capable of reading to 0.01g and 0.0001g
- 8.2 Solid Phase Extraction Manifold (Waters)
- 8.3 [REDACTED]
- 8.4 Silicone tubing, 1/16" diameter, various lengths (Nalgene)
- 8.5 Screw top polypropylene LC vials, 12x32mm (Waters)
- 8.6 HDPE Bottle various sizes (Nalgene)
- 8.7 Screw caps with pre-slit polypropylene septa, for 12x32mm vials (Waters)
- 8.8 Disposable polypropylene Pasteur pipets, various sizes
- 8.9 Chlorine test strips (Hach Aquacheck, or equivalent)
- 8.10 Organomation 24-Station N-Evaporator with water bath capable of heating to 65°C
- 8.11 Polypropylene centrifuge tubes, 13 mm x 100 mm
- 8.12 Wiretrol II Precision Disposable Micropipettes
- 8.13 Sonicator, VWR, Model 150T
- 8.14 Eppendorf Centrifuge, Model 5804
- 8.15 [REDACTED] particle size
- 8.16 [REDACTED]
- 8.17 Acquity Ultra Performance LC (Waters)
- 8.18 Lenovo computer work station with MassLynx Software
- 8.19 Quattro Premier XE with Micromass Technology (Waters)
- 8.20 Shimadzu X2 UPLC
- 8.21 Lenovo computer work station with Analyst and MultiQuant Software
- 8.22 API 4000Q (Sciex)

9. REAGENTS, SOLVENTS AND STANDARDS

- 9.1 Reagents (HPLC grade or above)
 - 9.1.1 Trizma pre-set crystals (Supelco cat #T-7193)

- 9.1.2 Sodium Acetate, HPLC grade
- 9.1.3 Ammonium Acetate, HPLC grade
- 9.1.4 Ammonium Hydroxide, Concentrated
- 9.1.5 Formic Acid, Concentrated
- 9.1.6 Ultra-pure nitrogen gas
- 9.1.7 Ultra-pure argon gas
- 9.2 Solvents (HPLC Grade or above)
 - 9.2.1 Reagent Water
 - 9.2.2 Acetonitrile
 - 9.2.3 Hexane
 - 9.2.4 Methanol (MeOH)
 - 9.2.5 Methylene chloride (DCM)
 - 9.2.6 Acetone
 - 9.2.7 Isopropyl Alcohol
- 9.3 Standards
 - 9.3.1 All analytical standards are obtained from a certified vendor.
 - 9.3.2 See SOP 15 and the current spike sheet for more information.

10. COLLECTION, PRESERVATION, AND HANDLING

- 10.1 HDPE or polypropylene bottles and jars must be used for collection.
- 10.2 Trizma is added to the sample bottles prior to the collection of drinking water samples in the amount of 5.0g/L.
- 10.3 Aqueous samples must be extracted or frozen within 14 days of collection and analyzed within 28 days of extraction.
- 10.4 Solid and Tissue samples must be extracted within 60 days from collection and analyzed within 30 days of extraction.
- 10.5 Store at < 6°C.

11. QUALITY CONTROL

- 11.1 Each time a modification is made to this method and the detection limit will be affected by the change, the laboratory is required to demonstrate that the MDL is lower than one-third the regulatory compliance level or one-third the method reporting limit (MRL) in the method, whichever is higher.
- 11.2 Method Blank (MB): Method blank is a matrix preparation that is free of native

analyte that has been prepared and analyzed using the same procedures followed for the rest of the analytical batch. Simulate as close as possible the matrix to be extracted.

- 11.2.1 Daily or with each extraction batch of up to 20 samples, (whichever is more frequent).
 - 11.2.2 For the determination of native PFAS, the levels measured in the method blank of all method analytes must be below 1/3 the MRL.
 - 11.2.3 If amount found is greater than the minimum level or one-third the regulatory compliance limit, whichever is greater; or if any potentially interfering compound is found in the blank at or above the minimum level for each congener, the data must be evaluated to determine whether the batch shall be re-extracted or the data are qualified appropriately.
 - 11.2.4 If there is evidence of contamination within the MB, then the source of the contamination must be located. The data must be evaluated to determine whether the batch shall be re-extracted or the data is qualified appropriately.
- 11.3 Ongoing Precision and Recovery Samples (OPR): An ongoing precision and recovery sample is prepared by adding a known quantity of native standards to an interferant free matrix and used to assess method performance (precision and recovery).
- 11.3.1 Add the appropriate amount of native spike. The native spikes contain the compounds listed in Table 1.
 - 11.3.2 An OPR is analyzed with every analytical batch.
 - 11.3.3 The OPR % recoveries for native and internal standards must be within the limits shown in table 4.
 - 11.3.4 If the percent recovery of the native or internal standard of an isomer in the OPR is out of method limits, it is recommended that the sample(s) be re-extracted and/or re-analyzed.
- 11.4 Matrix Spike (MS/MSD): A matrix spike sample is prepared by adding the appropriate quantity of native standards to a sample matrix prior to extraction. MS/MSD's are performed by client request
- 11.4.1 The relative percent difference (RPD) between MS/MSD samples should be $\leq 30\%$.
 - 11.4.2 If RPD does not meet the acceptance criteria, the data is evaluated and qualified appropriately.
- 11.5 Duplicate Samples: Duplicate samples are two separate aliquots taken from the same source. Duplicate samples are analyzed independently to assess

laboratory precision. Duplicate samples are performed by client request.

