Sampling and Analysis Plan
for
Site 1 Groundwater Monitoring

Naval Air Station
Joint Reserve Base (NAS JRB)
Willow Grove, Pennsylvania

Naval Facilities Engineering Command
Mid-Atlantic

Contract Number N62467-04-D-0055
Contract Task Order 412

July 2011
SAMPLING AND ANALYSIS PLAN
(Field Sampling Plan and Quality Assurance Project Plan)
July 2011

Site 1 Groundwater Monitoring
Naval Air Station Joint Reserve Base
Willow Grove, Pennsylvania

Prepared for:
Naval Facilities Engineering Command Mid-Atlantic
9742 Maryland Avenue
Norfolk, Virginia 23511-3095

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

Prepared under:
Comprehensive Long-Term Environmental Action Navy (CLEAN)
Contract Number N62467-04-D-0055
Contract Task Order 412

Review Signatures:

[Signature]
Tom Johnston/CLEAN QAM/Date
Tetra Tech

[Signature]
Russell Turner/Project Manager/Date
Tetra Tech

Approval Signatures:

[Signature]
Jeffrey Dale/RPM/Date
NAVFAC BRAC PMO NE

[Signature]
Lisa Cunningham/RPM/Date
EPA Region 3
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EPA Region 3
SAMPLING AND ANALYSIS PLAN
March 2009

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NAS JRB Willow Grove

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234 Mall Boulevard, Suite 260
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610-491-9688

Prepared under:
N62467-04-D-0055
CTO 412

Review Signatures:

[Signature]
3/23/09
Tom Johnston/CLEAN QAM/Date
Tetra Tech

[Signature]
3/23/2009
Russell Turner/Project Manager/Date
Tetra Tech

Approval Signatures:

[Signature]
Curtis Frye/RPM/Date
NAVFAC BRAC PMO NE

[Signature]
Lisa Cunningham/RPM/Date
EPA Region 3

[Signature]
kenneth.a.bowers
/Navy Chemist/Date
NAVFAC QA Review

SAP Worksheet No. 1 — Title and Approval Page
(UFP-QAPP Manual Section 2.1)
SAMPLING AND ANALYSIS PLAN
(Field Sampling Plan and Quality Assurance Project Plan)
July 2011

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Approval Signatures:

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NAVFAC BRAC PMO NE

Lisa Cunningham/RPM/Date
EPA Region 3
EXECUTIVE SUMMARY

Tetra Tech NUS, Inc. (Tetra Tech) has prepared this Sampling and Analysis Plan (SAP) for Site 1 Groundwater Monitoring (GWM) at the Naval Air Station Joint Reserve Base (NAS JRB) Willow Grove, Pennsylvania. The principal contaminants associated with Site 1 groundwater are volatile organic compounds (VOCs).

This SAP contains the technical scope of work and associated sampling plan to perform groundwater sampling at Site 1. The purpose of the GWM is to comply with the remedial action objectives outlined in the interim Record of Decision (ROD) for Operable Unit (OU) 3, Site 1.

This SAP outlines the organization, project management and objectives, planned activities, measurement/data acquisition, assessment/oversight, and data review procedures associated with GWM activities. This SAP specifies requirements for fieldwork related to field operations, the collection of groundwater samples from monitoring wells at Site 1, and field and laboratory analyses of groundwater. This SAP includes 37 worksheets required by the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) guidance as the main body of the document. Appendices (A through D) containing supplemental information, are included after the worksheets.
## SAP WORKSHEETS

1. SAP Worksheet No. 1 -- Title and Approval Page ................................................................. 1
2. SAP Worksheet No. 2 -- SAP Identifying Information .......................................................... 7
3. SAP Worksheet No. 3 -- Distribution List ........................................................................... 10
4. SAP Worksheet No. 4 -- Project Personnel Sign-Off Sheet ............................................... 11
5. SAP Worksheet No. 5 -- Project Organizational Chart ......................................................... 12
6. SAP Worksheet No. 6 -- Communication Pathways .............................................................. 13
7. SAP Worksheet No. 7 -- Personnel Responsibilities and Qualifications Table .................... 14
8. SAP Worksheet No. 8 -- Special Personnel Training Requirements Table ......................... 18
9. SAP Worksheet No. 9 -- Project Scoping Session Participants Sheet ............................... 19
10. SAP Worksheet No. 10 -- Problem Definition .................................................................. 21
11. SAP Worksheet No. 11 -- Project Quality Objectives/Systematic Planning Process Statements ......................................................... 27
12. SAP Worksheet No. 12 -- Measurement Performance Criteria Table .................................. 29
13. SAP Worksheet No. 13 -- Secondary Data Criteria and Limitations Table ......................... 30
14. SAP Worksheet No. 14 -- Summary of Project Tasks ........................................................ 31
15. SAP Worksheet No. 15 -- Reference Limits and Evaluation Table ...................................... 35
16. SAP Worksheet No. 16 -- Project Schedule / Timeline Table (optional format) ................. 38
17. SAP Worksheet No. 17 -- Sampling Design and Rationale .................................................. 39
18. SAP Worksheet No. 18 -- Sampling Locations and Methods/SOP Requirements Table ........ 40
19. SAP Worksheet No. 19 -- Analytical SOP Requirements Table ........................................ 41
20. SAP Worksheet No. 20 -- Field Quality Control Sample Summary Table ........................... 42
21. SAP Worksheet No. 21 -- Project Sampling SOP References Table ..................................... 43
22. SAP Worksheet No. 22 -- Field Equipment Calibration, Maintenance, Testing, and Inspection Table .............................................................. 44
23. SAP Worksheet No. 23 -- Analytical SOP References Table ............................................... 45
24. SAP Worksheet No. 24 -- Analytical Instrument Calibration Table .................................... 46
25. SAP Worksheet No. 25 -- Analytical Instrument and Equipment Maintenance, Testing, & Inspection Table .......................................................... 47
26. SAP Worksheet No. 26 -- Sample Handling System ............................................................. 48
27. SAP Worksheet No. 27 -- Sample Custody Requirements Table ......................................... 49
28. SAP Worksheet No. 28 -- Laboratory QC Samples Table ...................................................... 51
29. SAP Worksheet No. 29 -- Project Documents and Records Table ..................................... 54
30. SAP Worksheet No. 30 -- Analytical Services Table ........................................................... 55
31. SAP Worksheet No. 31 -- Planned Project Assessments Table .......................................... 56
32. SAP Worksheet No. 32 -- Assessment Findings and Corrective Action Responses ............ 57
33. SAP Worksheet No. 33 -- QA Management Reports Table ............................................... 58
34. SAP Worksheet No. 34 -- Verification (Step I) Process Table .............................................. 59
35. SAP Worksheet No. 35 -- Validation (Steps IIa and IIb) Process Table ............................... 60
36. SAP Worksheet No. 36 -- Analytical Validation (Steps IIa and IIb) Summary Table ............. 62
37. SAP Worksheet No. 37 -- Usability Assessment .................................................................. 63

## REFERENCES

### APPENDICES

- **A** - TETRA TECH STANDARD OPERATING PROCEDURES
- **B** - LABORATORY STANDARD OPERATING PROCEDURES
- **C** - FIGURES
- **D** - EPA REGION 3 RECOMMENDED PROCEDURE FOR LOW - FLOW PURGING AND SAMPLING OF GROUNDWATER MONITORING WELLS
- **E** - MONITORING WELL CONSTRUCTION LOGS
Acronyms

°C  Degree Centigrade
%R  Percent Recovery
ACT-POC  Activity Point of Contact
ARS  Air Reserve Station
BFB  Bromofluorobenzene
bgs  Below Ground Surface
BRAC  Base Realignment and Closure
PMO NE  Project Management Office Northeast
COC  Contaminant of Concern
CCC  Calibration Check Compound
CCV  Continuing Calibration Verification
CERCLA  Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN  Comprehensive Long-Term Environmental Action Navy
CLP  Contract Laboratory Program
CSM  Conceptual Site Model
DCE  Dichloroethene
DO  Dissolved oxygen
DoD QSM  Department of Defense Quality Systems Manual
DQI  Data Quality Indicator
DQO  Data Quality Objective
DVM  Data Validation Manager
EA  EA Engineering and Science
ESI  Expanded Site Investigation
FFS  Focused Feasibility Study
FOL  Field Operations Leader
FS  Feasibility Study
FTMR  Field Task Modification Request
FWENC  Foster Wheeler Environmental Corporation
GC/MS  Gas Chromatograph/Mass Spectrometer
GIS  Geographical Information System
GWM  Groundwater Monitoring
HASP  Health and Safety Plan
HAZWOPER  Hazardous Waste Site Operations
HCl  hydrochloric acid
HSM  Health and Safety Manager
IAS  Initial Assessment Survey
<table>
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<tr>
<th>Acronym</th>
<th>Definition</th>
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<tr>
<td>ICP–AES</td>
<td>Inductively Coupled Plasma-Atomic Emission Spectroscopy</td>
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<tr>
<td>IDW</td>
<td>Investigation-Derived Waste</td>
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<td>IS</td>
<td>Internal Standard</td>
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<tr>
<td>LCS</td>
<td>Laboratory Control Sample</td>
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<td>LCSD</td>
<td>Laboratory Control Sample Duplicate</td>
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<td>LTM</td>
<td>Long Term Monitoring</td>
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<td>LUC</td>
<td>Land Use Control</td>
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<td>MCL</td>
<td>Maximum Contaminant Level</td>
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<td>Method Detection Limit</td>
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<td>MPC</td>
<td>Measurement Performance Criterion</td>
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<td>Millivolt</td>
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<td>Naval Facilities Engineering Command</td>
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<tr>
<td>NELAP</td>
<td>National Environmental Laboratory Accreditation Program</td>
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<tr>
<td>NFESC</td>
<td>Naval Facilities Engineering Service Center</td>
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<tr>
<td>OU</td>
<td>Operable Unit</td>
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<tr>
<td>PA</td>
<td>Preliminary Assessment</td>
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<tr>
<td>PAL</td>
<td>Project Action Limit</td>
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<tr>
<td>PADEP</td>
<td>Pennsylvania Department of Environmental Protection</td>
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<tr>
<td>PCB</td>
<td>Polychlorinated Biphenyl</td>
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<tr>
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<td>Photoionization Detector</td>
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<td>Personal Protective Equipment</td>
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<td>Project Quality Objective</td>
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<td>PRAP</td>
<td>Proposed Remedial Action Plan</td>
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<td>Potentially Responsible Party</td>
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<td>Public Works Center Detachment</td>
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<td>RD</td>
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Acronyms (Continued)

RI    Remedial Investigation
RF    Response Factor
ROD   Record of Decision
RPD   Relative Percent Difference
RPM   Remedial Project Manager
RSD   Relative Standard Deviation
SAP   Sampling and Analysis Plan
SDG   Sample Delivery Group
SI    Site Inspection
SOP   Standard Operating Procedure
SPCC  System Performance Check Compound
SQL   Sample Quantitation Limit
SSO   Site Safety Officer
TAL   Target Analyte List
TCL   Target Compound List
Tetra Tech  Tetra Tech NUS, Inc.
TIC   Tentatively Identified Compound
toc   Top of Casing
UFP-QAPP Uniform Federal Policy for Quality Assurance Project Plans
USEPA United States Environmental Protection Agency
USGS  United States Geological Survey
VOC   Volatile Organic Compound
SAP Worksheet No. 2 -- SAP Identifying Information
(UFP-QAPP Manual Section 2.2.4)

Site Name/Number: Site 1
Operable Unit: 03
Contractor Name: Tetra Tech NUS, Inc.
Contract Number: N62467-04-D-0055
Contract Title: CLEAN
Work Assignment Number (optional): CTO 412

1. This SAP was prepared in accordance with the requirements of the Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP) (DoD, DOE, USEPA, March, 2005) and USEPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS (EPA 2002).

2. Identify regulatory program: CERCLA

3. This SAP is a project-specific SAP.

4. List dates of scoping sessions that were held:

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<td>NAS JRB Willow Grove Team Meeting 17</td>
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<td>Tetra Tech Project Team Meeting</td>
<td>November 12, 2008</td>
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5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.

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

USEPA (regulatory oversight), PADEP (regulatory oversight), BRAC PMO NE (property owner)

7. Lead organization

NAVFAC Mid-Atlantic

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

Worksheet 8 omitted. 40-Hour Hazardous Waste Site Operations (HAZWOPER) Training and 8-Hour Refresher training documented in Health and Safety Plan (HASP) (provided under separate cover).
# UFP-QAPP Worksheet

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### SAP Worksheet No. 3 -- Distribution List

(UFP-QAPP Manual Section 2.3.1)

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<tr>
<th>Name of SAP Recipient</th>
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<th>E-Mail Address or Mailing Address</th>
<th>Document Control Number (Optional)</th>
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<tr>
<td>Jeffrey Dale</td>
<td>Remedial Project Manager (RPM)</td>
<td>NAVFAC Mid-Atlantic</td>
<td>215-897-4914</td>
<td><a href="mailto:jeffrey.m.dale@navy.mil">jeffrey.m.dale@navy.mil</a></td>
<td>NA</td>
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<tr>
<td>Bob Lewandowski</td>
<td>Environmental Coordinator</td>
<td>BRAC PMO NE</td>
<td>215-897-4908</td>
<td><a href="mailto:robert.f.lewandowski@navy.mil">robert.f.lewandowski@navy.mil</a></td>
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<tr>
<td>Dave Barclift</td>
<td>Technical Manager</td>
<td>NAVFAC Atlantic</td>
<td>215-897-4913</td>
<td><a href="mailto:david.barclift@navy.mil">david.barclift@navy.mil</a></td>
<td>NA</td>
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<tr>
<td>Harold Dusen</td>
<td>Environmental Director Activity Point of Contact (ACT-POC)</td>
<td>NAS JRB Willow Grove</td>
<td>215-443-6937</td>
<td><a href="mailto:harold.dusen@navy.mil">harold.dusen@navy.mil</a></td>
<td>NA</td>
</tr>
<tr>
<td>Lt. Commander Suzanne Montgomery</td>
<td>Coordinator</td>
<td>Public Works Center Detachment (PWC-DET)</td>
<td>215-443-6221</td>
<td><a href="mailto:suzanne.montgomery@navy.mil">suzanne.montgomery@navy.mil</a></td>
<td>NA</td>
</tr>
<tr>
<td>Bill Heil</td>
<td>Facility Contact</td>
<td>NAS JRB Willow Grove</td>
<td>215-443-6938</td>
<td><a href="mailto:bill.heil@navy.mil">bill.heil@navy.mil</a></td>
<td>NA</td>
</tr>
<tr>
<td>Lisa Cunningham</td>
<td>USEPA RPM</td>
<td>USEPA Region 3</td>
<td>215-814-3363</td>
<td><a href="mailto:cunningham.lisa@epamail.gov">cunningham.lisa@epamail.gov</a></td>
<td>NA</td>
</tr>
<tr>
<td>Tim Sheehan</td>
<td>PADEP Project Manager (PM)</td>
<td>PADEP</td>
<td>484-250-5726</td>
<td><a href="mailto:tsheehan@state.pa.us">tsheehan@state.pa.us</a></td>
<td>NA</td>
</tr>
<tr>
<td>Russell Turner</td>
<td>PM</td>
<td>Tetra Tech</td>
<td>610-491-9688</td>
<td><a href="mailto:russ.turner@tetratech.com">russ.turner@tetratech.com</a></td>
<td>NA</td>
</tr>
<tr>
<td>Tom Johnston</td>
<td>Quality Assurance Manager (QAM)</td>
<td>Tetra Tech</td>
<td>412-921-8615</td>
<td><a href="mailto:tom.johnston@tetratech.com">tom.johnston@tetratech.com</a></td>
<td>NA</td>
</tr>
<tr>
<td>Don Whalen</td>
<td>Field Operations Leader (FOL)/Site Safety Officer (SSO)</td>
<td>Tetra Tech</td>
<td>610-491-9688</td>
<td><a href="mailto:don.whalen@tetratech.com">don.whalen@tetratech.com</a></td>
<td>NA</td>
</tr>
<tr>
<td>Megan Ritchie</td>
<td>Project Chemist</td>
<td>Tetra Tech</td>
<td>610-491-9688</td>
<td><a href="mailto:megan.ritchie@tetratech.com">megan.ritchie@tetratech.com</a></td>
<td>NA</td>
</tr>
<tr>
<td>TBD</td>
<td>Laboratory Project Manager</td>
<td>TBD</td>
<td>TBD</td>
<td>TBD</td>
<td>NA</td>
</tr>
</tbody>
</table>
### SAP Worksheet No. 4 – Project Personnel Sign-Off Sheet
**UFP-QAPP Manual Section 2.3.2**

<table>
<thead>
<tr>
<th>Name</th>
<th>Organization/Title/Role</th>
<th>Telephone Number (optional)</th>
<th>Signature/E-Mail Receipt</th>
<th>SAP Section Reviewed</th>
<th>Date SAP Read</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russell Turner</td>
<td>Tetra Tech PM</td>
<td>610-491-9688</td>
<td><a href="#">Signature</a></td>
<td>All</td>
<td>June 30, 2011</td>
</tr>
<tr>
<td>Don Whalen</td>
<td>Tetra Tech FOL/SSO</td>
<td>610-491-9688</td>
<td><a href="#">Signature</a></td>
<td>All</td>
<td>June 30, 2011</td>
</tr>
<tr>
<td>Tom Johnston</td>
<td>Tetra Tech QAM</td>
<td>412-921-8615</td>
<td>Signature obtained by e-mail</td>
<td>All</td>
<td>July 5, 2011</td>
</tr>
<tr>
<td>Megan Ritchie</td>
<td>Tetra Tech Project Chemist</td>
<td>610-491-9688</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To Be Determined (TBD)</td>
<td>Laboratory PM</td>
<td>TBD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jeffrey Dale</td>
<td>NAVFAC Mid-Atlantic RPM</td>
<td>215-897-4914</td>
<td><a href="#">Signature</a></td>
<td>All</td>
<td>July 1, 2011</td>
</tr>
<tr>
<td>Lisa Cunningham</td>
<td>USEPA RPM</td>
<td>215-814-3363</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tim Sheehan</td>
<td>PADEP PM</td>
<td>484-250-5726</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SAP Worksheet No. 5 -- Project Organizational Chart
(UFP-QAPP Manual Section 2.4.1)