- 11.5.1 The relative percent difference between duplicate samples should be $\leq 30\%$
 - 11.5.2 If the concentration is within a factor of 2 of the MRL, the relative percentage difference (RPD) must be $\leq 50\%$
 - 11.5.3 If the RPD does not meet the acceptance criteria, the data are evaluated and qualified appropriately.
- 11.6 Field Reagent Blank (FRB): A field reagent blank is a matrix preparation that is free of native analyte transported to the field in sealed containers and returned with the samples. FRB's are performed upon client request.
- 11.6.1 Analysis of the FRB is only necessary if a Field Sample contains a method analyte at or above the MRL.
- 11.7 Second source standard: Analytes from a different source than that of the calibration standards. This is prepared and analyzed in the same way as a CCC.
- 11.7.1 This is analyzed with every calibration curve.
 - 11.7.2 The calculated value for the second source standard must be within $\pm 30\%$ of the expected value.

12. SAMPLE PREPARATION

- 12.1 Residual Chlorine Determination
- 12.1.1 Obtain an Aquacheck strip and place it directly into a small amount of sample in a disposable weigh boat. Move the strip back and forth for 30 seconds.
 - 12.1.2 Check the color on the strip against the color chart on Aquacheck container.
 - 12.1.3 If there is chlorine present, add Trizma to the sample bottle.
 - 12.1.4 Record the procedure on extraction benchsheet.

13. EXTRACTION PROCEDURES

- 13.1 Aqueous Samples
- 13.1.1 Record the combined weight of the bottle, cap and sample for each sample to be extracted. After the sample has been removed from the bottle, allow it to drain overnight and reweigh it and the cap to determine the amount of sample extracted.
 - 13.1.2 For the method blank (MB) and OPR(s), transfer $\sim 125\text{mL}$ of reagent water into a bottle for each.
 - 13.1.3 Aqueous samples with high particulates must be centrifuged at $3000 \times g$ for 10 minutes, then decanted into a clean HDPE bottle.

13.1.4 Add the appropriate volume of Internal Standard (IS) solution and the appropriate volume of Native Standard (NS) solution to OPR, MS or MSD. Allow the spiked samples to equilibrate for at least 1 hour before extraction.

13.2 Solid/Tissue Samples

13.2.1 Digestion

13.2.1.1.1 Weigh out approximately 1g of solid or well ground fish/tissue into a polypropylene test tube.

13.2.1.1.2 Add the appropriate volume of Internal Standard (IS) solution and the appropriate volume of Native Standard (NS) solution to OPR, MS, or MSD.

13.2.1.1.3 [REDACTED].

13.2.1.1.4 Sonicate for 30 minutes.

13.2.1.1.5 Incubate for 12-18 hrs at ambient temperature

13.2.2 Neutralization

13.2.2.1.1 [REDACTED]

13.2.3 Extraction

13.2.3.1.1 Add [REDACTED]

13.2.3.1.2 Shake for 1 hour and centrifuge

13.2.3.1.3 Decant [REDACTED] Bottle containing [REDACTED].

13.2.3.1.4 Repeat the extraction process (13.2.3.1.1-13.2.3.1.3)

13.3 SPE Cleanup

13.3.1 [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED].

13.3.1.1.6 [REDACTED]

13.4 Cartridge Elution

13.4.1 [REDACTED]. Collect extracts eluted from the column into clean test tube containing the appropriate amount of RS.

13.5 Adjustment to Final Volume

13.5.1 Concentrate extract to near dryness under a gentle stream of nitrogen and a water bath set at $30 \pm 5^\circ\text{C}$

13.5.2 Reconstitute to [REDACTED]

13.5.3 If cloudy, centrifuge for 5 mins.

14. LC/MS ANALYSIS

14.1 Establish the necessary conditions. The LC conditions may be optimized for compound separation and sensitivity. Once optimized, the same LC conditions must be used for the analysis of all standards, blanks, OPR aliquots and samples. The following LC operating conditions are guidance and adjustments may be required

Column: [REDACTED] particle size

Ionization: Negative Ion Electrospray

Acquisition: MRM mode, unit resolution

Injection Volume: 5-15 μL

| General LC Conditions | |
|------------------------------|------------|
| Column Temp | 60°C |
| Max Pressure | 15,000 psi |
| Autosampler Tray Temp. | 18°C |
| MS Conditions | |
| Source Temp. | 150°C |
| Desolvation Temp. | 320°C |
| Cone/Desolvation | 25 L/hr |
| Gas Rate | 850 L/hr |

| <i>LC Gradient Program</i> | | | <i>LC Gradient Program</i> | Gradient |
|----------------------------|---------------|------|----------------------------|----------|
| Time (min) | Flow Mixture* | | | |
| 0.00 | 90%A | 10%B | 0.400 | |
| 5.00 | 10%A | 90%B | 0.400 | 6 |
| 8.00 | 6%A | 94%B | 0.400 | 6 |
| 8.10 | 1%A | 99%B | 0.400 | 6 |
| 10.00 | 1%A | 99%B | 0.400 | 6 |
| 10.10 | 90%A | 10%B | 0.400 | 1 |
| 11.40 | 90%A | 10%B | 0.400 | 6 |

- Solvent A = 20mM NH₄OAc in 95:5 HPLC water:MeOH
- Solvent B = 20mM NH₄OAc in MeOH

14.2 Initial Calibration (ICAL)

14.2.1 An initial calibration curve is created using a quadratic fit over the calibration range and consisting of at least 5 points. This curve must be forced through zero. An initial calibration is repeated at least annually, whenever a new set of spiking calibration standards is created or whenever the continuing calibration falls outside the acceptance criteria.

14.2.2 Establish the operating conditions suggested in Section 14.1

14.2.3 The following retention time criterion must be met:

14.2.3.1.1 The absolute retention time of the last-eluted compound must be $\pm 0.5\%$ of its targeted value.

14.2.4 The Coefficient of determination for all native compounds must be greater than or equal to 0.96.

14.2.5 RSD requirements are $\leq 35\%$ for all internal standards.

14.3 Continuing Calibration

14.3.1 A continuing calibration check (CCC) must be analyzed at the beginning, after every 10 samples and at the end of each analytical run. All CCC's are at a midlevel concentration.

14.3.2 The continuing calibration verification is acceptable if the following criteria are met:

- 14.3.2.1.1 The LC peak representing each native and labeled compound must be present with a S/N ≥ 10 .
- 14.3.2.1.2 The percent recovery for native standards and the internal standards must be within the limits shown in Table 4.
- 14.3.2.1.3 The retention times for internal compounds must be within ± 15 seconds of the respective retention times in the most recent CCC.

14.4 Qualitative Determination

- 14.4.1 The signal to noise ratio (S/N) at the LC peak maximum for each native compound must be greater than or equal to 3 for each compound detected in a sample extract.
- 14.4.2 The retention time of the peak for a native compound must be within ± 15 seconds of its RT in the most recent CCC standard.

14.5 Quantitative Determination

- 14.5.1 Calibration by Isotope Dilution: Isotope dilution calibration is used for the native PFAS for which labeled compounds are available.
- 14.5.2 Native compounds should have a retention time within 0.1 mins. of its equivalent internal standard.
- 14.5.3 Recovery of each internal standard versus the recovery standard must be within the limits shown in table 4.
- 14.5.4 Recoveries below the limits may be accepted if the signal to noise is $>10:1$. If the signal to noise is not $>10:1$, samples must be re-extracted and re-analyzed or the data must be qualified.
- 14.5.5 If a chromatographic peak of any of the analyte saturates the detector, a dilution of the extract must be analyzed.
- 14.5.6 PFBS, PFHpS, PFHxS, PFOS, N-MeFOSAA and N-EtFOSAA have both linear and branched isomers. All chromatographic peaks for these compounds are integrated and the areas totaled. Technical mixtures are referenced when available.
- 14.5.7 For PFAS compounds that are not identified, an estimated detection limit (EDL) must be calculated. Analytes must achieve a EDL of 1/3 the reporting limit or lower.

15. CALCULATIONS

- 15.1 The concentration of native compounds are determined by quadratic regression:

$$NRR = \frac{A_x}{A_y} Q_y$$

Where:

- NRR = Normalized relative response
- A_x = Area of the quantitation ion for the native compound in sample
- A_y = Area of the quantitation ion for the labeled compound in sample
- Q_y = Quantity of Internal Standard in sample

- 15.1.1 Determine the calibration equation for each compound by regressing the NRR against the native compound concentration.
- 15.1.2 The curve may be concentration weighted based on the analysts discretion.