Lines of Authority

Tim Sheehan
PADEP RPM
484-250-5726

Lisa Cunningham
USEPA RPM
215-814-3363

Jeffrey Dale
Navy RPM
215-897-4914

Sherri Eng
Navy QA Officer

Bill Heil
NAS JRB Willow Grove POC
215-443-6938

Tom Johnston
Tetra Tech QAM
412-921-8615

Russ Turner
Tetra Tech PM
610-382-1534

Megan Ritchie
Tetra Tech Chemist
610-382-1527

Lee Leck
Tetra Tech Data Manager
412-921-8856

TBD Laboratory Project Manager

Don Whalen
Tetra Tech FOL/SSO
610-382-1536

Matt Soltis
Tetra Tech HSM
412-921-8912

TBD
Tetra Tech Field Technician
[phone]

Lines of Communication
# SAP Worksheet No. 6 -- Communication Pathways

*(UFP-QAPP Manual Section 2.4.2)*

<table>
<thead>
<tr>
<th>Communication Driver</th>
<th>Responsible Affiliation</th>
<th>Name</th>
<th>Phone Number and/or E-Mail</th>
<th>Procedure (timing, pathway to and from, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Task Modification Request (FTMR)</td>
<td>PADEP RPM</td>
<td>Tim Sheehan</td>
<td>484-250-5726</td>
<td></td>
</tr>
<tr>
<td>SAP Amendments</td>
<td>Tetra Tech FOL</td>
<td>Don Whalen</td>
<td>610-382-1536</td>
<td>Immediately obtains approval from Tetra Tech PM; Documents via FTMR form.</td>
</tr>
<tr>
<td>Changes in Schedule</td>
<td>Navy RPM</td>
<td>Jeffrey Dale</td>
<td>215-897-4914</td>
<td>Immediately informs Tetra Tech PM; Documents via FTMR form.</td>
</tr>
<tr>
<td>Issues in the field that result in changes in scope of field work</td>
<td>Tetra Tech FOL Tetra Tech PM</td>
<td>Don Whalen Russell Turner</td>
<td>610-382-1536 610-382-1534</td>
<td>FOL informs PM, PM informs Navy RPM, and Navy RPM issues scope change if warranted.</td>
</tr>
<tr>
<td>Analytical data quality issues</td>
<td>Laboratory PM Tetra Tech Project Chemist</td>
<td>TBD Megan Ritchie</td>
<td>TBD 610-382-1527</td>
<td>Immediately notify Tetra Tech Project Chemist; Notify Data Validation Staff and Tetra Tech PM if necessary.</td>
</tr>
</tbody>
</table>
### SAP Worksheet No. 7 -- Personnel Responsibilities and Qualifications Table
*(UFP-QAPP Manual Section 2.4.3)*

<table>
<thead>
<tr>
<th>Name</th>
<th>Title/Role</th>
<th>Organizational Affiliation</th>
<th>Responsibilities</th>
<th>Education and/or Experience Qualifications (Optional)</th>
</tr>
</thead>
</table>
| Russell Turner| PM         | Tetra Tech                  | Oversees project, financial, schedule, and technical day-to-day management of the project, including the following:  
• Ensures timely resolution of project-related technical, quality, and safety questions associated with Tetra Tech operations.  
• Functions as the primary Tetra Tech interface with the Navy RPM, NAS JRB Willow Grove, Tetra Tech field and office personnel, and laboratory points of contact.  
• Ensures that Tetra Tech health and safety issues related to this project are communicated effectively to all personnel and off-site laboratory.  
• Monitors and evaluates all Tetra Tech subcontractor performance.  
• Coordinates and oversees work performed by Tetra Tech field and office technical staff (including data validation, data interpretation, and report preparation).  
• Coordinates and oversees maintenance of all Tetra Tech project records.  
• Coordinates and oversees review of Tetra Tech project deliverables.  
• Prepares and issues final Tetra Tech deliverables to the Navy. | B.A. Natural Sciences, 30 years environmental experience |
<table>
<thead>
<tr>
<th>Name</th>
<th>Title/Role</th>
<th>Organizational Affiliation</th>
<th>Responsibilities</th>
<th>Education and/or Experience Qualifications (Optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Don Whalen</td>
<td>FOL, SSO</td>
<td>Tetra Tech</td>
<td>Supervises, coordinates, and performs field sampling activities, including the following:</td>
<td>B.A. Geology, M.S. Marine Studies, 19 years environmental experience</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Ensures that health and safety requirements are implemented.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Functions as the on-site communications link between field staff members, NAS JRB Willow Grove, and the Tetra Tech PM.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Alerts off-site analytical laboratory of any special health and safety hazards associated with environmental samples.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Oversees the mobilization and demobilization of all field equipment and subcontractors.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Coordinates and manages the field technical staff.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Adheres to the work schedules provided by the Tetra Tech PM.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Ensures the proper maintenance of site logbooks, field logbooks, and field recordkeeping.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Initiates FTMRs when necessary.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Identifies and resolves problems in the field, resolving difficulties via consultation with the NAS JRB Willow Grove POC. Implements and documents corrective action procedures, and provides communication between the field team and project management.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>As SSO, will be responsible for training and monitoring site conditions. Details of the SSOs responsibilities are presented in the HASP and include the following:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Controlling specific health and safety-related field operations such as personnel decontamination, monitoring of worker heat or cold stress, and distribution of safety equipment.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Conducting and documenting a daily health and safety briefing each day while on site.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Assuring that field personnel comply with all procedures established in the HASP.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Identifying an assistant SSO in his absence.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Terminating work if an imminent safety hazard, emergency situation, or other potentially dangerous situation is encountered.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Ensuring the availability and the condition of health and safety monitoring equipment.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Coordinating with the PM to institute and document any necessary HASP modifications.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Ensuring that facility personnel and subcontractors are adequately advised and kept clear of potentially contaminated materials.</td>
<td></td>
</tr>
<tr>
<td>Name</td>
<td>Title/Role</td>
<td>Organizational Affiliation</td>
<td>Responsibilities</td>
<td>Education and/or Experience Qualifications (Optional)</td>
</tr>
<tr>
<td>--------------</td>
<td>--------------------</td>
<td>---------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Tom Johnston | QAM                | Tetra Tech                | Reviews the SAP, oversees preparation of the laboratory scope, coordinates with the laboratory, and conducts data quality review. Ensures quality aspects of the CLEAN program, including the following:  
  - Develops, maintains, and monitors quality assurance/quality control (QA/QC) policies and procedures.  
  - Provides training to Tetra Tech staff in QA/QC policies and procedures.  
  - Conducts systems and performance audits to monitor compliance with environmental regulations, contractual requirements, SAP requirements, and corporate policies and procedures.  
  - Audits project records.  
  - Monitors subcontractor quality controls and records.  
  - Assists in the development of corrective action plans and ensuring correction of non-conformances reported in internal or external audits.  
  - Ensures that this SAP meets Tetra Tech, Navy, and PADEP requirements.  
  - Prepares QA reports for management.                                                                                                          | PhD Chemistry, 30 years environmental experience as technical and quality specialist. |
| Megan Ritchie| Project Chemist    | Tetra Tech                | Coordinates analyses with laboratory chemists, ensures the scope is followed, reviews data packages, and communicates with Tetra Tech staff.  
  - Ensures that the project meets objectives from the standpoint of laboratory performance.  
  - Provides technical advice to the Tetra Tech team on project chemistry matters.  
  - Monitors and evaluates subcontractor laboratory performance.  
  - Ensures timely resolution of laboratory-related technical, quality, or other issues affecting project goals.  
  - Functions as the primary interface with the subcontracted laboratory and the Tetra Tech PM.  
  - Coordinates and oversees work performed by the subcontracted laboratory.  
  - Oversees the completion of Tetra Tech data validation.  
  - Coordinates and oversees review of laboratory deliverables.  
  - Recommends appropriate laboratory corrective actions.                                                                                         | B.S. Biology/Environmental Studies, 11 years environmental experience     |
<table>
<thead>
<tr>
<th>Name</th>
<th>Title/Role</th>
<th>Organizational Affiliation</th>
<th>Responsibilities</th>
<th>Education and/or Experience Qualifications (Optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matt Soltis</td>
<td>HSM</td>
<td>Tetra Tech</td>
<td>Oversees CLEAN Program Health and Safety Program</td>
<td>B.S. Industrial Safety Sciences, 24 years of environmental experience</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Provides technical advice to the Tetra Tech PM on matters of health and safety.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Oversees the development and review of the HASP.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Conducts health and safety audits.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Prepares health and safety reports for management.</td>
<td></td>
</tr>
<tr>
<td>TBD Laboratory PM</td>
<td>TBD</td>
<td>TBD</td>
<td>• Coordinates analyses with laboratory chemists.</td>
<td>Can be provided upon request.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Ensures that the scope is followed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Reviews data packages.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Communicates with Tetra Tech staff.</td>
<td></td>
</tr>
</tbody>
</table>
SAP Worksheet No. 8 -- Special Personnel Training Requirements Table  
(UFP-QAPP Manual Section 2.4.4)

This worksheet is used to identify and describe any specialized/non-routine project-specific training requirements or certifications needed by personnel to successfully complete the project or task. OPNAV 5090.1 instructions are not considered specialized training; the OPNAV training requirements represent routine minimum requirements that are mandatory for all Department of Navy projects.

No special training is required for this activity. Certification of 40-Hour HAZWOPER and 8-Hour Refresher Training is located in the site-specific HASP.

The analytical laboratory has successfully completed the laboratory evaluation process required as part of the Naval Facilities Engineering Service Center (NFESC) Quality Assurance Program and described in the Department of Defense Quality Systems Manual (DoD QSM) (2006) and is additionally certified by the National Environmental Laboratory Accreditation Program (NELAP), which is the recognized certifying authority for the Commonwealth of Pennsylvania.
SAP Worksheet No. 9 -- Project Scoping Session Participants Sheet  
(UFP-QAPP Manual Section 2.5.1)

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Affiliation</th>
<th>Phone No.</th>
<th>E-Mail Address</th>
<th>Project Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russell Turner</td>
<td>PM</td>
<td>Tetra Tech</td>
<td>(610) 382-1534</td>
<td><a href="mailto:russ.turner@tetratech.com">russ.turner@tetratech.com</a></td>
<td>Management</td>
</tr>
<tr>
<td>Curtis Frye</td>
<td>Navy RPM</td>
<td>Navy</td>
<td>(215) 897-4914</td>
<td><a href="mailto:curtis.frye@navy.mil">curtis.frye@navy.mil</a></td>
<td>Management</td>
</tr>
<tr>
<td>Kevin Kilmartin</td>
<td>Geologist</td>
<td>Tetra Tech</td>
<td>(610) 382-1173</td>
<td><a href="mailto:kevin.kilmartin@tetratech.com">kevin.kilmartin@tetratech.com</a></td>
<td>Lead Geologist</td>
</tr>
<tr>
<td>Linda Watson</td>
<td>Risk Assessor</td>
<td>USEPA</td>
<td></td>
<td><a href="mailto:watson.linda@epamail.gov">watson.linda@epamail.gov</a></td>
<td>Regulatory Oversight</td>
</tr>
<tr>
<td>Lisa Cunningham</td>
<td>BRAC PMO</td>
<td>USEPA</td>
<td>(215) 814-3363</td>
<td><a href="mailto:cunningham.lisa@epamail.gov">cunningham.lisa@epamail.gov</a></td>
<td>Management</td>
</tr>
<tr>
<td>Bernice Pasquini</td>
<td>Hydrogeologist</td>
<td>USEPA</td>
<td>(215) 814-3326</td>
<td><a href="mailto:pasquini.bernice@epamail.gov">pasquini.bernice@epamail.gov</a></td>
<td>Regulatory Oversight</td>
</tr>
<tr>
<td>Bob Lewandowski</td>
<td>BRAC Coordinator</td>
<td>Navy</td>
<td>(215) 897-4908</td>
<td><a href="mailto:robert.lewandowski@navy.mil">robert.lewandowski@navy.mil</a></td>
<td>Management</td>
</tr>
<tr>
<td>Gloria Abarca</td>
<td>Base Coordinator</td>
<td>Navy</td>
<td>(215) 773-2106</td>
<td><a href="mailto:gloria.abarca@navy.mil">gloria.abarca@navy.mil</a></td>
<td>Management</td>
</tr>
<tr>
<td>Charles Clark</td>
<td>PADEP PM</td>
<td>PADEP</td>
<td>(484) 250-5731</td>
<td><a href="mailto:cclark@state.pa.us">cclark@state.pa.us</a></td>
<td>Regulatory Oversight</td>
</tr>
<tr>
<td>Jessica Kasmari</td>
<td>Hydrogeologist</td>
<td>PADEP</td>
<td>(484) 250-5724</td>
<td><a href="mailto:jkasmari@state.pa.us">jkasmari@state.pa.us</a></td>
<td>Regulatory Oversight</td>
</tr>
</tbody>
</table>

Comments/Decisions: USEPA comments from Bernice Pasquini were distributed for review. USEPA recommends that the remedy include GWM. The Proposed Remedial Action Plan (PRAP) now specifies land use controls (LUCs) only, under the generally agreed upon premise that groundwater contamination beneath the site does not originate from Site 1 or even on base. A lengthy discussion ensued regarding the probable source area, USEPA plans for off-Base site discovery, the absence of a potentially responsible party (PRP) at this time, USEPA’s desire to secure periodic monitoring to support periodic assessment of risks, and level of monitoring USEPA would accept. The Navy agreed that GWM would initially consist of biennial groundwater sampling of the three shallow monitoring wells and the two Navy supply wells, with limited VOC (trichloroethene [TCE] and tetrachloroethene [PCE]) analysis until a PRP is identified to take responsibility for periodic sampling, or the site becomes a fund-lead site. Details of the periodic groundwater monitoring program will be agreed upon in the OU 3 LUC Remedial Design (RD).

USEPA is preparing to authorize their subcontractor to perform an extended site investigation (ESI) for the off-site source. USEPA will coordinate with Gloria Abarca for any Base access that may be needed.

Action Items: None.
Consensus Decisions: None.
Project Name: Site 1 GWM  
Projected Date(s) of Sampling: April 2009  
Project Manager: Russell Turner

Site Name: Site 1  
Site Location: NAS JRB Willow Grove

Date of Session: November 12, 2008  
Scoping Session Purpose: Tetra Tech Scoping Meeting for UFP-SAP

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Affiliation</th>
<th>Phone No.</th>
<th>E-mail Address</th>
<th>Project Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russell Turner</td>
<td>PM</td>
<td>Tetra Tech</td>
<td>610-491-9688</td>
<td><a href="mailto:russ.turner@tetratech.com">russ.turner@tetratech.com</a></td>
<td>Management</td>
</tr>
<tr>
<td>Don Whalen</td>
<td>FOL</td>
<td>Tetra Tech</td>
<td>610-491-9688</td>
<td><a href="mailto:don.whalen@tetratech.com">don.whalen@tetratech.com</a></td>
<td>Task Management</td>
</tr>
<tr>
<td>Megan Ritchie</td>
<td>Project Chemist</td>
<td>Tetra Tech</td>
<td>610-491-9688</td>
<td><a href="mailto:megan.ritchie@tetratech.com">megan.ritchie@tetratech.com</a></td>
<td>QA/QC</td>
</tr>
<tr>
<td>Kevin Kilmartin</td>
<td>Project Geologist</td>
<td>Tetra Tech</td>
<td>610-491-9688</td>
<td><a href="mailto:kevin.kilmartin@tetratech.com">kevin.kilmartin@tetratech.com</a></td>
<td>Technical</td>
</tr>
</tbody>
</table>

Comments/Decisions: Agreed on Data Quality Objectives (DQOs) based on previous scoping meeting with the NAS JRB Willow Grove team. Agreed on compound list and regulatory criteria. Agreed on which wells would be sampled and the frequency of sampling.

Action Items: Complete worksheets and associated text for SAP and implement review process.
10.1 SITE LOCATION

NAS JRB Willow Grove, Pennsylvania is located in Horsham Township, Montgomery County, in southeastern Pennsylvania, approximately 20 miles north of the City of Philadelphia. Site 1, the Privet Road Compound, was a fenced area approximately ½ acre in size located on Privet Road in the northeastern section of the base (Figure 10-1). Figure 10-2 shows the site features.

10.2 SITE HISTORY

The Privet Road compound was constructed to serve as a transfer station for wastes after closure of the Ninth Street Landfill (Site 3) in 1967. The compound operated from 1967 to 1975 and was used as an open disposal area where appreciable quantities of waste were reportedly burned and buried. Materials reported to have been disposed at the site include general refuse, sewage sludge, oil and grease emulsion, paint wastes, VOCs, and polychlorinated biphenyl (PCB)-containing fluids from transformers. The suspected waste-handling area extends beyond the limits of the fenced compound and covers more than 2 acres, including the present locations of the bowling alley and parking area.

10.3 PHYSICAL SETTING

Surface Features

The Air Station is comprised of flat to slightly rolling terrain and is generally bounded by State Route 611 to the east, State Route 463 to the southwest, and Keith Valley Road to the north.

The Privet Road Compound is in a heavily developed section of NAS JRB adjacent to Privet Road and the Air Reserve and Pennsylvania National Guard facilities. The bowling alley and associated parking area cover a significant portion of the ground surface south of the compound. The ground surface slopes at a grade of approximately 2 percent toward the northwest.

Geology

Regional Geology

NAS JRB Willow Grove is located within the Triassic Basin of southeastern Pennsylvania. The bedrock underlying the NAS JRB consists of the middle arkose member of the late Triassic Stockton Formation. The Stockton Formation locally is about 5,000 feet thick and is unconformably underlain by Ordovician to PreCambrian basement rocks. Previous environmental investigations indicate that the top of bedrock at the air station is generally encountered between 5 feet and 25 feet below ground surface (bgs).