- 15.2 The concentration of each internal standard is calculated as follows:

$$C_{Samp} = \frac{A_x Q_y}{A_y RRF S_w}$$

Where:

- C_{Samp} = Concentration of compound in sample
- A_x = Area of the quantitation ion for the native compound in sample
- A_y = Area of the quantitation ion for the labeled compound in sample
- Q_y = Quantity, in pg, of Internal Standard in sample
- S_w = Sample weight
- RRF = Relative response factor, a sum of the response factors (RF):

$$\sum RF = \frac{A_n C_l}{A_l C_n}$$

Where:

- C_l = Internal Standard Concentration at the curve point
- A_x = Area of daughter m/z for native compound
- A_l = Area of daughter m/z for labeled compound
- C_n = Concentration of Native Standard at the curve point

- 15.3 The detection limits can be calculated using the following formula:

$$DL = \frac{(2.5)(H_N)(Q_{IS})}{(H_{IS})(S)(RRF_N)}$$

Where:

- DL = Detection Limit,
- H_N = Noise height (peak to peak),
- H_{IS} = Peak height of the internal standard,
- Q_{IS} = Quantity, in pg, of the internal standard added to the

sample before extraction

S = Weight or volume of the sample, and

RRF_N = Calculated relative response factor for the analyte.

15.4 Internal standard recoveries are calculated by using the formula:

$$\%Rec = \frac{(A_{IS})(Q_{RS}) \times 100}{(A_{RS})(Q_{IS})(RRF_{IS})}$$

Where:

A_{IS} = Area of the quantitation ion for the internal standard.

A_{RS} = Area of the quantitation ion for the recovery standard.

Q_{IS} = Quantity of the internal standard.

Q_{RS} = Quantity of the recovery standard.

RRF_{IS} = Calculated relative response factor for the internal standard analyte.

15.5 Relative Response Factors can be calculated using the following formula:

$$RRF = \frac{(A_N)(Q_{IS})}{(A_{IS})(Q_N)}$$

Where:

A_N = Area of the quantitation ion for the native compound

A_{IS} = Area of the quantitation ion for the labeled compound.

Q_{IS} = Quantity of the internal standard in the calibration standard.

Q_N = Quantity of the native compound in the calibration standard

15.6 RRF for unlabeled analytes (optional) (RRF_N) and for labeled analytes (RRF_{IS}):

$$RRF_N = \frac{(A_X)(Q_{IS})}{(Q_X)(A_{IS})} \qquad RRF_{IS} = \frac{(A_{IS})(Q_{RS})}{(Q_{IS})(A_{RS})}$$

Where:

A_X = Sum of the integrated ion abundances of the quantitation ions for the unlabeled analyte

A_{IS} = Sum of the integrated ion abundances of the quantitation ions for the labeled standards

A_{RS} = Sum of the integrated ion abundances of the quantitation ions for the labeled recovery standards

Q_{IS} = Quantity of internal standard injected (pg)

Q_{RS} = Quantity of recovery standard injected (pg)

Q_X = Quantity of unlabeled analyte injected (pg)

15.7 The RPD is calculated as follows:

$$RPD = \frac{(H - L)}{(H + L) / 2} * 100$$

Where:

RPD = *Relative Percentage Difference*
H = *Highest area*
L = *Lowest area*

16. POLLUTION PREVENTION

- 16.1 The solvent evaporation techniques used in this method are amenable to solvent recovery, and the laboratory shall recover solvents wherever feasible.
- 16.2 Standards should be prepared in volumes consistent with laboratory use to minimize disposal of standard.

17. WASTE MANAGEMENT

- 17.1 Waste generated in the procedure must be segregated and disposed according to the facility hazardous waste procedures. Safety officer should be contacted if additional information is required.
- 17.2 The laboratory waste management is in compliance with all federal, state, and local regulations to protect the air, water, and land by minimizing and controlling all releases from fume hoods and bench operations

18. METHOD PERFORMANCE

- 18.1 This SOP is based on methods noted as references (Section 19).

19. REFERENCES

- 19.1 ISO 25101:2009 – Water Quality – Determination of perfluorooctanesulfonate (PFOS) and perfluorooctanonate (PFOA) – Method for unfiltered samples using solid phase extraction and liquid chromatography/mass spectrometry, 1st edition, Dated March 2009.
- 19.2 EPA 821-R-11-007- Draft Procedure for Analysis of Perfluorinated Carboxylic Acids and Sulfonic Acids in Sewage Sludge and Biosolids by HPLC/MS/MS, Draft, December 2011.
- 19.3 Method 537, Determination of Selected Perfluorinated Alkyl Acids in Drinking Water by Solid Phase Extraction and Liquid Chromatography/Tandem Mass Spectrometry (LC/MS/MS), Version 1.1, September 2009.