The Stockton Formation is composed of fine- to coarse-grained arkosic sandstones and conglomerates that are interbedded with finer-grained shales and siltstones. Bedding is very irregular throughout the Stockton Formation, although coarse-grained units commonly overlie fine-grained units. Based principally on dominant grain size and lithology, the Stockton Formation is divided into lower, middle, and upper members.

The middle member of the Stockton Formation is approximately 4,200 feet thick and consists of fine- to medium-grained arkosic sandstone interbedded with shale. Beds of shale and siltstone are common in the upper portion of the member, and coarser-grained units are more common in the lower portion of the member. The rocks of the middle member are well sorted and weakly cemented, which creates a relatively high porosity compared to the lower and upper members of the formation (Rima et al., 1962). The middle member of the Stockton Formation typically weathers to a depth of 15 to 35 feet.
Geology of Site 1

The subsurface data collected during the Remedial Investigation (RI) (Tetra Tech, 2002) indicate that the local geology beneath the site is generally consistent with the regional geology discussed above.

Soil and well borings consistently encountered a variably thick overburden section underlain by weathered sandstone. The overburden consisted of sandy silt, silty sand, and silty clay. The thickness of the overburden (or the depth to the top of the weathered bedrock) ranged from approximately 4 feet in the vicinity east of Privet Road (01MW04) to about 9 feet in the northeastern corner of the compound (01MW01). Gravel-rich apparent fill material was encountered within 2 feet of the surface at most locations within the former compound but was not encountered beyond the limits of the suspected waste area.

The bedrock encountered during monitoring well drilling typically consisted of alternating sequences of siltstone and fine- to medium-grained sandstone. Thin beds of shale and claystone were inconsistently encountered within the compound and the northern portion of the Site area.

Driller’s boring logs for Navy Supply Well No. 1 (396 feet deep) and Navy Supply Well No. 2 (351 feet deep) and the results of a borehole geophysical logging program (USGS, 2001) indicate that the lithology below the depth of investigation of the monitoring well network is also consistent with the regional geology and is generally similar to the lithology described from the shallower monitoring well boreholes. Overall, the rock becomes somewhat coarser grained with increasing subsurface depth, and the thickness of the individual lithologic units increases, especially below a subsurface depth of about 200 feet.

Hydrogeology

The major source of groundwater in the vicinity of NAS JRB Willow Grove is the fractured bedrock of the Stockton Formation (Earth Data, Inc., 1986). These rocks form a multi-aquifer system of relatively discrete water-bearing zones separated by less-permeable zones. Transmissivity and groundwater movement within water-bearing zones are greater parallel to bedding than across bedding. Groundwater can generally be found between 5 and 25 feet below ground surface (bgs).

Groundwater within the Stockton Formation locally occurs under both unconfined and confined conditions. The unconfined conditions generally extend to a subsurface depth of about 75 to 100 feet, depending on the local lithologies. Confined conditions are generally encountered below a depth of about 150 feet. A semi-confined or transitional aquifer lies between the unconfined and confined aquifers. Vertical or nearly vertical fractures that cut across bedding and the weathering of various beds are expected to permit varying degrees of leakage between individual water-bearing zones, particularly at shallower depths.

Although significant amounts of groundwater may be held in storage within the primary porosity of the fine- to medium-grained sandstones, groundwater migration is chiefly through the secondary porosity created by fractures and joints and along bedding-plane partings. The finer-grained shale and siltstone beds typically have very low permeabilities. In addition, fractures and joints are typically not as well developed in these finer-grained beds. Consequently, the shale and siltstone units often act as confining layers to groundwater flow.

10.4 PREVIOUS INVESTIGATIONS

Work undertaken pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) at NAS JRB Willow Grove included the Initial Assessment Study (IAS), now known as a Preliminary Assessment (PA) (NEESA, 1986), Site Inspection (SI) (EA Engineering and Science, 1990), a two-phased RI (Halliburton NUS, 1993; Brown & Root Environmental, 1998), a soil removal action (FWENC, 1999), and additional groundwater investigations. The PA identified 16 sites requiring further investigation, seven at the Air Reserve Facility and nine at the NAS (NEESA, 1986). One additional site was added to the CERCLA program in 1988 (EA, 1990). SI work was performed at 12 of the 17 sites, including Site 1 in 1989. RI/Feasibility Study (FS) activities were subsequently completed or are
underway at eight sites, four on Air Force property and four on Navy property, including Site 1. The Phase I RI Report characterized the physical and chemical nature of these four Navy sites and identified data gaps requiring further study. Recommendations for further investigation included in the Phase I RI Report were incorporated into subsequent discussions among the Navy and regulatory agencies for additional work and led to Phase II RI activities at Site 1 that began in 1996 and were reported in the Phase II RI Report and Addenda RI reports through 2008 (Tetra Tech 2008b). A Focused FS (FFS) for Site 1 groundwater was completed in 2008.

Twelve monitoring wells and four supply wells were sampled for Target Compound List (TCL) VOCs and Target Analyte List (TAL) inorganics during the Phase I RI, and 21 monitoring wells and two supply wells were sampled for TCL VOCs during the Phase II RI. Table 10-1 lists the monitoring well construction details for Site 1. Figure 10-3 shows sample locations and concentrations of contaminants that exceed human health risk-based screening levels.

Several VOCs were detected in the groundwater samples collected during both phases of the RI. The most frequently detected compounds were PCE, ranging from 2 to 53 micrograms per liter (µg/L) in 11 samples, and TCE, ranging from 1 to 120 µg/L in 26 samples.

Groundwater in the immediate vicinity of Site 1 is the primary source of water supply for the Air Station. NAS JRB Willow Grove obtains its potable water from two deep water supply wells that are located east of Site 1, on the opposite side of Privet Road (Figure 10-2). The water produced from these wells contains VOCs at concentrations above the regulatory-permitted levels. Water drawn from the Navy supply wells is treated to remove VOCs before distribution and use. This treatment is conducted in order for the base to comply with the Safe Drinking Water Act (SDWA) and pre-dates any CERCLA remedial decisions for this site. Treated Site 1 groundwater does not currently pose a threat to public health.

An investigation of the Base supply wells conducted by the United States Geological Survey (USGS, 2001) concluded that the deeper intervals of both Navy supply wells contained significantly more VOCs than the shallower intervals. The lack of VOCs in the soil and their low concentrations in shallow groundwater indicate that the Privet Road Compound is not a significant source of the VOCs detected in Site 1 groundwater and in Navy supply wells.

The Navy searched for the primary source of VOCs during the RI by installing monitoring wells at various depths throughout Site 1 and adjacent areas, by determining groundwater flow directions, by researching the land use history of all Base property in the vicinity of Site 1, and by reviewing the publicly available environmental data for off-Base properties located nearby along Route 611.

The RI concluded that the principal contaminants associated with Site 1 groundwater are the VOCs PCE and TCE. VOCs occur chiefly in deep monitoring wells and are detected infrequently and at lower concentrations in shallow monitoring wells. No source could be identified for the low-level (less than 10 µg/L) groundwater VOC concentrations in shallow groundwater on Navy property in the vicinity of Site 1. These low-level concentrations are limited to isolated detections in shallow groundwater and do not represent definable plumes. None of these isolated detections could account for the levels of contamination detected in the deeper Site 1 monitoring wells or in the base supply wells. Based on groundwater flow directions, however, the site could not be ruled out as a potential source of low-level PCE contamination observed in monitoring wells located downgradient of the northwestern corner of the site. This contamination was observed in monitoring wells 01MW01S (6 µg/L), 01MW06S (4 µg/L), 01MW01I (5 µg/L), and 01MW06I (11 µg/L). These wells contained the following TCE concentrations: 2 µg/L in 01MW06S, 9 µg/L in 01MW01I, and 8 µg/L in 01MW06I. TCE was not detected in well 01MW01S.

Based on an analysis of the distribution of contamination in the unconfined and confined aquifers and of the interpreted groundwater flow directions under pumping and non-pumping conditions, the RI report concluded that the most significant source of VOCs is located off-Base, southeast of the Privet Road Compound, possibly in the vicinity of the former Kellett Aircraft Facility (Figure 10-4). From this location, the plume migrates onto Base property through a combination of natural flow conditions and the pumping effects of the Navy supply wells, which capture some of the off-Base groundwater and draw it
TABLE 10-1
MONITORING WELL CONSTRUCTION SUMMARY
SITE 1, PRIVET ROAD COMPOUND
NAS JRB WILLOW GROVE, PENNSYLVANIA

<table>
<thead>
<tr>
<th>Original ID</th>
<th>Current ID</th>
<th>Well Depth (feet bgs)</th>
<th>Screen Interval (feet bgs)</th>
<th>Groundwater Elevation (feet above msl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRW-2</td>
<td>01MW02S</td>
<td>27</td>
<td>7 - 27</td>
<td>303.11</td>
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<tr>
<td>PRW-2B</td>
<td>01MW02I</td>
<td>88</td>
<td>78 - 88</td>
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<td>PRW-3</td>
<td>01MW03S</td>
<td>26.5</td>
<td>6.5 - 26.5</td>
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<td>15 - 35</td>
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<td>80 - 90</td>
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</tr>
<tr>
<td>PRW-5</td>
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<td>18.5 - 38.5</td>
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<td>75 - 85</td>
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</tr>
<tr>
<td>PRW-6</td>
<td>01MW06S</td>
<td>26</td>
<td>6 - 26</td>
<td>297.15</td>
</tr>
<tr>
<td>PRW-6B</td>
<td>01MW06I</td>
<td>84.5</td>
<td>74.5 - 84.5</td>
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</tr>
<tr>
<td>PRW-7</td>
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<td>6 - 26</td>
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<td>01MW07I</td>
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<td>74 - 84</td>
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<tr>
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<td>9 - 29</td>
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<tr>
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<td>80 - 100</td>
<td>290.19</td>
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<tr>
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<td>? - 21.7 (toc)</td>
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<tr>
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<td>? - 21.95 (toc)</td>
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</tbody>
</table>

<table>
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<tr>
<th>Original ID</th>
<th>Current ID</th>
<th>Well Depth (feet bgs)</th>
<th>Screen Interval (feet bgs)</th>
<th>Groundwater Elevation (feet above msl)</th>
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</thead>
<tbody>
<tr>
<td>- -</td>
<td>01MW01SO-R</td>
<td>24</td>
<td>11 - 24</td>
<td>NA</td>
</tr>
<tr>
<td>- -</td>
<td>01MW01S-R</td>
<td>40</td>
<td>32 - 40</td>
<td>NA</td>
</tr>
<tr>
<td>- -</td>
<td>01MW01I</td>
<td>85</td>
<td>75 - 85</td>
<td>304.49</td>
</tr>
<tr>
<td>- -</td>
<td>01MW03I</td>
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<td>69 - 79</td>
<td>302.80</td>
</tr>
<tr>
<td>- -</td>
<td>01MW08SO</td>
<td>17</td>
<td>7 - 17</td>
<td>309.87</td>
</tr>
<tr>
<td>- -</td>
<td>01MW08S</td>
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<td>24 - 34</td>
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</tr>
<tr>
<td>- -</td>
<td>01MW08I</td>
<td>86</td>
<td>76 - 86</td>
<td>309.69</td>
</tr>
<tr>
<td>- -</td>
<td>01MW09S</td>
<td>130</td>
<td>120 - 130</td>
<td>338.53</td>
</tr>
<tr>
<td>- -</td>
<td>01MW10S</td>
<td>163</td>
<td>143 - 163</td>
<td>317.00</td>
</tr>
<tr>
<td>- -</td>
<td>01MW10D</td>
<td>320</td>
<td>295 - 320</td>
<td>317.01</td>
</tr>
</tbody>
</table>

bgs = Below ground surface.
msl = Mean sea level.
toc = Top of casing.
NA = Not available.
1 All pre-RI and Phase I RI wells are 4 inches in diameter.
2 All Phase II RI wells are 2 inches in diameter.
3 Monitoring wells 01MW01SO-R and 01MW01S-R were installed in April 2011 as replacements for wells 01MW01SO and 01MW01S, which were abandoned during the construction of the Armed Forces Reserve Center. The well completion reports are included in Appendix E.

onto Navy property. This source creates a mixed TCE and PCE plume contributing to the deeper (greater than 160 feet) groundwater contamination detected in the Navy supply wells.

In response to USEPA requests for further delineation of potential VOC sources in the vicinity of the Navy Fuel Farm and Public Works Building, the Navy installed additional monitoring wells in 2003. These wells were sampled for TCL VOCs in June 2003 and September 2004. The analytical data from the new wells confirmed that the source of PCE in the unconfined aquifer at Site 1 was not in the vicinity of Navy Supply Well No. 1 or the Public Works Building, and that the Fuel Farm was not a significant source of TCE. The interpretation supported the conclusion of the RI that contamination in the confined aquifer at Site 1 is due
to an upgradient off-Base source, in the general vicinity of the former Kellett Aircraft Facility. The full discussion of these results is included in the Site 1 RI Addendum 3 for Groundwater – Privet Road Compound (Tetra Tech, 2005).

In 2005, the Navy performed an additional investigation to determine the quality of groundwater migrating onto the Air Station from upgradient off-Base locations. Three new monitoring wells, 01MW09S, 01MW10S, and 01MW10D, were installed. 01MW09S was installed between the former Kellett facility and the Navy supply wells. 01MW10S and 01MW10D were installed at locations geologically down dip of the former Kellett facility and generally along bedrock strike from the Navy supply wells. The wells were sampled for TCL VOCs. Analytical results confirmed the RI conclusion that the VOCs detected in the Navy supply wells are not related to Site 1 but are migrating onto Navy property from upgradient off-Base location. The full discussion of these results is included in the Site 1 RI Addendum 5 - Groundwater Continuing Investigation (Tetra Tech, 2008a).

USEPA considers the Air Force Wash Rack (Air Reserve Station [ARS] Site SD-4), which is approximately 600 feet northwest of Site 1 and hydraulically downgradient, as an additional potential source of VOC groundwater contamination at Site 1; PCE and TCE have been detected in SD-4 groundwater monitoring wells. The Air Force is currently conducting additional RI work to determine the full nature and extent of contamination of groundwater contamination at Site SD-4.

The Record of Decision (ROD) for Site 1 Groundwater, Operable Unit (OU) 3, was signed in September 2008. The ROD presented a selected interim remedial action for OU 3, which consisted of land use controls (LUCs), periodic groundwater monitoring (GWM), and five-year reviews. The purpose of the LUCs is to prevent uncontrolled use of groundwater. It was expected that a final ROD would be issued after action had been taken to address the off-site source of groundwater contamination (Tetra Tech, 2008d).

10.5 SITE CONCEPTUAL MODEL

Contaminant Sources

VOCs, consisting mainly of PCE and TCE, were detected in groundwater samples collected from monitoring wells surrounding the Privet Road Compound. The absence of VOC contamination in surface or subsurface soil indicates that the site itself is not a present source of the groundwater contamination. The RI concluded that the most significant source of VOCs is located off-Base, southeast of the Privet Road Compound.

Migration Pathways

Due to their high vapor pressure, aqueous solubility, and low potential for adsorption to soil, VOCs released to soil will be readily lost by volatilization and transported to groundwater by dissolution in infiltrating precipitation. Once in the groundwater, compounds of this class will be transported by groundwater movement through advection and dispersion. Under anaerobic conditions, PCE will biodegrade to TCE, and TCE may itself be slowly biodegraded to yield vinyl chloride.

Exposure Pathways

Human Health Risk

Groundwater at the site may be contacted by human receptors engaged in activities associated with future exposure scenarios. The exposure pathways for groundwater consist of ingestion and dermal absorption.

Ecological Risk

Site groundwater does not pose an ecological risk. Terrestrial receptors associated with Site 1 may be exposed to surface soil contaminants via incidental ingestion of soil and ingestion of contaminated food items, although this pathway is limited due to the lack of extensive terrestrial habitat at the site.
Potential Receptors

Human Receptors

Anticipated exposure scenarios include future excavation workers, future recreational children, and future residents.

Ecological Receptors

The site contains limited terrestrial habitat due to previous burning activities, which removed the existing natural organic matter. No migration pathways exist at the site that could carry contaminants to the higher quality upland areas that border the site. Although some metals are present in surface soil indicate moderate potential risks to terrestrial receptors, almost all of the metals were detected at concentrations comparable to background levels. The ecological screening assessment found that the site does not pose a threat to current or reasonably anticipated future ecological receptors.

10.6 PROBLEM DEFINITION

The selected interim remedy for Site 1 groundwater consists of LUCs, five-year reviews, and periodic GWM. Five-year reviews are required because contaminants remain on site in excess of levels that allow for unlimited use and unrestricted exposure. The purpose of the GWM is to provide the data to support the 5-year reviews.

Although the RI concluded that the primary source of VOCs in Site 1 groundwater is at an unknown upgradient location off of Navy property, the site may be a minor source of PCE and TCE because of low concentrations of these compounds in several shallow and intermediate monitoring wells downgradient of the northwestern corner of the site.

GWM data from the Navy Supply wells will be used to monitor the contamination that is migrating on-site from the unidentified upgradient source, and GWM data from the three shallow monitoring wells will be used to monitor the contamination that may be site-related.

The following environmental question is being asked:

Is contamination present in the unconfined aquifer downgradient of the northwestern corner of the site at concentrations that require monitoring?

(There is no environmental question associated with the monitoring of the Navy Supply wells. Sampling data from these wells will be used to support the five-year reviews.)
SAP Worksheet No. 11 -- Project Quality Objectives/Systematic Planning Process Statements
(UFP-QAPP Manual Section 2.6.1)

The following text describes the development of project quality objectives (PQOs) using EPA’s data quality objective (DQO) process.