Appendix

- 19.4 Figure 1. Extraction Manifold Set-up

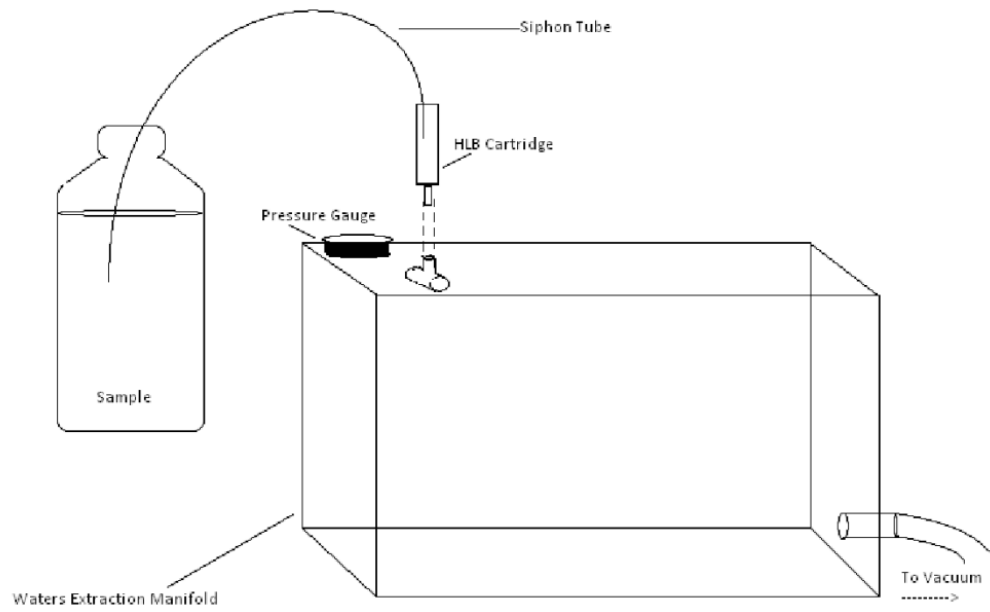


Table 1
Calibration Curve Concentration (pg/μL)

| Compound | CS(-1) | CS0* | CS1 | CS2 | CS3 | CS4* | CS5 | CS6* |
|-----------|--------|------|-----|-----|-----|------|------|------|
| PFBS | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFHpA | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFHxS | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFHxA | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFOS | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFOA | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFBA | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFHpS | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFDS | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFPeA | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFDA | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFNA | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFUdA | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFDoA | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFTTrDA | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFTeDA | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFHxDA | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| PFODA | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| 6:2 FTS | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| 8:2 FTS | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| N-MeFOSA | 5.0 | 10 | 20 | 50 | 100 | 500 | 1000 | 2000 |
| N-EtFOSA | 5.0 | 10 | 20 | 50 | 100 | 500 | 1000 | 2000 |
| PFOSA | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| N-MeFOSE | 5.0 | 10 | 20 | 50 | 100 | 500 | 1000 | 2000 |
| N-EtFOSE | 5.0 | 10 | 20 | 50 | 100 | 500 | 1000 | 2000 |
| N-EtFOSAA | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |
| N-MeFOSAA | 0.5 | 1.0 | 2.0 | 5.0 | 10 | 50 | 100 | 200 |

* Calibration Verification Solution

Table 2
Calibration Curve Concentration (pg/ μ L)

| Internal Standard | CS-1 | CS0 | CS1 | CS2 | CS3 | CS4* | CS5 | CS6 |
|---------------------------------------|------|-----|-----|-----|-----|------|-----|-----|
| ¹³ C ₃ -PFBA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₃ -PFPeA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₂ -PFDA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₄ -PFHpA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹⁸ O ₂ -PFHxS | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₂ -6:2 FTS | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₂ -PFOA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₈ -PFOS | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₅ -PFNA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₂ -8:2 FTS | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₈ -PFOSA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₂ -PFUdA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₂ -PFDoA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| d ₃ -N-MeFOSA | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| d ₇ -N-MeFOSE | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| d ₉ -N-EtFOSE | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| d ₅ -N-EtFOSA | 150 | 150 | 150 | 150 | 150 | 150 | 150 | 150 |
| ¹³ C ₂ -PFTeDA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₂ -PFHxDA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| d ₅ -N-EtFOSAA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |

Table 2
Calibration Curve Concentration (pg/μL)

| Recovery Standard | | | | | | | | |
|--------------------------------------|----|----|----|----|----|----|----|----|
| ¹³ C ₂ -PFHxA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₄ -PFBA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₂ -4:2FTS | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₈ -PFOA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₄ -PFOS | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₉ -PFNA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| d ₃ -N-MeFOSAA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₇ -PFUdA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |
| ¹³ C ₂ -FOUEA | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |

* Calibration Verification Solution

Table 3
Exact Masses Monitored

| Compound | Native Parent-Daughter | Internal Standard | Native Parent-Daughter |
|---------------------------------------|------------------------|---------------------------------------|------------------------|
| PFBS | 299.0 – 79.7 | ¹³ C ₄ -PFHpA | 367.2 – 321.8 |
| PFHpA | 363.0 – 318.9 | ¹³ C ₄ -PFHpA | 367.2 – 321.8 |
| PFHxS | 398.9 – 79.6 | ¹⁸ O ₂ -PFHxS | 403.0 – 102.6 |
| PFHxA | 313.2 – 268.9 | ¹³ C ₄ -PFHpA | 367.2 – 321.8 |
| PFOS | 499.0 – 98.7 | ¹³ C ₈ -PFOS | 507.1 – 98.6 |
| PFOA | 413.0 – 368.7 | ¹³ C ₂ -PFOA | 414.9 – 369.7 |
| PFBA | 213.1 – 168.8 | ¹³ C ₃ -PFBA | 216.1 – 171.8 |
| PFHpS | 449.0 – 98.7 | ¹⁸ O ₂ -PFHxS | 403.0 – 102.6 |
| PFDS | 598.8 – 98.7 | ¹³ C ₂ -PFDA | 515.1 – 469.9 |
| PFPeA | 263.1 – 218.9 | ¹³ C ₃ -PFPeA | 266.0 – 221.8 |
| PFDA | 513.0 – 468.8 | ¹³ C ₂ -PFDA | 515.1 – 469.9 |
| PFNA | 463.0 – 418.8 | ¹³ C ₅ -PFNA | 468.2 – 422.9 |
| PFUdA | 563.0 – 518.9 | ¹³ C ₂ -PFUdA | 565.0 – 519.8 |
| PFDoA | 612.9 – 568.8 | ¹³ C ₂ -PFDoA | 615.0 – 569.7 |
| PFTTrDA | 662.9 – 618.9 | ¹³ C ₂ -PFDoA | 615.0 – 569.7 |
| | | ¹³ C ₂ -PFTTeDA | 715.0 – 669.7 |
| PFTTeDA | 712.9 – 668.8 | ¹³ C ₂ -PFTTeDA | 715.0 – 669.7 |
| PFHxDA | 813.1 – 768.6 | ¹³ C ₂ -PFHxDA | 815.0 – 769.7 |
| PFODA | 913.1 – 868.8 | ¹³ C ₂ -PFHxDA | 815.0 – 769.7 |
| 6:2 FTS | 427.1 – 407.0 | ¹³ C ₂ -6:2 FTS | 429.1 – 408.9 |
| 8:2 FTS | 527.0 – 506.9 | ¹³ C ₂ -8:2 FTS | 529.1 – 508.7 |
| N-MeFOSA | 512.1 – 168.9 | d ₃ -N-MeFOSA | 515.2 – 168.9 |
| N-EtFOSA | 526.1 – 168.9 | d ₅ -N-EtFOSA | 531.1 – 168.9 |
| PFOSA | 498.1 – 77.8 | ¹³ C ₈ -PFOSA | 506.1 – 77.7 |
| N-MeFOSE | 616.1 – 58.9 | d ₇ -N-MeFOSE | 623.1 – 58.9 |
| N-EtFOSE | 630.1 – 58.9 | d ₉ -N-EtFOSE | 639.2 – 58.8 |
| N-EtFOSAA | 584.2 – 419.0 | d ₅ -N-EtFOSAA | 589.3 – 419.0 |
| N-MeFOSAA | 570.1 – 419.0 | d ₅ -N-EtFOSAA | 589.3 – 419.0 |
| Recovery Standard | | | |
| ¹³ C ₂ -PFHxA | 315.0 – 269.8 | NA | NA |
| ¹³ C ₂ -FOUEA | 459.1 – 393.9 | NA | NA |
| ¹³ C ₄ -PFBA | 217 – 171.8 | NA | NA |
| ¹³ C ₂ -4:2 FTS | 329.2 – 308.9 | NA | NA |

| Compound | Native Parent-Daughter | Internal Standard | Native Parent-Daughter |
|------------------------------------|------------------------|-------------------|------------------------|
| ¹³ C ₈ -PFOA | 421.3 – 376.0 | NA | NA |

Table 3
Exact Masses Monitored

| Recovery Standard | | | |
|-------------------------------------|---------------|----|----|
| ¹³ C ₄ -PFOS | 503.2 – 98.6 | NA | NA |
| ¹³ C ₉ -PFNA | 472.2 – 426.9 | NA | NA |
| d ₃ -N-MeFOSAA | 573.3 – 419.0 | NA | NA |
| ¹³ C ₇ -PFUdA | 570.1 – 524.8 | NA | NA |