11.1 DECISIONS TO BE MADE

The primary goal of this investigation is to obtain environmental data for use in making the following decision:

Determine whether PCE and TCE are present in shallow groundwater downgradient of the northwestern corner of the site at concentrations that exceed Maximum Contaminant Levels (MCLs) and thus require monitoring. If concentrations exceed MCLs, then the wells will be sampled as part of the GWM program. If the concentrations do not exceed MCLs, then the wells will not be included in the GWM program.

11.2 INPUTS REQUIRED TO MAKE THE DECISION

Data and information required to make this decision include the following:

1. Concentrations of PCE, TCE, and their degradation products cis-1,2-dichloroethene (DCE); trans-1,2-DCE; and vinyl chloride in the unconfined aquifer immediately downgradient of the site.

2. Laboratory reporting limits less than Project Action Limits (PALs), which are USEPA MCLs.

All chemical data will undergo validation. The analytical data will get the fullest level of QC and documentation in accordance with Navy guidance. The laboratory will hold a current National Environmental Laboratory Accreditation Program (NELAP) accreditation in Pennsylvania and comply with the requirements of the Naval Facilities Engineering Service Center (NFESC) in analytical results reporting and QA/QC.

11.3 DELINEATION OF STUDY BOUNDARY

The study boundary is defined by the LUC area (see Figure 10-2). The LUC area corresponds to the area of the Base affected by the groundwater contaminant plume originating at the unidentified off-Base source.

11.4 DEFINITION OF RULES FOR DECISION MAKING

Contaminant concentrations in each of the monitoring wells will be compared directly with MCLs.

Decision Rule

If the sample result for each compound in each of the three wells is less than its corresponding MCL for two consecutive sampling rounds, then, with the agreement of all parties, discontinue monitoring; otherwise, continue monitoring for as long as the interim remedy is in effect.

11.5 PERFORMANCE CRITERIA

Since a biased sampling approach is being utilized, performance criteria for analytical laboratory data are described in Worksheet Nos. 12, 15, and 28.

11.6 PLANS FOR OBTAINING THE DATA

Sample Collection and Analyses

One groundwater sample will be collected from each of the three shallow site monitoring wells, 01MW01S-R, 01MW01SO-R, and 01MW06S, and each of the two Navy supply wells, 01MWNW1 and
01MWNW2. The samples from the three monitoring wells will be analyzed for select VOCs (PCE, TCE, and degradation products), and the samples from the two supply wells will be analyzed for TCL VOCs [including Tentatively Identified Compounds (TICs)] and TAL metals. The three shallow monitoring wells will be purged and sampled with a submersible pump using either the low-flow or well-volume method, as appropriate. The two Navy supply wells will be sampled from faucets that allow access to the water prior to treatment.

**Data Generation, Validation, Reporting, and Archiving**

Tetra Tech field personnel will collect the groundwater samples listed on **Worksheet No. 18**. A chain-of-custody form will accompany all groundwater samples sent to the laboratory. The samples will be analyzed and data generated at a fixed-base laboratory in accordance with this SAP. The laboratory will provide paper and electronic data deliverables to Tetra Tech.

The laboratory will report the data to Tetra Tech, where the data will be validated. Full data validation (IIb) will be performed on all data. Laboratory data deliverables and hard copy validation reports produced by Tetra Tech will be archived in the Tetra Tech docketing and filing system.

The validated electronic data will be added to the NAS JRB Willow Grove Structured Query Language (SQL) database stored on the Tetra Tech server. A Portable Document Format (PDF) copy of the data will be maintained by Tetra Tech.

Site maps and figures detailing the site location, boundaries, and sampling locations are included in **Appendix C** of this SAP.
SAP Worksheet No. 12 -- Measurement Performance Criteria Table
(UFP-QAPP Manual Section 2.6.2)

<table>
<thead>
<tr>
<th>QC Sample</th>
<th>Analytical Group</th>
<th>Frequency</th>
<th>Data Quality Indicators (DQIs)</th>
<th>Measurement Performance Criteria (MPC)</th>
<th>QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&amp;A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trip Blank</td>
<td>VOCs</td>
<td>One per cooler of VOC samples shipped to laboratory</td>
<td>Bias/Contamination</td>
<td>No target analytes ≥ Quantitation Limits (QLs), with the exception of common field/laboratory contaminants</td>
<td>S &amp; A</td>
</tr>
<tr>
<td>Field Duplicate</td>
<td>VOCs, metals</td>
<td>One per 10 samples</td>
<td>Precision</td>
<td>Values &gt; 5X QLs: Relative Percent Difference (RPD) &lt;30 Values &lt; 5X QLs: absolute difference of values must be within 2X QLs</td>
<td>S &amp; A</td>
</tr>
<tr>
<td>Field/Rinsate Blank</td>
<td>VOCs</td>
<td>One per 20 samples per sampling equipment</td>
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<td>Temperature Blank</td>
<td>VOCs, metals</td>
<td>One per cooler</td>
<td>Accuracy/Representativeness</td>
<td>Between 2 and 6 °C</td>
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### SAP Worksheet No. 13 -- Secondary Data Criteria and Limitations Table

*(UFP-QAPP Manual Section 2.7)*

<table>
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<tr>
<th>Secondary Data</th>
<th>Data Source (originating organization, report title and date)</th>
<th>Data Generator(s) (originating organization, data types, data generation / collection dates)</th>
<th>How Data Will Be Used</th>
<th>Limitations on Data Use</th>
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<tr>
<td>RI Phase I Analytical Data</td>
<td>RI Report for Sites 1, 2, 3, and 5, Naval Air Station Willow Grove, Pennsylvania, 1993</td>
<td>Halliburton NUS Environmental Corporation, February 1993</td>
<td>Historical concentrations of TCE and PCE and their degradation products will be compared to current concentrations to determine changes in conditions.</td>
<td>No limitations on data use.</td>
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<td>RI Phase II Analytical Data</td>
<td>RI Report for Site 1- Privet Road Compound, NAS JRB Willow Grove, Pennsylvania; July, 2002.</td>
<td>Tetra Tech (data collected in 1997)</td>
<td>Historical concentrations of TCE and PCE and their degradation products will be compared to current concentrations to determine changes in conditions.</td>
<td>No limitations on data use.</td>
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</table>
SAP Worksheet No. 14 -- Summary of Project Tasks
(UFP-QAPP Manual Section 2.8.1)

FIELD TASKS

Monitoring Well Sampling and Analysis

Monitoring well 01MW01S-R which has a screen length of 8 feet, will be purged and sampled using low-flow techniques in accordance with the USEPA Region 3 Recommended Procedure for Low-Flow Purging and Sampling of Groundwater Monitoring Wells, Bulletin No. QAD023, June 16, 1999 (Appendix D), using a submersible pump with an adjustable flow rate. In each well, the pump will be positioned within the well screen interval at the depth of the water-producing fracture. This depth will be identified using the available boring logs and geophysical logs. The pumping rate will be set at between 0.1 to 0.4 liters per minute. The purge water discharge will be monitored for the water quality indicator parameters of pH, specific conductivity, turbidity, redox potential, and dissolved oxygen (DO). When the levels of these parameters stabilize, and a minimum of two saturated screen volumes have been removed from the well, the purging is complete and sampling can begin. Parameter stabilization is defined as three successive readings (taken at least 5 minutes apart) within 0.1 unit for pH, 3 percent for conductivity, 10 percent for turbidity and DO, and 10 millivolts (mV) for redox potential. If possible, the stabilized turbidity reading should be less than 10 nephelometric turbidity units (NTUs). The pumping rate will be controlled and the well’s water level will be constantly monitored to assure that the static water level is not drawn down into or below the screen, for those wells where the static water level is above the top of the well screen. For each well, the vertical location of the pump, required minimum purge volume, and calculations for parameter stabilization will be recorded on the groundwater sample log sheet.

Monitoring wells 01MW01SO-R, which is screened from 11 feet to 24 feet bgs, and 01MW06S, which is screened from 6 feet to 26 feet bgs, will be sampled by purging three to five well volumes with a submersible pump prior to sample collection. The pump will be positioned at the top of the well screen interval. Water quality indicator parameters (pH, specific conductivity, turbidity, redox potential, and DO) will be recorded for every half well volume. Monitoring well sampling procedures are discussed in SOP SA-1.1, which is included in Appendix A. Monitoring well construction logs for monitoring wells 01MW01S-R, 01MW01SO-R, and 01MW06S are included in Appendix E.

The two Navy supply wells will be sampled from faucets that allow access to the water prior to treatment. The faucets will be allowed to run for several minutes before sampling to drain the pipes of any stagnant water. No purging is necessary because the wells are pumped daily for production.

The locations of the existing monitoring wells to be sampled are shown on Figure 10-2. The sampling and analysis program is outlined in Worksheet No. 18, and the sampling requirements for each type of analysis (i.e., bottleware, preservation, holding time) are listed in Worksheet No. 19.

Field Quality Control Samples

Field quality control samples will be collected as part of the investigation, including field duplicates, trip blanks, equipment rinsate blanks, and field blanks. Worksheet No. 20 presents the field QC sample summary. Also, additional sample volume will be collected as necessary for the laboratory QC analysis of matrix spike (MS) and matrix spike duplicate (MSD) analyses (VOCs) or matrix spike and laboratory duplicate analyses (metals).

Equipment Decontamination

All non-disposable equipment that comes in contact with the sample medium will be decontaminated according to SOP SA-7.1 (Appendix A) to prevent cross contamination between sampling points. Personnel decontamination is discussed in the HASP.

Investigation-Derived Waste (IDW) Management

IDW includes decontamination fluid, used personal protective equipment (PPE), and used sampling equipment. IDW will be handled in accordance with SOP SA-7.1 (Appendix A) and the Base requirements.
ANALYTICAL TASKS

Chemical analysis for VOCs and metals will be performed by a subcontracted laboratory. Chemical analyses will be performed in accordance with the analytical methods identified in Worksheet No. 30 and the requirements of the analytical specifications for laboratory services developed by Tetra Tech for this work. The laboratory will meet the PQLs specified in Worksheet No. 15.

The analytical specifications detail the analytical requirements, number of samples, matrix, analytical method to be performed, preservatives, holding times, the quantitation limits required for the project, and data deliverables. The laboratory will perform the chemical analyses following laboratory-specific SOPs (Worksheets Nos. 19 and 23) developed based on the methods listed in Worksheets Nos. 19 and 30. Copies of the SOPs are included in Appendix B.

DATA MANAGEMENT TASKS

This section describes how project information will be managed, organized, and maintained for efficient use by project personnel. The information management process is outlined from data generation to ultimate storage.

Project Documentation and Records

A summary of project documentation and records to be generated and stored in the project files is provided in Worksheet No. 29.

Data Package Deliverables

Certain field measurements (e.g., photoionization detector (PID) readings) are made primarily for health and safety monitoring. Additional field measurements may include readings such as pH, temperature, and specific conductance to monitor ambient conditions prior to sample collection. These data will be recorded on the appropriate log sheets.

For the Site 1 GWM sampling events, a fixed-base laboratory will provide Contract Laboratory Program (CLP)-equivalent data packages for all analyses. Additionally, electronic deliverables, formatted according to the requirements stated in the laboratory subcontract, will be provided by the laboratory for all analytical data. Worksheet No. 30 summarizes the analytical requirements.

Data Reporting Formats

Field data will be recorded on log sheets or in the project logbook. The laboratory will provide CLP-equivalent data reporting forms 1 through 15 for the required metals and organic analyses.

Data Handling and Management

The data-handling procedures to be followed by the laboratory will meet the requirements in the laboratory subcontract. All analytical and field data will be maintained in the project files. The project files will contain hard copies of the chain-of-custody forms, sample log forms, sample location maps, and documentation of QA of data manipulation.

Data Tracking and Control

A “cradle-to-grave” sample tracking system will be used from the beginning to the end of each sampling event. Before field mobilization, the FOL will coordinate/initiate the sample tracking process. Sample jar labels will be handwritten in the field and will be reviewed for adherence to SAP requirements as well as for accuracy. The PM will coordinate with the analytical laboratory to ensure that they are aware of the number and type of samples and analyses.

When field sampling is underway, the FOL will forward the chain-of-custody forms to the PM or designee and the laboratory for each day that samples are collected. The PM or designee will confirm that the chain-of-custody forms provide the information required by the SAP. This will allow for early detection of errors made in the field so that adjustments can be made while the field team is mobilized. After successful completion of all requested
analyses, the laboratory will submit an electronic deliverable for every Sample Delivery Group (SDG). When all electronic deliverables have been received from the laboratory, the PM or designee will ensure that the laboratory performed all the requested analyses. Ideally, discrepancies can be noted early enough so that all samples can be analyzed within the prescribed holding times.

Sample Information

Data from field measurements will be recorded using the appropriate log sheets. Reduction of field data entails the summarization and presentation of these data in tabular form. The reduction of laboratory data entails the manipulation of raw data instrument output into reportable results. Field data (e.g., PID readings) will be verified on a daily basis by the FOL. Laboratory data will be verified by the group supervisor and then by the laboratory's QC/Documentation Department.

For field data, the FOL will coordinate with the Geographical Information System (GIS) lead to ensure that all survey technical specifications are consistent with the underlying coordinate system in the GIS.

Electronic data arriving from the laboratory will be forwarded to the Data Validation Manager (DVM) for database compilation and validation. The DVM will compile all the formatted laboratory electronic deliverables into a working project database. Data that are to be validated will be printed as data packages that include the samples as part of each SDG and the appropriate analytical fraction, and these data packages will be distributed to the appropriate data validators. The data validators will enter all data qualifiers and qualifier codes into the database and print out a hard copy and return it to the DVM. The DVM will check the data qualifiers and qualifier codes in the project database and print the final validated data for incorporation into the data validation letter. When all samples and analyses have been accounted for and validated, the PM will ensure that the analytical data are incorporated into the project database.

Project Data Compilation

The analytical laboratory will generate a PDF file of the analytical data packages, as well as electronic database deliverables. The electronic database will be checked against the PDF file provided by the laboratory and updated as required, based on data qualifier flags applied during the data validation process. The data generated during the implementation of the QAPP will be incorporated into the NAS JRB Willow Grove database and GIS. All data, such as units of measure and chemical nomenclature, will be manipulated to maintain consistency with the project database.

Geographical Information System

Data management systems consist of a relational database and GIS that are being used to manage environmental information pertaining to NAS JRB Willow Grove. The relational database stores chemical, geological, hydrogeological, and other environmental data collected during environmental investigations. The GIS is built from the relational database and contains subsets of the larger data pool. Using the GIS, environmental data can be posted on base mapping to provide a graphical representation of the information.

Upon compilation of sample, chemical, and positional data, the data will be compiled and incorporated into the NAS JRB Willow Grove GIS. The GIS system can be used to generate various maps for NAS JRB Willow Grove data including site location maps, sample location maps, and contaminant tag maps, as needed. The GIS software that is used will be documented in performance monitoring reports.

DATA REVIEW

The internal data verification requirements for this project include the maintenance and periodic review of field documentation (i.e., site logbooks, instrument calibration logs, chain-of-custody forms, field summary reports, and field modification records) and laboratory analytical data packages. After receipt of analytical laboratory results, Tetra Tech will perform data validation according to the requirements outlined in the Region 3 Modifications to the National Functional Guidelines for Organic Review (USEPA, 1994) and method-specific requirements to ensure that the analytical results meet the Project Quality Objectives (PQOs).
After the data are validated, a list of nonconformities will be generated. Nonconformities require data qualifiers, which are used to alert the data user to inaccurate or imprecise data. For situations in which several QC criteria are out of specification with regard to the limits specified in the DoD QSM (2006), the data validator may make professional judgments and/or comments on the validity of the overall data package. In situations where the validity of an entire data package is in question, it may be necessary for the sample(s) to be reanalyzed. The reviewer will then prepare a technical memorandum presenting changes in the data, if necessary, and the rationale for making such changes.

The net result is a data package that has been carefully reviewed for its adherence to prescribed requirements and is suitable for its intended use. Data validation therefore plays a major role in determining the confidence with which key technical evaluations may be made.

Data validation reports for all parameters will be generated according to the procedures described in Standard Operating Procedures (SOPs) **DV-02** and **DV-04**, included in Appendix A. The final data validation report will include a technical memorandum, qualified analytical results, results reported by the laboratory, and documentation to support data qualification. Qualified data will be flagged by an appropriate qualifying symbol.

The data and field records will also be reviewed by project personnel to ensure that the samples represent the intended sampling conditions and populations. Data qualified during validation will be reviewed to assess the impact of the qualifiers on the attainment of project objectives.