Table 4
Acceptance Criteria for Performance Tests

| Compound | CCC | IPR | | OPR % | Labeled compound recovery in samples % |
|----------|--------|-------|--------|--------|--|
| | | RSD % | Ave % | | |
| PFBA | 70-130 | 20 | 70-130 | 70-130 | NA |
| PFPeA | 70-130 | 20 | 70-130 | 70-130 | NA |
| PFBS | 70-130 | 20 | 60-130 | 60-130 | NA |
| PFHxA | 70-130 | 20 | 70-130 | 70-130 | NA |
| PFHpA | 70-130 | 20 | 70-130 | 70-130 | NA |
| PFHxS | 70-130 | 20 | 70-130 | 70-130 | NA |
| 6:2 FTS | 70-130 | 20 | 60-130 | 60-130 | NA |
| PFOA | 70-130 | 20 | 70-130 | 70-130 | NA |
| PFHpS | 70-130 | 20 | 70-130 | 70-130 | NA |
| PFOS | 70-130 | 20 | 70-130 | 70-130 | NA |
| PFNA | 70-130 | 20 | 50-130 | 50-130 | NA |
| PFDA | 70-130 | 20 | 70-130 | 70-130 | NA |
| 8:2 FTS | 70-130 | 20 | 60-130 | 60-130 | NA |
| PFOSA | 70-130 | 20 | 20-130 | 20-130 | NA |
| PFDS | 70-130 | 20 | 40-130 | 40-130 | NA |
| PFUdA | 70-130 | 20 | 70-130 | 70-130 | NA |
| PFDoA | 70-130 | 20 | 70-130 | 70-130 | NA |
| N-MeFOSA | 70-130 | 20 | 5-130 | 5-130 | NA |

| Compound | CCC | IPR | | OPR % | Labeled compound recovery in samples % |
|---------------------------------------|--------|-------|--------|--------|--|
| | | RSD % | Ave % | | |
| N-MeFOSE | 70-130 | 20 | 40-130 | 40-130 | NA |
| PFTrDA | 70-130 | 20 | 20-130 | 20-130 | NA |
| N-EtFOSA | 70-130 | 20 | 5-130 | 5-130 | NA |
| N-EtFOSE | 70-130 | 20 | 10-130 | 10-130 | NA |
| PFTeDA | 70-130 | 20 | 20-130 | 20-130 | NA |
| PFHxDA | 70-130 | 20 | 40-130 | 40-130 | NA |
| PFODA | 70-130 | 20 | 40-130 | 40-130 | NA |
| N-EtFOSAA | 70-130 | 20 | 70-130 | 70-130 | NA |
| N-MeFOSAA | 70-130 | 20 | 70-130 | 70-130 | NA |
| ¹³ C ₃ -PFBA | 60-150 | 20 | 60-150 | 60-150 | 60-150 |
| ¹³ C ₃ -PFPeA | N/A | N/A | N/A | N/A | N/A |
| ¹³ C ₄ -PFHpA | N/A | N/A | N/A | N/A | N/A |
| ¹⁸ O ₂ -PFHxS | 60-150 | 20 | 60-150 | 60-150 | 60-150 |
| ¹³ C ₂ -6:2 FTS | N/A | N/A | N/A | N/A | N/A |
| ¹³ C ₂ -PFOA | 60-150 | 20 | 60-150 | 60-150 | 60-150 |
| ¹³ C ₈ -PFOS | 60-150 | 20 | 60-150 | 60-150 | 60-150 |
| ¹³ C ₅ -PFNA | 50-150 | 20 | 50-150 | 50-150 | 50-150 |
| ¹³ C ₂ -PFDA | 60-150 | 20 | 60-150 | 60-150 | 60-150 |
| ¹³ C ₂ -8:2 FTS | N/A | N/A | N/A | N/A | N/A |
| ¹³ C ₈ -PFOSA | N/A | N/A | N/A | N/A | N/A |

| Compound | CCC | IPR | | OPR % | Labeled compound recovery in samples % |
|--|--------|-------|--------|--------|--|
| | | RSD % | Ave % | | |
| ¹³ C ₂ -PFUdA | 60-150 | 20 | 60-150 | 60-150 | 60-150 |
| ¹³ C ₂ -PFD _o A | 30-150 | 20 | 30-150 | 30-150 | 30-150 |
| d ₃ -N-MeFOSA | N/A | N/A | N/A | N/A | N/A |
| d ₇ -N-MeFOSE | 5-150 | 20 | 5-150 | 5-150 | 5-150 |
| d ₉ -N-EtFOSE | N/A | N/A | N/A | N/A | N/A |
| d ₅ -N-EtFOSA | N/A | N/A | N/A | N/A | N/A |
| ¹³ C ₂ -PFTeDA | N/A | N/A | N/A | N/A | N/A |
| ¹³ C ₂ -PFHxDA | N/A | N/A | N/A | N/A | N/A |
| d ₅ -N-EtFOSAA | 20-150 | 20 | 20-150 | 20-150 | 20-150 |