**PROJECT REPORTS**

Draft and Final sampling reports will be prepared for each biennial sampling round and submitted to the Navy, EPA, and PADEP for review. The reports will present the results of the groundwater sampling and compare the results to regulatory criteria.
SAP Worksheet No. 15 -- Reference Limits and Evaluation Table  
(UFP-QAPP Manual Section 2.8.1)

Matrix: Groundwater  
Analytical Group: VOCs

<table>
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<tr>
<th>Analyte</th>
<th>CAS Number</th>
<th>Project Action Limit (μg/L)</th>
<th>Project Action Limit Reference(1)</th>
<th>Project Quantitation Limit Goal(2) (μg/L)</th>
<th>Laboratory-specific Limits(3)</th>
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</table>

2 Project Quantitation Limit Goals are determined as at least 3X less than the PAL, if achievable.
3 Laboratory-specific Method Detection Limits (MDLs) and Quantitation Limits (QLs) are limits that an individual laboratory can achieve.
4 This compound is included in the abbreviated VOC list for the three shallow site monitoring wells.
### Matrix: Groundwater

### Analytical Group: Metals

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<thead>
<tr>
<th>Analyte</th>
<th>CAS Number</th>
<th>Project Action Limit (μg/L)</th>
<th>Project Action Limit Reference</th>
<th>Project Quantitation Limit Goal (μg/L)</th>
<th>Laboratory-Specific Limits (μg/L)</th>
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<td>---</td>
<td>---</td>
<td>TBD</td>
</tr>
<tr>
<td>Manganese</td>
<td>7439-96-5</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>TBD</td>
</tr>
<tr>
<td>Mercury</td>
<td>7439-97-6</td>
<td>2</td>
<td>MCL</td>
<td>0.67</td>
<td>TBD</td>
</tr>
<tr>
<td>Nickel</td>
<td>7440-02-0</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>TBD</td>
</tr>
<tr>
<td>Potassium</td>
<td>7440-9-7</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>TBD</td>
</tr>
<tr>
<td>Selenium</td>
<td>7782-49-2</td>
<td>50</td>
<td>MCL</td>
<td>16.7</td>
<td>TBD</td>
</tr>
<tr>
<td>Silver</td>
<td>7440-22-4</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>TBD</td>
</tr>
<tr>
<td>Sodium</td>
<td>7440-23-5</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>TBD</td>
</tr>
<tr>
<td>Thallium</td>
<td>7440-28-0</td>
<td>2</td>
<td>MCL</td>
<td>0.67</td>
<td>TBD</td>
</tr>
<tr>
<td>Vanadium</td>
<td>7440-62-2</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>TBD</td>
</tr>
<tr>
<td>Zinc</td>
<td>7440-66-6</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>TBD</td>
</tr>
</tbody>
</table>

2 Project Quantitation Limit Goals are determined as at least 3X less than the PAL, if achievable.
3 Laboratory-specific Method Detection Limits (MDLs) and Quantitation Limits (QLs) are limits that an individual laboratory can achieve.
**SAP Worksheet No. 16 -- Project Schedule / Timeline Table (optional format)**
*(UFP-QAPP Manual Section 2.8.2)*

<table>
<thead>
<tr>
<th>Activities</th>
<th>Organization</th>
<th>Dates (MM/DD/YYYY)</th>
<th>Deliverable</th>
<th>Deliverable Due Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Anticipated Date(s) of Initiation</td>
<td>Anticipated Date of Completion</td>
<td></td>
</tr>
<tr>
<td>Biennial Event 1 Groundwater Sampling</td>
<td>Tetra Tech</td>
<td>April 2009</td>
<td>April 2009</td>
<td>NA</td>
</tr>
<tr>
<td>Biennial Event 2 Groundwater Sampling</td>
<td>Tetra Tech</td>
<td>April 2011</td>
<td>April 2011</td>
<td>NA</td>
</tr>
<tr>
<td>Biennial Event 3 Groundwater Sampling</td>
<td>Tetra Tech</td>
<td>April 2013</td>
<td>April 2013</td>
<td>NA</td>
</tr>
<tr>
<td>First 5-Year Review</td>
<td>Tetra Tech</td>
<td>May 2013</td>
<td>September 2013</td>
<td>First 5-Year Review Report</td>
</tr>
</tbody>
</table>
SAP Worksheet No. 17 -- Sampling Design and Rationale
(UFP-QAPP Manual Section 3.1.1)

Describe and provide a rationale for choosing the sampling approach (e.g., grid system, biased statistical approach):

- The two Navy supply wells will be sampled to provide an indication of groundwater conditions within the LUC area. Monitoring wells 01MW01S-R, 01MW01SO-R, and 01MW06S will be sampled because the RI determined that the PCE contamination in these wells could potentially originate at Site 1. Site maps and figures detailing the site location, boundaries, and sampling locations are included in Appendix C of this SAP.

- One groundwater sample will be collected from each of three monitoring wells and analyzed for PCE, TCE, and their degradation products, cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride. This list of analytes was chosen based on the RI conclusion that the site could not be ruled out as a source of the PCE detected in the shallow groundwater downgradient of the northwestern corner of the site.

- One groundwater sample will be collected from each of the two Navy supply wells and analyzed for TCL VOCs (including TICs) and TAL metals. These analytes were chosen to comply with the list of COCs identified in the ROD (arsenic, barium, chromium, lead, manganese, carbon tetrachloride, chloroform, PCE, and TCE), and to include any additional contaminants that may be present in the off-site source, which has not been characterized. The source is a known source of VOCs, and likely contains metals, since the source area was used as a machine shop. If conditions at the source change, additional contaminants could potentially be mobilized.

- Sampling events will be performed every two years starting in April 2009.

- See Worksheet No. 18 for a list of the samples to be collected.
### SAP Worksheet No. 18 -- Sampling Locations and Methods/SOP Requirements Table
*(UFP-QAPP Manual Section 3.1.1)*

<table>
<thead>
<tr>
<th>Sampling Location/ID Number</th>
<th>Matrix</th>
<th>Depth (feet)</th>
<th>Analytical Group</th>
<th>Number of Samples (identify field duplicates)</th>
<th>Sampling SOP Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>01MW01S-R</td>
<td>Groundwater</td>
<td>32 - 40</td>
<td>VOCs</td>
<td>1</td>
<td>SA-1.1</td>
</tr>
<tr>
<td>01MW01SO-R</td>
<td>Groundwater</td>
<td>11 - 24</td>
<td>VOCs</td>
<td>1</td>
<td>SA-1.1</td>
</tr>
<tr>
<td>01MW06S</td>
<td>Groundwater</td>
<td>6 - 26</td>
<td>VOCs</td>
<td>1</td>
<td>SA-1.1</td>
</tr>
<tr>
<td>01MWNW1</td>
<td>Groundwater</td>
<td>52 - 396</td>
<td>VOCs, metals</td>
<td>1</td>
<td>SA-1.1</td>
</tr>
<tr>
<td>01MWNW2</td>
<td>Groundwater</td>
<td>68 - 351</td>
<td>VOCs, metals</td>
<td>2 (field duplicate*)</td>
<td>SA-1.1</td>
</tr>
</tbody>
</table>

* It is not mandatory that the field duplicate be collected at this location. The field duplicate location can be determined in the field; however, one field duplicate must be collected per sampling event.
### SAP Worksheet No. 19 -- Analytical SOP Requirements Table
(UFP-QAPP Manual Section 3.1.1)

<table>
<thead>
<tr>
<th>Matrix</th>
<th>Analytical Group</th>
<th>Analytical and Preparation Method/ SOP Reference</th>
<th>Containers (number, size, and type)</th>
<th>Sample volume</th>
<th>Preservation Requirements (chemical, temperature, light protected)</th>
<th>Maximum Holding Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater</td>
<td>VOCs</td>
<td>SW-846 8260B LAB SOP- TBD</td>
<td>Three 40 milliliter (mL) glass vials with Teflon septa</td>
<td>120 mL</td>
<td>Hydrochloric acid (HCl) to pH&lt;2, cool to 4(±2)°C no headspace</td>
<td>14 days to analysis</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Metals</td>
<td>SW-846 6010 LAB SOP- TBD</td>
<td>1 – 500 mL Polypropylene bottle</td>
<td>150 mL minimum</td>
<td>Cool to 4°C with nitric acid HNO₃</td>
<td>180 days to analysis; except for mercury which is 28 days</td>
</tr>
</tbody>
</table>
## SAP Worksheet No. 20 -- Field Quality Control Sample Summary Table

(UFP-QAPP Manual Section 3.1.1)

<table>
<thead>
<tr>
<th>Matrix</th>
<th>Analytical Group</th>
<th>No. of Sampling Locations</th>
<th>No. of Field Duplicates</th>
<th>No. of MS/MSDs(^1)</th>
<th>No. of Field Blanks</th>
<th>No. of Equip. Blanks</th>
<th>No. of Trip Blanks</th>
<th>No. of PT Samples</th>
<th>Total No. of Samples to Laboratory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater</td>
<td>VOCs</td>
<td>5</td>
<td>1</td>
<td>1/1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>NA</td>
<td>9</td>
</tr>
<tr>
<td>Groundwater</td>
<td>Metals</td>
<td>2</td>
<td>1</td>
<td>1/1</td>
<td>NA(^2)</td>
<td>NA(^2)</td>
<td>NA</td>
<td>NA</td>
<td>3</td>
</tr>
</tbody>
</table>

1. Although the matrix spike/matrix spike duplicate (MS/MSD) is not typically considered a field QC sample, it is included here because additional volume must be collected in the field.

2. Groundwater from the Navy supply wells will be sampled from a faucet directly into the sample containers, therefore, no field QC blanks are necessary.

PT – Performance Testing.
<table>
<thead>
<tr>
<th>Reference Number</th>
<th>Title, Revision Date and/or Number</th>
<th>Originating Organization of Sampling SOP</th>
<th>Equipment Type</th>
<th>Modified for Project Work? (Y/N)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>SA-1.1</td>
<td>Groundwater Sample Acquisition and Onsite Water Quality Testing</td>
<td>Tetra Tech</td>
<td>Bladder pump, submersible pump</td>
<td>N</td>
<td>Samples will be named according to Worksheet No. 18</td>
</tr>
<tr>
<td>CT-04</td>
<td>Sample Nomenclature</td>
<td>Tetra Tech</td>
<td>NA</td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>SA-6.1</td>
<td>Non-Radiological Sample Handling</td>
<td>Tetra Tech</td>
<td>Sample bottleware, packaging material, shipping materials</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>SA-6.3</td>
<td>Field Documentation</td>
<td>Tetra Tech</td>
<td>NA</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>SA-7.1</td>
<td>Decontamination of Field Equipment</td>
<td>Tetra Tech</td>
<td>Decontamination equipment (scrub brushes, phosphate-free detergent, deionized water)</td>
<td>N</td>
<td></td>
</tr>
</tbody>
</table>
### SAP Worksheet No. 22 -- Field Equipment Calibration, Maintenance, Testing, and Inspection Table

(UFP-QAPP Manual Section 3.1.2.4)

<table>
<thead>
<tr>
<th>Field Equipment</th>
<th>Activity</th>
<th>Frequency</th>
<th>Acceptance Criteria</th>
<th>Corrective Action</th>
<th>Responsible Person</th>
<th>SOP Reference</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photoionization Detector</td>
<td>Calibration and Visual Inspection</td>
<td>Daily</td>
<td>Manufacturer’s Guidance</td>
<td>Replace</td>
<td>FOL</td>
<td></td>
<td>Manufacturer’s Guidance</td>
</tr>
<tr>
<td>Multi-Parameter Water Quality Meter</td>
<td>Visual Inspection</td>
<td>Daily</td>
<td>Manufacturer’s Guidance</td>
<td>Replace</td>
<td>FOL</td>
<td>SA-1.1</td>
<td></td>
</tr>
<tr>
<td>Bladder Pump</td>
<td>Visual Inspection</td>
<td>Daily</td>
<td>Equipment Inspection Sheet Criteria</td>
<td>Replace</td>
<td>FOL</td>
<td>SA-1.1</td>
<td></td>
</tr>
<tr>
<td>Redi Flo™ Submersible Pump</td>
<td>Visual Inspection</td>
<td>Daily</td>
<td>Equipment Inspection Sheet Criteria</td>
<td>Replace</td>
<td>FOL</td>
<td>SA-1.1</td>
<td></td>
</tr>
</tbody>
</table>
### SAP Worksheet No. 23 -- Analytical SOP References Table
(UFP-QAPP Manual Section 3.2.1)

<table>
<thead>
<tr>
<th>Laboratory SOP Number</th>
<th>Title, Revision Date, and/or Number</th>
<th>Definitive or Screening Data</th>
<th>Matrix and Analytical Group</th>
<th>Instrument</th>
<th>Organization Performing Analysis</th>
<th>Modified for Project Work? (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBD</td>
<td>TBD</td>
<td>Definitive</td>
<td>Aqueous VOCs</td>
<td>GC/MS</td>
<td>TBD</td>
<td>N</td>
</tr>
<tr>
<td>TBD</td>
<td>TBD</td>
<td>Definitive</td>
<td>Aqueous metals</td>
<td>ICP-AES</td>
<td>TBD</td>
<td>N</td>
</tr>
</tbody>
</table>

**GC/MS** – Gas chromatograph/mass spectrometer  
**ICP-AES** – Inductively Coupled Plasma – Atomic Emission Spectroscopy  
**TBD** – To be determined

The laboratory will be procured every 2 years prior to each sampling event. Prior to sampling, TBDs will be filled in with laboratory specific information and Laboratory SOPs will be submitted to stake holders for review.
## SAP Worksheet No. 24 -- Analytical Instrument Calibration Table
(UFP-QAPP Manual Section 3.2.2)

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Calibration Procedure</th>
<th>Frequency of Calibration</th>
<th>Acceptance Criteria</th>
<th>Corrective Action (CA)</th>
<th>Person Responsible for CA</th>
<th>SOP Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>GC/MS</td>
<td>Minimum five-point calibration for all analytes.</td>
<td>Instrument receipt, instrument change (new trap, column, etc.), when Continuing Calibration Verification (CCV) does not meet criteria.</td>
<td>Relative Standard Deviation (RSD) for each Calibration Check Compound (CCC) &lt; 30%, minimum mean Response Factor (RF) for each System Performance Check Compound (SPCC) as noted in Section 7.3.5.4 of Method 8260B. If RSD for an analyte is &gt; 15%, apply linear ($r^2 &gt; 0.99$) or quadratic method for quantitation.</td>
<td>Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data.</td>
<td>Analyst/Supervisor</td>
<td>TBD</td>
</tr>
<tr>
<td>ICP-AES</td>
<td>4-5 point calibration plus blank per manufacturer's guidelines.</td>
<td>At the beginning of each day or if QC is out of criteria.</td>
<td>4-5 point calibration plus blank per manufacturer's guidelines; analytes run at their calibration levels must fall within 90-110% of True Values.</td>
<td>Recalibrate and/or perform necessary equipment maintenance. Check calibration standards.</td>
<td>Analyst/Supervisor</td>
<td>TBD</td>
</tr>
</tbody>
</table>
### SAP Worksheet No. 25 -- Analytical Instrument and Equipment Maintenance, Testing, & Inspection Table
(UFP-QAPP Manual Section 3.2.3)

<table>
<thead>
<tr>
<th>Instrument / Equipment</th>
<th>Maintenance Activity</th>
<th>Testing Activity</th>
<th>Inspection Activity</th>
<th>Frequency</th>
<th>Acceptance Criteria</th>
<th>Corrective Action</th>
<th>Responsible Person</th>
<th>SOP Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>GC/MS</td>
<td>Check pressure and gas supply daily. Bake out trap and column, manual tune if bromofluorobenzene (BFB) not in criteria, change septa as needed, cut column as needed, change trap as needed.</td>
<td>VOC Analysis</td>
<td>Initial and Continuing Calibration</td>
<td>Initial Calibration: Instrument receipt, instrument change (new trap, column, etc.), when CCC does not meet criteria; Continuing Calibration: At beginning of each 12 hour shift immediately after BFB tune.</td>
<td>Initial Calibration: RSD for each CCC &lt; 30%, min. mean RF for each SPCC as noted in Section 7.3.5.4 of Method 8260B. If RSD for an analyte is &gt; 15%, apply linear or quadratic method for quantitation; Continuing Calibration: % difference for each CCC &lt; 20%, min. RF for each SPCC as noted in Section 7.3.5.4 of Method 8260B.</td>
<td>Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected data. Record maintenance activities in Maintenance Logbook.</td>
<td>Analyst/Supervisor</td>
<td>TBD</td>
</tr>
<tr>
<td>ICP-AES</td>
<td>Clean torch assembly and spray chamber when discolored or when degradation in data quality is observed. Clean nebulizer, check argon, and replace peristaltic pump tubing as needed.</td>
<td>Metals Analysis</td>
<td>Initial Calibration, Initial Calibration Verification (ICV), Continuing Calibration Verification</td>
<td>Initial Calibration: At the beginning of each day or if QC is out of criteria; Initial Calibration Verification: Immediately after instrument calibration; Continuing Calibration Verification: After every 10 samples and at end of analytical sequence.</td>
<td>Initial Calibration: 4-5 point calibration plus blank with .995 or better correction coefficient; Initial Calibration Verification and Continuing Calibration Verification: 90-110% of true value for Inductively Coupled Plasma.</td>
<td>Recalibrate and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected metals. Record maintenance activities in Maintenance Logbook.</td>
<td>Analyst/Supervisor</td>
<td>TBD</td>
</tr>
</tbody>
</table>
### Sample Handling System

#### SAMPLE COLLECTION, PACKAGING, AND SHIPMENT

- **Sample Collection (Personnel/Organization):** Don Whalen/Tetra Tech
- **Sample Packaging (Personnel/Organization):** Don Whalen/Tetra Tech
- **Coordination of Shipment (Personnel/Organization):** Don Whalen/Tetra Tech
- **Type of Shipment/Carrier:** Overnight courier service (Federal Express)

#### SAMPLE RECEIPT AND ANALYSIS

- **Sample Receipt (Personnel/Organization):** Sample custodians/TBD
- **Sample Custody and Storage (Personnel/Organization):** Sample custodians/TBD
- **Sample Preparation (Personnel/Organization):** Preparation Laboratory Staff/TBD
- **Sample Determinative Analysis (Personnel/Organization):** GC/MS chemists/TBD

#### SAMPLE ARCHIVING

- **Field Sample Storage (No. of days from sample collection):** Ship immediately to laboratory, maximum field holding time of 1 day
- **Sample Extract/Digestate Storage (No. of days from extraction/digestion):** Not applicable
- **Biological Sample Storage (No. of days from sample collection):** Not applicable

#### SAMPLE DISPOSAL

- **Personnel/Organization:** Sample custodians/TBD
- **Number of Days from Analysis:** 30 days from submittal of final report
SAP Worksheet No. 27 -- Sample Custody Requirements Table  
(UFP-QAPP Manual Section 3.3.3)

Field Sample Custody Procedures (sample collection, packaging, shipment, and delivery to laboratory): Following sample collection into the appropriate bottleware. All samples will be enclosed in bubble-wrap and immediately placed on ice in a cooler. The cooler will be secured using duct or clear packaging tape along with signed custody seals. Sample coolers will be delivered to a local courier location for priority overnight delivery to the selected laboratory for analysis. Samples will be preserved as appropriate based on the analytical method. The laboratory will provide pre-preserved sample containers for sample collection. Samples will be maintained at 4°C until delivery to the laboratory. Proper custody procedures will be followed throughout all phases of sample collection and handling. Chain-of-custody protocols will be used throughout sample handling to establish the evidentiary integrity of sample containers. These protocols will be used to demonstrate that the samples were handled and transferred in a manner that would eliminate possible tampering. Samples for the laboratory will be packaged and shipped in accordance with Tetra Tech SOP SA-6.1.