Table 5
Reporting Limits

| Compound | RL Aqueous (ng/L) | RL Solid (ng/g) | RL Tissue (ng/g) |
|-----------------|--------------------------|------------------------|-------------------------|
| PFBS | 4.0 | 0.5 | 0.5 |
| PFHpA | 4.0 | 0.5 | 0.5 |
| PFHxS | 4.0 | 0.5 | 0.5 |
| PFHxA | 4.0 | 0.5 | 0.5 |
| PFOS | 4.0 | 0.5 | 0.5 |
| PFOA | 4.0 | 0.5 | 0.5 |
| PFBA | 4.0 | 0.5 | 0.5 |
| PFHpS | 4.0 | 0.5 | 0.5 |
| PFDS | 4.0 | 0.5 | 0.5 |
| PFPeA | 4.0 | 0.5 | 0.5 |
| PFDA | 4.0 | 0.5 | 0.5 |
| PFNA | 4.0 | 0.5 | 0.5 |
| Compound | RL Aqueous (ng/L) | RL Solid (ng/g) | RL Tissue (ng/g) |
| PFUdA | 4.0 | 0.5 | 0.5 |
| PFDoA | 4.0 | 0.5 | 0.5 |
| PFTTrDA | 4.0 | 0.5 | 0.5 |
| PFTeDA | 4.0 | 0.5 | 0.5 |
| PFHxDA | 4.0 | 0.5 | 0.5 |
| PFODA | 4.0 | 0.5 | 0.5 |
| 6:2 FTS | 4.0 | 0.5 | 0.5 |
| 8:2 FTS | 4.0 | 0.5 | 0.5 |
| N-MeFOSA | 40 | 5.0 | 5.0 |
| N-EtFOSA | 40 | 5.0 | 5.0 |
| PFOSA | 4.0 | 0.5 | 0.5 |
| N-MeFOSE | 40 | 5.0 | 5.0 |
| N-EtFOSE | 40 | 5.0 | 5.0 |
| N-MeFOSAA | 4.0 | 0.5 | 0.5 |
| N-EtFOSAA | 4.0 | 0.5 | 0.5 |

*RL's based on 125mLs for aqueous samples and 1g for solids and tissues.

Glossary

Analyte — Compound of interest. The analytes are listed in Table 1.

Calibration Standard — A solution prepared from a stock solution and used to calibrate the response of the HPLC/MSMS.

Calibration Verification Standard (CCC) — Calibration Standard containing a known concentration of native analytes, internal standard and recovery standards. This is analyzed to verify the accuracy of the existing calibration for those analytes.

Field Reagent Blank — A field reagent blank is a matrix preparation that is free of native analyte transported to the field in sealed containers and returned with the samples

Internal Standard – A labeled compound used as a reference for quantitation of other labeled and native compounds.

IPR — Initial precision and recovery; four aliquots of a reference material spiked with analytes of interest are analyzed to establish the ability of the laboratory to generate acceptable precision and recovery. An IPR is performed anytime the method or instrumentation is modified.

Isotope dilution quantitation – Determination of a naturally occurring (native) compound by reference to the same compound in which one or more atoms has been isotopically enriched. This method employs ^2H or ^{13}C labeled analogs which are spiked into each sample

LC – Liquid chromatography

Labeled Compound – A molecule in which one or more of the atoms is isotopically enriched, thereby increasing the mass of the molecule

Laboratory Blank — See method blank.

May — This action, activity, or procedural step is neither required nor prohibited.

May Not — This action, activity, or procedural step is prohibited.

Method Blank — An aliquot of reagent water that is treated exactly as a sample including exposure to all glassware, equipment, solvents, reagents, internal standards, and surrogates that are used with samples. The method blank is used to determine if analytes or interferences are present in the laboratory environment, the reagents, or the apparatus.

Method Detection Limit (MDL) — The lowest concentration at which an analyte can be detected under routine operating conditions (see 40 CFR 136, Appendix B).

MS — Mass spectrometer or mass spectrometry.

Must — This action, activity, or procedural step is required.

Native Compound – A molecule in which all atoms have naturally occurring isotopic abundances

OPR — Ongoing precision and recovery sample (OPR); a laboratory blank spiked with known quantities of analytes. The OPR is analyzed exactly like a sample. Its purpose is to assure that the results produced by the laboratory remain within the limits specified in this method for precision and recovery.

Reagent Water — Water demonstrated to be free from the analytes of interest and potentially interfering substances at the method detection limit for the analyte.

Relative Standard Deviation (RSD) — The standard deviation times 100 divided by the mean. Also termed "coefficient of variation."

RPD – Relative Percent Difference shown

RF — Response factor.

RRF — Relative response factor.

Should — Although this action, activity, or procedural step is suggested, it is not required.

SICP — Selected ion current profile; the line described by the signal at an exact m/z.

Signal-to-noise ratio (S/N) – The height of the signal as measured from the mean of the noise to the peak maximum divided by the width of the noise.

SPE — Solid-phase extraction; an extraction technique in which an analyte is extracted from an aqueous sample by passage over or through a material capable of reversibly adsorbing the analyte.

Stock Solution — A solution containing an analyte that is prepared using a reference material traceable to EPA, the National Institute of Science and Technology (NIST), or a source that will attest to the purity and authenticity of the reference material.

UPLC — Ultra performance liquid chromatography