Laboratory Sample Custody Procedures (receipt of samples, archiving, disposal): TBD (The laboratory will be procured every 2 years prior to each sampling event. Prior to this, TBDs will be filled in with laboratory specific information and Laboratory SOPs will be submitted to stakeholders for review.)

Sample Identification Procedures: Sample nomenclature will be assigned in general accordance with the procedures outlined in Tetra Tech SOP CT-04 (Sample Nomenclature) included in Appendix A and as outlined in Worksheet No. 18. Sample nomenclature for these field events has been selected based on previous nomenclature and includes designations for the site being investigated, sample medium identifier or Quality Assurance/Quality Control sample designation, and sample location number. The standard sample matrix and type codes used for this field event are as follows:

Site Identifier:

01 = Site 1

Sample Type:

MW = Monitoring Well

QA/QC Sample Designation:

TB = Trip Blank
FB = Field Blank
RB = Rinsate Blank

Sample Location:

The sample location will consist of the monitoring well number followed by eight-digits indicating the date on which the sample was collected. For example, a sample collected from MW-05 on April 14, 2009 will be assigned the sample designation 01MW05-20090414.

QC Sample Number:

All QC samples will be assigned a sample number based on the sample date. For example, a trip blank collected on January 14, 2009 will be assigned the tracking number TB-20090114.

Duplicate samples will be submitted to the laboratory as blind duplicates; therefore, duplicate codes will be reflective of the standard sample matrix code followed by a “DUP” tag and sequentially listed. An example of a duplicate sample would be “01DUP01.” Samples for matrix spike/matrix spike duplicate (MS/MSD) analysis will be labeled MS/MSD on the bottle label and noted on the chain-of-custody form, as required in the laboratory QA Plan; however, “MS/MSD” will not be part of the unique sample identifier to maintain
consistency with the project database. Additional information regarding sample labeling is contained in Tetra Tech SOP SA-6.3.

**Chain-of-Custody Procedures:** After collection, each sample will be maintained in the sampler’s custody until formally transferred to another party (e.g., Federal Express). For all samples collected, custody records will document the date and time of sample collection, the sampler’s name, and the names of all others who subsequently held custody of the sample. Specifications for chemical analyses will also be documented on the custody record. Attached SOP SA-6.3 (Field Documentation) provides further details on the chain-of-custody procedure. Chain-of-custody requirements are also documented with instructions contained in each shipment from the laboratory (LAB SOP TBD).
SAP Worksheet No. 28 -- Laboratory QC Samples Table  
(UFP-QAPP Manual Section 3.4)

The laboratory will be procured every 2 years prior to each sampling event. Prior to this TBDs will be filled in with laboratory specific information and Laboratory SOPs will be submitted to stakeholders for review.

<table>
<thead>
<tr>
<th>Matrix</th>
<th>Groundwater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analytical Group</td>
<td>VOCs</td>
</tr>
<tr>
<td>Analytical Method / SOP Reference</td>
<td>SW-846 8260B/ LAB SOP-TBD</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QC Sample</th>
<th>Frequency/Number</th>
<th>Method/SOP QC Acceptance Limits</th>
<th>Corrective Action</th>
<th>Person(s) Responsible for Corrective Action</th>
<th>Data Quality Indicator (DQI)</th>
<th>Measurement Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method Blank</td>
<td>One every 12 hours prior to sample analysis</td>
<td>No target compounds $\geq \frac{1}{2}$ QLs except common laboratory contaminants</td>
<td>Reclean, retest, re-extract, reanalyze, and/or qualify data.</td>
<td>Analyst, Laboratory Supervisor</td>
<td>Bias/Contamination</td>
<td>No target compounds $\geq \frac{1}{2}$ QLs (except common laboratory contaminants)</td>
</tr>
<tr>
<td>Surrogate</td>
<td>3 per sample</td>
<td>Statistically derived limits.</td>
<td>(1) Reprep and reanalyze for confirmation of matrix interference when appropriate</td>
<td>Analyst, Laboratory Supervisor</td>
<td>Accuracy/Bias</td>
<td>Within laboratory's statistically derived limits</td>
</tr>
</tbody>
</table>
| Laboratory Control Spike (LCS) | One per batch of 20 or less | Statistically derived from laboratory data or nominal limits depending on the project. Statistical limits are used as default limits. | (1) Evaluate and reanalyze if possible  
(2) If a MS/MSD was performed in the same 12-hour clock and acceptable, narrate.  
(3) If LCS recoveries are high but the sample results are $<\text{QLs}$, narrate, otherwise reprep and reanalyze. | Analyst, Laboratory Supervisor | Precision/Accuracy/Bias | Statistically derived from laboratory data or nominal limits depending on the project. Statistical limits are used as default limits. |
| Internal Standard (IS) | 3 per sample | Retention time ± 30 seconds; extracted ion current profile area within -50% to +100% of last calibration verification (12 hours) for each IS. | Inspect MS or GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning. | Analyst, Laboratory Supervisor | Precision/Accuracy/Bias | Retention time ± 30 seconds; extracted ion current profile area within -50% to +100% of last calibration verification (12 hours) for each IS. |
| MS/MSD | One per SDG or every 20 samples | Statistically derived from laboratory data or nominal limits depending on the project. Statistical limits are used as default limits. | (1) Corrective action will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met.  
(2) If both the LCS and MS/MSD are unacceptable, reprep the samples and QC. | Analyst, Laboratory Supervisor | Precision/Accuracy/Bias | Statistically derived from laboratory data or nominal limits depending on the project. Statistical limits are used as default limits. |
<table>
<thead>
<tr>
<th>Matrix</th>
<th>Groundwater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analytical Group</td>
<td>Metals</td>
</tr>
<tr>
<td>Analytical Method / SOP Reference</td>
<td>SW-846 6010B/ LAB SOP-TBD</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QC Sample</th>
<th>Frequency / Number</th>
<th>Method / SOP QC Acceptance Limits</th>
<th>Corrective Action</th>
<th>Person(s) Responsible for Corrective Action</th>
<th>Data Quality Indicator (DQI)</th>
<th>Measurement Performance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method Blank</td>
<td>One per digestion batch of 20 or fewer samples</td>
<td>Less than 1/2 quantitation limit)</td>
<td>1) Investigate source of contamination. Re-digest and reanalyze all associated samples if sample concentration ≥ quantitation limit) and &lt;10x the blank concentration.</td>
<td>Laboratory Supervisor</td>
<td>Bias / Contamination</td>
<td>Less than ½ quantitation limit</td>
</tr>
<tr>
<td>Laboratory Control Sample</td>
<td>One per digestion batch of 20 or fewer samples</td>
<td>Recovery within ± 20% of true value, unless vendor-supplied or statistical limits have been established.</td>
<td>1) Investigate source of problem. Re-digest and reanalyze all associated samples.</td>
<td>Laboratory Supervisor</td>
<td>Accuracy / Bias / Contamination</td>
<td>Recovery within ± 20% of true value, unless vendor-supplied or statistical limits have been established.</td>
</tr>
<tr>
<td>Duplicate Sample</td>
<td>One per digestion batch of 20 or fewer samples</td>
<td>RPD ≤20% for duplicate spikes.</td>
<td>Flag results.</td>
<td>Analyst, Laboratory Supervisor and Data Validator</td>
<td>Precision</td>
<td>RPD≤20% for duplicate spikes</td>
</tr>
<tr>
<td>Matrix Spike</td>
<td>One per digestion batch of 20 or fewer samples</td>
<td>Recovery ± 25% of true value, if sample &lt; 4x spike added.</td>
<td>Flag results.</td>
<td>Analyst, Laboratory Supervisor and Data Validator</td>
<td>Accuracy / Bias</td>
<td>Recovery ± 25% of true value, if sample &lt; 4x spike added.</td>
</tr>
<tr>
<td>ICP Serial Dilution</td>
<td>One per digestion batch</td>
<td>If original sample result is at least 50x Instrument Detection Limit (IDL), 5-fold dilution must agree within ± 10% of the original result.</td>
<td>Flag result or dilute and reanalyzed sample to eliminate interference.</td>
<td>Analyst, Laboratory Supervisor and Data Validator</td>
<td>Accuracy / Bias</td>
<td>If original sample result is at least 50x IDL, 5-fold dilution must agree within ± 10% of the original result.</td>
</tr>
<tr>
<td>Matrix</td>
<td>Groundwater</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analytical Group</td>
<td>Mercury</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analytical Method / SOP Reference</td>
<td>SW-846 7470A/ LAB SOP-TBD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>QC Sample</th>
<th>Frequency / Number</th>
<th>Method / SOP QC Acceptance Limits</th>
<th>Corrective Action</th>
<th>Person(s) Responsible for Corrective Action</th>
<th>Data Quality Indicator (DQI)</th>
<th>Measurement Performance Criteria</th>
</tr>
</thead>
</table>
| Method Blank     | One per prep batch | No analyte detected $> \frac{1}{2}$ quantitation limit | (1) Investigate source of contamination.  
(2) Report all sample results $< \text{quantitation limit}$.  
(3) Report sample results $>10X$ the blank result and flag results with a "B".  
(4) Reanalyze all other samples associated with the failing blank. | Laboratory Supervisor | Bias Contamination | No analyte detected $>\frac{1}{2}$ quantitation limit |
| Laboratory Control Sample | One per prep batch | 80-120 % recovery | (1) If the laboratory control sample (LCS) fails high, report samples that are $<\text{quantitation limit}$.  
(2) Recalibrate and/or reanalyze other samples. | Laboratory Supervisor | Accuracy / Bias | 80-120 % recovery |
| Duplicate Sample | One sample duplicate per 20 samples | Relative percent difference $<20$ for samples $>3X$ the Quantitation Limit | (1) Investigate problem and reanalyze sample in duplicate  
(2) If Relative Percent Difference still $>20$, report original result with notation or narration. | Analyst, Laboratory Supervisor and Data Validator | Precision | Relative percent difference $<20$ for samples $<3X$ the quantitation limit and $<100\%$ for samples $>3X$ the quantitation limit |
| Matrix Spike     | One for every set of 10 samples | 85-115% recovery if sample is $<4x$ the spike added | (1) If both the laboratory control sample and MS are unacceptable re-prep and reanalyze the samples and QC.  
(2) For 7196, dilute a new pH adjusted aliquot, re-spike and reanalyze to confirm matrix interference; narrate. | Analyst, Laboratory Supervisor and Data Validator | Accuracy / Bias | 85-115% recovery |
## SAP Worksheet No. 29 -- Project Documents and Records Table
(UFP-QAPP Manual Section 3.5.1)

<table>
<thead>
<tr>
<th>Document</th>
<th>Where Maintained</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Field Documents</strong></td>
<td></td>
</tr>
<tr>
<td>Field Logbook</td>
<td>Field documents will be maintained in the project file located in the Tetra Tech King of Prussia, Pennsylvania office.</td>
</tr>
<tr>
<td>Field Sample Forms</td>
<td></td>
</tr>
<tr>
<td>Chain-of-Custody Records</td>
<td></td>
</tr>
<tr>
<td>Air Bills</td>
<td></td>
</tr>
<tr>
<td>Sampling Instrument Calibration Logs</td>
<td></td>
</tr>
<tr>
<td>Sampling Notes</td>
<td></td>
</tr>
<tr>
<td>Photographs</td>
<td></td>
</tr>
<tr>
<td>Field Task Modification Request Forms</td>
<td></td>
</tr>
<tr>
<td>This SAP</td>
<td></td>
</tr>
<tr>
<td>Health and Safety Plan</td>
<td></td>
</tr>
<tr>
<td><strong>Laboratory Documents</strong></td>
<td></td>
</tr>
<tr>
<td>Sample Receipt, Custody, and Tracking Records</td>
<td>Laboratory documents will be included in the hardcopy and PDF deliverables from the laboratory. Laboratory data deliverables will be maintained in the Tetra Tech King of Prussia, Pennsylvania project file and in long-term data package storage at a third-party professional document storage firm.</td>
</tr>
<tr>
<td>Standards Traceability Logs</td>
<td></td>
</tr>
<tr>
<td>Equipment Calibration Logs</td>
<td></td>
</tr>
<tr>
<td>Sample Preparation Logs</td>
<td></td>
</tr>
<tr>
<td>Analysis Run Logs</td>
<td></td>
</tr>
<tr>
<td>Equipment Maintenance, Testing, and Inspection Logs</td>
<td></td>
</tr>
<tr>
<td>Corrective Action Forms</td>
<td></td>
</tr>
<tr>
<td>Reported Field Sample Results</td>
<td></td>
</tr>
<tr>
<td>Reported Results for Standards, QC Checks, and QC Samples</td>
<td>Electronic data results will be maintained in a database on a password-protected SQL server.</td>
</tr>
<tr>
<td>Sample Storage and Disposal Records</td>
<td></td>
</tr>
<tr>
<td>Telephone Logs</td>
<td></td>
</tr>
<tr>
<td>Extraction/Clean-Up Records</td>
<td></td>
</tr>
<tr>
<td>Raw Data</td>
<td></td>
</tr>
<tr>
<td>Data Completeness Checklists</td>
<td></td>
</tr>
<tr>
<td><strong>Assessment Findings</strong></td>
<td></td>
</tr>
<tr>
<td>Data Review Memoranda (including tabulated data summary forms)</td>
<td>All data review memoranda will be maintained in the Tetra Tech King of Prussia, Pennsylvania project file.</td>
</tr>
<tr>
<td><strong>Reports</strong></td>
<td></td>
</tr>
<tr>
<td>Site 1 Sampling Reports</td>
<td>All Site 1 reports will be stored in hardcopy format in the Tetra Tech King of Prussia, Pennsylvania, project file and electronically in the server library.</td>
</tr>
<tr>
<td>First Five-Year Review Report</td>
<td></td>
</tr>
</tbody>
</table>
SAP Worksheet No. 30 -- Analytical Services Table
(UFP-QAPP Manual Section 3.5.2.3)

<table>
<thead>
<tr>
<th>Matrix</th>
<th>Analytical Group</th>
<th>Sample Locations/ID Number</th>
<th>Analytical Method</th>
<th>Data Package Turnaround Time</th>
<th>Laboratory/Organization (name and address, contact person and telephone number)</th>
<th>Backup Laboratory/Organization (name and address, contact person and telephone number)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater</td>
<td>VOCs</td>
<td>See Worksheet No. 18</td>
<td>SW-846 8260B</td>
<td>21 days</td>
<td>TBD</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LAB SOP- TBD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Groundwater</td>
<td>Metals</td>
<td>See Worksheet No. 18</td>
<td>SW-846 6010B</td>
<td>21 days</td>
<td>TBD</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LAB SOP-TBD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Groundwater</td>
<td>Mercury</td>
<td>See Worksheet No. 18</td>
<td>SW-846 7470A</td>
<td>21 days</td>
<td>TBD</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>LAB SOP-TBD</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The laboratory will be procured every 2 years prior to each sampling event. Prior to this TBDs will be filled in with laboratory specific information and Laboratory SOPs will be submitted to stakeholders for review.
<table>
<thead>
<tr>
<th>Assessment Type</th>
<th>Frequency</th>
<th>Internal or External</th>
<th>Organization Performing Assessment</th>
<th>Person(s) Responsible for Performing Assessment (title and organizational affiliation)</th>
<th>Person(s) Responsible for Responding to Assessment Findings (title and organizational affiliation)</th>
<th>Person(s) Responsible for Identifying and Implementing Corrective Actions (CA) (title and organizational affiliation)</th>
<th>Person(s) Responsible for Monitoring Effectiveness of CA (title and organizational affiliation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health and Safety</td>
<td>One per contract year</td>
<td>Internal</td>
<td>Tetra Tech</td>
<td>Health and Safety Personnel, Tetra Tech</td>
<td>PM, Tetra Tech</td>
<td>Auditor and HSM, Tetra Tech</td>
<td>HSM, Tetra Tech</td>
</tr>
<tr>
<td>Laboratory Systems Audit</td>
<td>Every 18 months</td>
<td>External</td>
<td>Naval Facilities Engineering Service Center (NFESC)</td>
<td>NFESC Auditor</td>
<td>QAM Laboratory</td>
<td>QAM Laboratory</td>
<td>QAM Laboratory</td>
</tr>
<tr>
<td>Field Quality Assurance</td>
<td>One per contract year</td>
<td>Internal</td>
<td>Tetra Tech</td>
<td>Auditor, Tetra Tech</td>
<td>PM, Tetra Tech</td>
<td>Auditor and QAM, Tetra Tech</td>
<td>QAM, Tetra Tech</td>
</tr>
<tr>
<td>Assessment Type</td>
<td>Nature of Deficiencies Documentation</td>
<td>Individual(s) Notified of Findings (name, title, organization)</td>
<td>Time Frame of Notification</td>
<td>Nature of Corrective Action Response Documentation</td>
<td>Individual(s) Receiving Corrective Action Response (name, title, organization)</td>
<td>Time Frame for Response</td>
<td></td>
</tr>
<tr>
<td>---------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------</td>
<td></td>
</tr>
<tr>
<td>Health and Safety Audit</td>
<td>Audit checklist and written audit finding summary</td>
<td>Russ Turner PM, Tetra Tech TBD FOL, Tetra Tech John Trepanowski Program Manager, Tetra Tech</td>
<td>Dependant on findings: if major, a stop work may be issued immediately; however, if minor, within 1 week of audit.</td>
<td>Written Memorandum</td>
<td>Matt Soltis HSM Tetra Tech TBD Auditor, Tetra Tech John Trepanowski Program Manager, Tetra Tech</td>
<td>Within 48 hours of notification</td>
<td></td>
</tr>
<tr>
<td>Field Sampling System Audit</td>
<td>Audit checklist and written audit finding summary</td>
<td>Russ Turner PM, Tetra Tech TBD FOL, Tetra Tech John Trepanowski Program Manager, Tetra Tech</td>
<td>Dependant on findings: if major, a stop work may be issued immediately; however, if minor, within 1 week of audit.</td>
<td>Written Memorandum</td>
<td>Tom Johnston QAM, Tetra Tech TBD Auditor, Tetra Tech John Trepanowski Program Manager, Tetra Tech</td>
<td>Within 48 hours of notification</td>
<td></td>
</tr>
<tr>
<td>Laboratory Systems Audit</td>
<td>Written audit report</td>
<td>Laboratory QAM, TBD</td>
<td>Not specified by NFESC</td>
<td>Letter</td>
<td>NFESC</td>
<td>Specified by NFESC</td>
<td></td>
</tr>
</tbody>
</table>
### SAP Worksheet No. 33 -- QA Management Reports Table
(UFP QAPP Manual Section 4.2)

<table>
<thead>
<tr>
<th>Type of Report</th>
<th>Frequency (Daily, weekly monthly, quarterly, annually, etc.)</th>
<th>Projected Delivery Date(s)</th>
<th>Person(s) Responsible for Report Preparation (title and organizational affiliation)</th>
<th>Report Recipient(s) (title and organizational affiliation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Validation Report</td>
<td>Per SDG</td>
<td>Within 2 weeks of receipt of laboratory data</td>
<td>Data Validator, Tetra Tech</td>
<td>PM Tetra Tech, project file</td>
</tr>
<tr>
<td>Major Analysis Problem Identification (Internal Memorandum)</td>
<td>When persistent analysis problems are detected</td>
<td>Immediately</td>
<td>QAM, Tetra Tech</td>
<td>PM Tetra Tech, project file</td>
</tr>
<tr>
<td>Project Monthly Progress Report</td>
<td>Monthly for duration of project</td>
<td>Monthly</td>
<td>PM, Tetra Tech</td>
<td>PM Tetra Tech, QAM Tetra Tech, Program Manager, Tetra Tech, project file</td>
</tr>
<tr>
<td>Field Progress Report</td>
<td>Daily, oral, during the course of sampling</td>
<td>Every day that field sampling occurs</td>
<td>FOL, Tetra Tech</td>
<td>PM Tetra Tech</td>
</tr>
<tr>
<td>Laboratory QA Report</td>
<td>When significant plan deviations result from unanticipated circumstances</td>
<td>Immediately</td>
<td>Subcontracted laboratory, TBD</td>
<td>PM Tetra Tech - project file</td>
</tr>
</tbody>
</table>
## SAP Worksheet No. 34 -- Verification (Step I) Process Table
*(UFP-QAPP Manual Section 5.2.1)*

<table>
<thead>
<tr>
<th>Verification Input</th>
<th>Description</th>
<th>Internal / External</th>
<th>Responsible for Verification (name, organization)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chain-of-Custody Forms</strong></td>
<td>The Tetra Tech FOL or designee will review and sign each chain-of-custody form to verify that all samples listed are included in the shipment to the laboratory and the sample information is accurate. The forms will be signed by the sampler and a copy will be retained for the project file, the PM, and the data validator. See <a href="#">SOP SA-6.3</a>.</td>
<td>Internal</td>
<td>FOL and Field Crew, Tetra Tech</td>
</tr>
<tr>
<td></td>
<td>The laboratory sample custodian will review the sample shipment for completeness and integrity and will sign accepting the shipment. The data validator will check that the chain-of-custody form was signed and dated by the Tetra Tech FOL or designee relinquishing the samples and also by the laboratory sample custodian receiving the samples for analyses.</td>
<td>Internal/External</td>
<td>1 - Laboratory Sample Custodian, TBD 2 – Data Validator, Tetra Tech</td>
</tr>
<tr>
<td><strong>Sample Tables</strong></td>
<td>Proposed samples verified to have been collected.</td>
<td>Internal</td>
<td>FOL and Field Crew, Tetra Tech</td>
</tr>
<tr>
<td><strong>Sample Log Sheets</strong></td>
<td>Log sheets completed as samples are collected in the field are verified for completeness and are maintained at the project office.</td>
<td>Internal</td>
<td>PM, FOL, or designee, Tetra Tech</td>
</tr>
<tr>
<td><strong>Sample Coordinates</strong></td>
<td>Sample locations will be verified to be correct and in accordance with the SAP (compare map of proposed locations to map of actual locations).</td>
<td>Internal</td>
<td>PM, FOL, or designee, Tetra Tech</td>
</tr>
<tr>
<td><strong>Field QC Samples</strong></td>
<td>Check that field QC samples listed in <a href="#">Worksheet No. 20</a> were collected as required.</td>
<td>Internal</td>
<td>FOL or designee, Tetra Tech</td>
</tr>
<tr>
<td><strong>Analytical Data Packages</strong></td>
<td>All analytical data packages will be verified internally for completeness by the laboratory performing the work. The laboratory QAM will sign the case narrative for each data package.</td>
<td>Internal</td>
<td>Laboratory QAM, TBD</td>
</tr>
<tr>
<td></td>
<td>Verify that the data package contains all the elements required by the functional guidelines and scope of work. This occurs as part of the data validation process.</td>
<td>Internal</td>
<td>Data Validator, Tetra Tech</td>
</tr>
<tr>
<td><strong>Electronic Data Deliverables</strong></td>
<td>The electronic data will be compared to the chain-of-custody form and hard copy data package to verify accuracy and completeness.</td>
<td>External</td>
<td>Data Validator, Tetra Tech</td>
</tr>
</tbody>
</table>
**SAP Worksheet No. 35 -- Validation (Steps Ila and Iib) Process Table**

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

<table>
<thead>
<tr>
<th>Step Ila/Iib</th>
<th>Validation Input</th>
<th>Description</th>
<th>Responsible for Validation (name, organization)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ila</td>
<td>Field SOPs/Field Logs/Sample Collection</td>
<td>Ensure that all sampling SOPs were followed. Verify that deviations have been documented and MPCs have been achieved, particularly that samples were correctly identified, that sampling location coordinates are accurate, and that documentation establishes an unbroken chain of custody from sample collection to report generation. Verify that the correct sampling and analytical methods/SOPs were applied. Verify that the SAP was implemented and carried out as written and that any deviations are documented.</td>
<td>PM, FOL, or designee, Tetra Tech</td>
</tr>
<tr>
<td>Ila</td>
<td>Analytical SOPs</td>
<td>Ensure that all laboratory SOPs were followed. Verify that the correct analytical methods/SOPs were applied.</td>
<td>Laboratory QAM, TBD</td>
</tr>
<tr>
<td>Ila</td>
<td>Documentation of Method QC Results</td>
<td>Establish that all method QC samples were analyzed and in control as listed in the analytical SOPs. If method QA is not in control, the laboratory will contact Tetra Tech for guidance prior to report preparation.</td>
<td>Laboratory QAM, TBD</td>
</tr>
<tr>
<td>Ila</td>
<td>Chain-of-Custody Forms</td>
<td>Ensure that the custody and integrity of the samples were maintained from collection to analysis and that custody records are complete and any deviations are recorded.</td>
<td>Data Validator, Tetra Tech</td>
</tr>
<tr>
<td>Ila</td>
<td>Holding Times</td>
<td>Verify that the samples were shipped and stored at the required temperature and that sample pH values for chemically preserved samples meet the requirements listed in Worksheet No. 19. Verify that the analyses were performed within the holding times listed in Worksheet No. 19.</td>
<td>Data Validator, Tetra Tech</td>
</tr>
<tr>
<td>Ila</td>
<td>Data Results</td>
<td>Verify that summary form results match the raw data.</td>
<td>Data Validator, Tetra Tech</td>
</tr>
<tr>
<td>Ila/Iib</td>
<td>Laboratory Data Results</td>
<td>Ensure that the laboratory QC samples listed in Worksheet No. 28 were analyzed and that the measurement performance criteria listed in Worksheet No. 12 were met for all field samples and QC analyses. Verify that specified field QC samples were collected and analyzed and that the analytical quality control criteria set up for this project were met.</td>
<td>Data Validator, Tetra Tech</td>
</tr>
<tr>
<td>Ila/Iib</td>
<td>Field and Laboratory Duplicate Analyses for Precision</td>
<td>Verify the field sampling precision by checking the RPD for field duplicate samples. Verify laboratory precision by checking RPDs or percent difference values from laboratory duplicate, MS/MSD, and LCS/LCSD analyses. Ensure compliance with the methods and project MPC accuracy goals listed in Worksheet No. 12.</td>
<td>Data Validator, Tetra Tech</td>
</tr>
<tr>
<td>Step Ila/Ilb</td>
<td>Validation Input</td>
<td>Description</td>
<td>Responsible for Validation (name, organization)</td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Ila/Ilb</td>
<td>Sample Results for Representativeness</td>
<td>Verify that the laboratory recorded the temperature of each sample at sample receipt and the pH of chemically preserved samples to ensure sample integrity from sample collection to analysis</td>
<td>Data Validator, Tetra Tech</td>
</tr>
<tr>
<td>Ila/Ilb</td>
<td>Project Action Limits</td>
<td>Discuss the impact of matrix interferences or sample dilutions performed, because of the high concentration of one or more contaminants, on the other target compounds reported as not detected. Document this usability issue and inform the PM.</td>
<td>Data Validator, Tetra Tech</td>
</tr>
<tr>
<td>Ila/Ilb</td>
<td>Project Action Limits</td>
<td>Review and add PALs to the laboratory electronic data deliverable. Flag samples and notify the PM of samples that exceed PALs as listed in Worksheet No. 15.</td>
<td>PM or designee, Tetra Tech</td>
</tr>
<tr>
<td>Ila/Ilb</td>
<td>Data Validation Report</td>
<td>Summarize deviations from methods, procedures, or contracts. Qualify data results based on method or QC deviation and explain all data qualifications. Print a copy of the project database, qualified data depicting data qualifiers, and data qualifiers codes that summarize the reason for data qualifications. Determine if the data met the MPCs and determine the impact of any deviations on the technical usability of the data.</td>
<td>Data Validator, Tetra Tech</td>
</tr>
<tr>
<td>Ila, I Ib</td>
<td>SAP QC Sample Documentation</td>
<td>Verify that all QC samples specified in the SAP were collected and analyzed and that the associated results were within prescribed SAP acceptance limits. Verify that QC samples and standards prescribed in analytical SOPs were analyzed and within the prescribed control limits. If any significant QC deviations occur, the laboratory shall have contacted the Tetra Tech Project Chemist or PM.</td>
<td>Data Validator, Tetra Tech</td>
</tr>
<tr>
<td>Ila, I Ib</td>
<td>Documentation of Analytical Reports for Completeness</td>
<td>Ensure that the required analytical samples have been collected, appropriate sample identifications have been used, and correct analytical methods have been applied. Validator will verify that elements of the data package required for validation are present, and if not, the laboratory will be contacted and the missing information will be requested. Validation will be performed as per Worksheet No. 36. Verify all data have been transferred correctly and completely to the final Structured Query Language (SQL) database.</td>
<td>Data Validator, Tetra Tech</td>
</tr>
<tr>
<td>I Ib</td>
<td>Project Quantitation Limits for Sensitivity</td>
<td>Verify that the project quantitation limits (PQLs) listed in Worksheet No. 15 were achieved.</td>
<td>Data Validator, Tetra Tech</td>
</tr>
<tr>
<td>I Ib</td>
<td>Analytical Data Deviations</td>
<td>Determine the impact of any deviation from sampling or analytical methods SOP requirements, and matrix interferences effect on the analytical results.</td>
<td>Data Validator, Tetra Tech</td>
</tr>
</tbody>
</table>
### SAP Worksheet No. 36 -- Analytical Validation (Steps Ila and Ilb) Summary Table

(UFP-QAPP Manual Section 5.2.2.1)

<table>
<thead>
<tr>
<th>Step Ila / Ilb</th>
<th>Matrix</th>
<th>Analytical Group</th>
<th>Validation Criteria</th>
<th>Data Validator (title and organizational affiliation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ila and Ilb</td>
<td>Groundwater</td>
<td>VOCs</td>
<td>A full data validation will be performed using criteria for SW-846 8260B listed in Worksheet Nos. 12, 15, 24, 25, and 28, DOD QSM (January 2006). If not included in the aforementioned, the logic outlined in USEPA Region 3 Modifications to the Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses (September 2004) should be used to apply qualifiers to data.</td>
<td>Data Validator, Tetra Tech</td>
</tr>
</tbody>
</table>
SAP Worksheet No. 37 -- Usability Assessment
(UFP-QAPP Manual Section 5.2.3)

The usability of the data generated during GWM activities at Site 1 directly affects whether project objectives can be achieved. The following characteristics will be evaluated at a minimum. The results of these evaluations will be included in the project reports. The characteristics will be evaluated for multiple concentration levels if the evaluator determines that this is necessary. To the extent required by the type of data being reviewed, the assessors will consult with other technically competent individuals to render sound technical assessments of these data characteristics:

**Completeness**
- The FOL acting on behalf of the project team will prepare a table comparing planned samples/analyses to collected samples/analyses. If deviations from the scheduled sample collection or analyses are identified, the Tetra Tech PM and risk assessor will determine whether the deviations compromise the ability to meet project objectives. If they do, the Tetra Tech PM will consult with the Navy RPM and other project team members, as necessary (determined by the Navy RPM), to develop appropriate corrective actions.

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

RPD values will be computed as follows:

\[
\text{RPD} = \frac{|\text{Amount in Sample 1} - \text{Amount in Sample 2}|}{0.5 (\text{Amount in Sample 1} + \text{Amount in Sample 2})} \times 100
\]

**Accuracy**
- The Project Chemist acting on behalf of the project team will determine whether the accuracy/bias goals were met for project data. This will be accomplished by comparing percent recoveries of LCS, LCSD, MS, MSD, and surrogate compounds to accuracy goals identified in Worksheet No. 28. This assessment will include an evaluation of field and laboratory contamination and analyte recoveries for surrogates and matrix spike and laboratory control samples. If the goals are not met, limitations on the use of the data will be described in the project reports. Bias of the qualified results and a description of the impact of identified non-compliances on a specific data package or on the overall project data will be described in the project reports.

The Percent Recovery (%R) for each spiked sample will be calculated by using the following formula:

\[
\%R = \frac{\text{Amount in Spiked Sample} - \text{Amount in Sample}}{\text{Known Amount Added}} \times 100\%
\]

The %R calculation for LCSs and surrogate spikes will be as follows:

\[
\%R = \frac{\text{Experimental Concentration}}{\text{Certified or Known Concentration}} \times 100\%
\]

**Representativeness**
- A project scientist identified by the Tetra Tech PM and acting on behalf of the project team will determine whether the data are adequately representative of intended populations, both spatially and temporally. This will be accomplished by verifying that samples were collected and processed for analysis in accordance with the SAP, by reviewing spatial and temporal data variations, and by
comparing these characteristics to expectations. The usability report will describe the representativeness of the data. This will not require quantitative comparisons.

Comparability

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

Sensitivity

- The Project Chemist acting on behalf of the project team will determine whether project sensitivity goals listed in Worksheet No. 15 are achieved. The overall sensitivity and Quantitation Limits from multiple data sets for each matrix and analysis will be compared. If sensitivity goals are not achieved, the limitations on the data will be described.

Project Assumptions and Data Outliers

The Tetra Tech PM and designated team members will evaluate whether project assumptions are valid. This will be a qualitative evaluation. A quantitative evaluation is not necessary for the Site 1 GWM.

The following evaluative procedures will be used to assess overall measurement error associated with the project:

After completion of data validation, the data and data quality will be reviewed to determine whether sufficient data of acceptable quality are available for decision making. The project team members identified by the PM will assess whether the data collectively support the attainment of project objectives. They will consider whether any missing or rejected data have compromised the ability to make decisions or to make the decisions with the desired level of confidence. The data will be evaluated to determine whether any missing or rejected data can be compensated for by other data. Although rejected data will generally not be used, there may be reason to use them in a weight-of-evidence argument, especially when they supplement data that have not been rejected. If rejected data are used, their use will be supported by technically defensible rationales.

Duplicate results (original and duplicate) will not be averaged for the purpose of representing the range of concentrations. However, the average of the original and duplicate samples will be used to represent the concentration at a particular sampled location.

Personnel responsible for performing the usability assessment include the following:

The Tetra Tech PM, Project Chemist, FOL, and designated technical staff will be responsible for conducting the listed data usability assessments. The data usability assessments will be reviewed with the Navy RPM if major deficiencies occur. If deficiencies affecting the attainment of project objectives are identified, the review will take place either in a face-to-face meeting or a teleconference depending on the extent of identified deficiencies. If no significant deficiencies are identified, the data usability assessment will simply be documented in the project reports and reviewed during the normal document review cycle.

The following documentation will be generated during usability assessment, and usability assessment results will be presented as follows so that they identify trends, relationships (correlations), and anomalies:

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


Halliburton NUS, 1993. Remedial Investigation Report for Sites 1, 2, 3 and 5 Naval Air Station Willow Grove (Volume I and Volume II). February.

NEESA (Naval Energy and Environmental Support Activity), 1986. Initial Assessment Study of Naval Air Station Willow Grove.


Tetra Tech, 2008a. Site 1 - Privet Road Compound Remedial Investigation Addendum 5 Groundwater (OU 3), NAS JRB Willow Grove, Pennsylvania.


REFERENCES (Continued)


APPENDIX A

TETRA TECH NUS, INC.
STANDARD OPERATING PROCEDURES

CT-04  Sample Nomenclature
DV-02  Data Validation - Non-CLP Organics for Solid and Aqueous Matrices
DV-04  Data Validation - Non-CLP Inorganics for Solid and Aqueous Matrices
SA-1.1  Groundwater Sample Acquisition & On-Site Water Quality Testing
SA-6.1  Non-Radiological Sample Handling
SA-6.3  Field Documentation
SA-7.1  Decontamination of Field Equipment
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>SECTION</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 PURPOSE</td>
<td>2</td>
</tr>
<tr>
<td>2.0 SCOPE</td>
<td>2</td>
</tr>
<tr>
<td>3.0 GLOSSARY</td>
<td>2</td>
</tr>
<tr>
<td>4.0 RESPONSIBILITIES</td>
<td>2</td>
</tr>
<tr>
<td>5.0 PROCEDURES</td>
<td>2</td>
</tr>
<tr>
<td>5.1 INTRODUCTION</td>
<td>2</td>
</tr>
<tr>
<td>5.2 SAMPLE IDENTIFICATION FIELD REQUIREMENTS</td>
<td>3</td>
</tr>
<tr>
<td>5.3 EXAMPLE SAMPLE FIELD DESIGNATIONS</td>
<td>4</td>
</tr>
<tr>
<td>5.4 EXAMPLES OF SAMPLE NOMENCLATURE</td>
<td>5</td>
</tr>
<tr>
<td>5.5 FIELD QUALITY ASSURANCE/QUALITY CONTROL (QA/QC) SAMPLE NOMENCLATURE</td>
<td>6</td>
</tr>
<tr>
<td>5.6 EXAMPLES OF FIELD QA/QC SAMPLE NOMENCLATURE</td>
<td>6</td>
</tr>
<tr>
<td>6.0 DEVIATIONS</td>
<td>6</td>
</tr>
</tbody>
</table>
1.0 PURPOSE

The purpose of this document is to specify a consistent sample nomenclature system that will facilitate subsequent data management in a cost-effective manner. The sample nomenclature system has been devised such that the following objectives can be attained:

- Sorting of data by matrix.
- Sorting of data by depth.
- Maintenance of consistency (field, laboratory, and data base sample numbers).
- Accommodation of all project-specific requirements.
- Accommodation of laboratory sample number length constraints (maximum of 20 characters).

2.0 SCOPE

The methods described in this procedure shall be used consistently for all projects requiring electronic data.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES

Program Manager - It shall be the responsibility of the Program Manager (or designee) to inform contract-specific Project Managers of the existence and requirements of this Standard Operating Procedure.

Project Manager - It shall be the responsibility of the Project Manager to determine the applicability of this Standard Operating Procedure based on: (1) program-specific requirements, and (2) project size and objectives. It shall be the responsibility of the Project Manager (or designee) to ensure that the sample nomenclature is thoroughly specified in the relevant project planning document (e.g., sampling and analysis plan) and is consistent with this Standard Operating Procedure if relevant. It shall be the responsibility of the project manager to ensure that the Field Operations Leader is familiar with the sample nomenclature system.

Field Operations Leader - It shall be the responsibility of the Field Operations Leader to ensure that all field technicians or sampling personnel are thoroughly familiar with this Standard Operating Procedure and the project-specific sample nomenclature system. It shall be the responsibility of the Field Operations Leader to ensure that the sample nomenclature system is used during all project-specific sampling efforts.

5.0 PROCEDURES

5.1 Introduction

The sample identification (ID) system can consist of as few as 8 but not more than 20 distinct alphanumeric characters. The sample ID will be provided to the laboratory on the sample labels and chain-of-custody forms. The basic sample ID provided to the lab has three segments and shall be as follows where "A" indicates "alpha," and "N" indicates "numeric":

<table>
<thead>
<tr>
<th>A or N</th>
<th>AAA</th>
<th>A or N</th>
</tr>
</thead>
<tbody>
<tr>
<td>3- or 4-Characters</td>
<td>2- or 3-Characters</td>
<td>3- to 6-Characters</td>
</tr>
<tr>
<td>Site Identifier</td>
<td>Sample Type</td>
<td>Sample Location</td>
</tr>
</tbody>
</table>
Additional segments may be added as needed. For example:

(1) Soil and Sediment Sample ID

<table>
<thead>
<tr>
<th>A or N 3- or 4-Characters</th>
<th>AAA 2- or 3-Characters</th>
<th>A or N 3- to 6-Characters</th>
<th>NNNN 4-Characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Identifier</td>
<td>Sample Type</td>
<td>Sample Location</td>
<td>Sample Depth</td>
</tr>
</tbody>
</table>

(2) Aqueous (groundwater or surface water) Sample ID

<table>
<thead>
<tr>
<th>A or N 3- or 4-Characters</th>
<th>AAA 2- or 3-Characters</th>
<th>A or N 3- to 6-Characters</th>
<th>NNN 2-Characters</th>
<th>-A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Identifier</td>
<td>Sample type</td>
<td>Sample Location</td>
<td>Round Number</td>
<td>Filtered Sample only</td>
</tr>
</tbody>
</table>

(3) Biota Sample ID

<table>
<thead>
<tr>
<th>A or N 3- or 4-Characters</th>
<th>AAA 2- or 3-Characters</th>
<th>A or N 3- to 6-Characters</th>
<th>AA 2-Characters</th>
<th>NNNN 3-Characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Site Identifier</td>
<td>Sample Type</td>
<td>Sample Location</td>
<td>Species Identifier</td>
<td>Sample Group Number</td>
</tr>
</tbody>
</table>

5.2 Sample Identification Field Requirements

The various fields in the sample ID will include but are not limited to the following:

- Site Identifier
- Sample Type
- Sample Location
- Sample Depth
- Sampling Round Number
- Filtered
- Species Identifier
- Sample Group Number

The site identifier must be a three- or four-character field (numeric characters, alpha characters, or a mixture of alpha and numeric characters may be used). A site number is necessary since many facilities/sites have multiple individual sites, SWMUs, operable units, etc. Several examples are presented in Section 5.3 of this SOP.

The sample type must be a two- or three-character alpha field. Suggested codes are provided in Section 5.3 of this SOP.

The sample location must be at least a three-character field but may have up to six-characters (alpha, numeric, or a mixture). The six-characters may be useful in identifying a monitoring well to be sampled or describing a grid location.

The sample depth field is used to note the depth below ground surface (bgs) at which a soil or sediment sample is collected. The first two numbers of the four-number code specify the top interval, and the third and fourth specify the bottom interval in feet bgs of the sample. If the sample depth is equal to or greater than 100, then only the top interval would be represented and the sampling depth would be truncated to...
three-characters. The depths will be noted in whole numbers only; further detail, if needed, will be recorded on the sample log sheet, boring log, logbook, etc.

A two-digit round number will be used to track the number of aqueous samples taken from a particular aqueous sample location. The first sample collected from a location will be assigned the round identifier 01, the second 02, etc. This applies to both existing and proposed monitoring wells and surface water locations.

Aqueous samples that are field filtered (dissolved analysis) will be identified with an "-F" in the last field segment. No entry in this segment signifies an unfiltered (total) sample.

The species identifier must be a two-character alpha field. Several suggested codes are provided in Section 5.3 of this SOP.

The three digit sample group number will be used to track the number of biota sample groups (a particular group size may be determined by sample technique, media type, the number of individual caught, weight issues, time, etc.) by species and location. The first sample group of a particular species collected from a given location will be assigned the sample group number 001 and the second sample group of the same species collected from the same location will be assigned the sample group number 002.

5.3 Example Sample Field Designations

Examples of each of the fields are as follows:

**Site Identifier** - Examples of site numbers/designations are as follows:

- A01 - Area of Concern Number 1
- 125 - Solid Waste Management Unit Number 125
- 000 - Base or Facility Wide Sample (e.g., upgradient well)
- BBG - Base Background

The examples cited are only suggestions. Each Project Manager (or designee) must designate appropriate (and consistent) site designations for their individual project.

**Sample Type** - Examples of sample types are as follows:

- AH - Ash Sample
- AS - Air Sample
- BM - Building Material Sample
- BSB - Biota Sample Full Body
- BSF - Biota Sample Fillet
- CP - Composite Sample
- CS - Chip Sample
- DS - Drum Sample
- DU - Dust Sample
- FP - Free Product
- IDW - Investigation Derived Waste Sample
- LT - Leachate Sample
- MW - Monitoring Well Groundwater Sample
- OF - Outfall Sample
- RW - Residential Well Sample
- SB - Soil Boring Sample
- SD - Sediment Sample
- SC - Scrape Sample
Samples Location - Examples of the location field are as follows:

001 - Monitoring Well 1
N32E92 - Grid location 32 North and 92 East
D096 - Investigation derived waste drum number 96

Species Identifier - Examples of species identifier are as follows:

BC - Blue Crab
GB - Blue Gill
CO - Corn
SB - Soybean

5.4 Examples of Sample Nomenclature

The first round monitoring well groundwater sample collected from existing monitoring well 001 at SWMU 16 for a filtered sample would be designated as 016MW00101-F.

The second round monitoring well groundwater sample collected from existing monitoring well C20P2 at Site 23 for an unfiltered sample would be designated as 023MWC20P202.

The second surface water sample collected from point 01 at SWMU 130 for an unfiltered sample would be designated as 130SW00102.

A surface soil sample collected from grid location 32 North and 92 East at Site 32 at the 0- to 2-foot interval would be designated as 032SSN32E920002.

A subsurface soil sample from soil boring 03 at SWMU 32 at an interval of 4 to 5 feet bgs would be designated as 032SB0030405.

A sediment sample collected at SWMU 19 from 0 to 6 inches at location 14 would be designated as 019SD0140001. The sample data sheet would reflect the precise depth at which this sample was collected.

During biota sampling for full body analysis the first time a minnow trap was checked at grid location A25 of SWMU 1415 three small blue gills were captured, collected and designated with the sample ID of 1415BSBA25BG001. The second time blue gill were collected at the same location (grid location A25 at SWMU 1415) the sample ID designation given was 1415BSBA25BG002.

Note: No dash (-) or spacing is used between the segments with the exception of the filtered segment. The "F" used for a filtered aqueous sample is preceded by a dash ".-F".
5.5  **Field Quality Assurance/Quality Control (QA/QC) Sample Nomenclature**

Field QA/QC will be designated using a different coding system. The QC code will consist of a three- to four-segment alpha-numeric code that identifies the sample QC type, the date the sample was collected, and the number of this type of QC sample collected on that date.

<table>
<thead>
<tr>
<th>AA</th>
<th>NNNNNN</th>
<th>NN</th>
<th>-F</th>
</tr>
</thead>
<tbody>
<tr>
<td>QC Type</td>
<td>Date</td>
<td>Sequence Number (per day)</td>
<td>Filtered (aqueous only, if needed)</td>
</tr>
</tbody>
</table>

The QC types are identified as:

- TB = Trip Blank
- RB = Rinsate Blank (Equipment Blank)
- FD = Field Duplicate
- AB = Ambient Conditions Blank
- WB = Source Water Blank

The sampling time recorded on the Chain-of-Custody Form, labels, and tags for duplicate samples will be 0000 so that the samples are "blind" to the laboratory. Notes detailing the sample number, time, date, and type will be recorded on the routine sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory). Documentation for all other QC types (TB, RB, AB, and WB) will be recorded on the QC Sample Log sheet (see SOP on Field Documentation).

5.6  **Examples of Field QA/QC Sample Nomenclature**

The first duplicate of the day for a filtered ground water sample collected on June 3, 2000 would be designated as FD06030001-F.

The third duplicate of the day taken of a subsurface soil sample collected on November 17, 2003 would be designated as FD11170303.

The first trip blank associated with samples collected on October 12, 2000 would be designated as TB10120001.

The only rinsate blank collected on November 17, 2001 would be designated as RB11170101.

6.0  **DEVIATIONS**

Any deviation from this SOP must be addressed in detail in the site specific planning documents.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>SECTION</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 PURPOSE</td>
<td>3</td>
</tr>
<tr>
<td>2.0 AVAILABILITY</td>
<td>3</td>
</tr>
<tr>
<td>3.0 PERSONNEL QUALIFICATIONS</td>
<td>3</td>
</tr>
<tr>
<td>4.0 SW-846 ORGANICS BY GC/MS</td>
<td>3</td>
</tr>
<tr>
<td>4.1 VOLATILES (METHOD 8260B)</td>
<td>3</td>
</tr>
<tr>
<td>4.1.1 Applicability</td>
<td>3</td>
</tr>
<tr>
<td>4.1.2 Interferences</td>
<td>4</td>
</tr>
<tr>
<td>4.1.3 General Laboratory Practices</td>
<td>4</td>
</tr>
<tr>
<td>4.1.4 Sample Preparation</td>
<td>4</td>
</tr>
<tr>
<td>4.1.5 Data Overview Prior to Validation</td>
<td>4</td>
</tr>
<tr>
<td>4.1.6 Technical Evaluation Summary</td>
<td>5</td>
</tr>
<tr>
<td>4.1.7 Deliverables Guidance</td>
<td>10</td>
</tr>
<tr>
<td>4.2 SEMIVOLATILES (METHOD 8270C)</td>
<td>10</td>
</tr>
<tr>
<td>4.2.1 Applicability</td>
<td>10</td>
</tr>
<tr>
<td>4.2.2 Interferences</td>
<td>11</td>
</tr>
<tr>
<td>4.2.3 General Laboratory Practices</td>
<td>11</td>
</tr>
<tr>
<td>4.2.4 Sample Preparation</td>
<td>11</td>
</tr>
<tr>
<td>4.2.5 Data Overview to Validation</td>
<td>11</td>
</tr>
<tr>
<td>4.2.6 Technical Evaluation Summary</td>
<td>12</td>
</tr>
<tr>
<td>4.2.7 Deliverables Guidance</td>
<td>17</td>
</tr>
<tr>
<td>5.0 SW-846 NON-CLP ORGANICS BY GAS CHROMATOGRAPHY</td>
<td>18</td>
</tr>
<tr>
<td>5.1 VOLATILES (SW 5030/SW 8011/8015B/8021A/8031)</td>
<td>18</td>
</tr>
<tr>
<td>5.1.1 Applicability</td>
<td>19</td>
</tr>
<tr>
<td>5.1.2 Interferences</td>
<td>19</td>
</tr>
<tr>
<td>5.1.3 General Laboratory Practices</td>
<td>19</td>
</tr>
<tr>
<td>5.1.4 Sample Preparation</td>
<td>19</td>
</tr>
<tr>
<td>5.1.5 Data Overview Prior to Validation</td>
<td>19</td>
</tr>
<tr>
<td>5.1.6 Technical Evaluation Summary</td>
<td>20</td>
</tr>
<tr>
<td>5.1.7 Deliverables Guidance</td>
<td>23</td>
</tr>
<tr>
<td>5.2 SEMIVOLATILES (SW8041/8061A/8091/8310)</td>
<td>24</td>
</tr>
<tr>
<td>5.2.1 Applicability</td>
<td>24</td>
</tr>
<tr>
<td>5.2.2 Interferences</td>
<td>25</td>
</tr>
<tr>
<td>5.2.3 General Laboratory Practices</td>
<td>25</td>
</tr>
<tr>
<td>5.2.4 Sample Preparation</td>
<td>25</td>
</tr>
<tr>
<td>5.2.5 Data Overview Prior to Validation</td>
<td>25</td>
</tr>
<tr>
<td>5.2.6 Technical Evaluation Summary</td>
<td>26</td>
</tr>
<tr>
<td>5.2.7 Deliverables Guidance</td>
<td>29</td>
</tr>
</tbody>
</table>
### TABLE OF CONTENTS (Continued)

<table>
<thead>
<tr>
<th>SECTION</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.3 ORGANOCHLORINE PESTICIDES AND POLYCHLORINATED BIPHENYLS (PCBS),</td>
<td></td>
</tr>
<tr>
<td>ORGANOPHOSPHOROUS PESTICIDES, CHLORINATED HERBICIDES (SW 8081A/8082/8141A/8151A)</td>
<td></td>
</tr>
<tr>
<td>5.3.1 Applicability</td>
<td>29</td>
</tr>
<tr>
<td>5.3.2 Interferences</td>
<td>31</td>
</tr>
<tr>
<td>5.3.3 General Laboratory Practices</td>
<td>31</td>
</tr>
<tr>
<td>5.3.4 Sample Preparation</td>
<td>31</td>
</tr>
<tr>
<td>5.3.5 Data Overview Prior to Validation</td>
<td>31</td>
</tr>
<tr>
<td>5.3.6 Technical Evaluation Summary</td>
<td>32</td>
</tr>
<tr>
<td>5.3.7 Deliverables Guidance</td>
<td>36</td>
</tr>
<tr>
<td>5.4 EXPLOSIVES/NITROAROMATICS/NITROAMINES(SW 8330)</td>
<td>36</td>
</tr>
<tr>
<td>5.4.1 Applicability</td>
<td>36</td>
</tr>
<tr>
<td>5.4.2 Interferences</td>
<td>36</td>
</tr>
<tr>
<td>5.4.3 General Laboratory Practices</td>
<td>37</td>
</tr>
<tr>
<td>5.4.4 Sample Preparation</td>
<td>37</td>
</tr>
<tr>
<td>5.4.5 Data Overview Prior to Validation</td>
<td>37</td>
</tr>
<tr>
<td>5.4.6 Technical Evaluation Summary</td>
<td>37</td>
</tr>
<tr>
<td>5.4.7 Deliverable Guidance</td>
<td>40</td>
</tr>
</tbody>
</table>

**APPENDIX A - SAMPLE CALCULATIONS (excerpted from EPA SOM01.1)**
1.0 PURPOSE

This SOPC governs the validation of data generated by the following methods:

- Gas Chromatography/Mass Spectrometry
  - Volatile Organic Compounds (VOCs) by METHOD 8260B
  - Semivolatile Organic Compounds (SVOCs) by METHOD 8270C
- Gas Chromatography
  - Volatile Organic Compounds (VOCs) by SW 5030/SW 8011/8015B/8021A/8031
  - Semivolatile Organic Compounds (SVOCs) by SW 8041/8061A/8091/8310
  - Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs), Organophosphorous Pesticides, Chlorinated Herbicides by SW 8081A/8082/8141A/8151A

2.0 APPLICABILITY

The applicability of each set of validation criteria is described in the appropriate section below.

3.0 PERSONNEL QUALIFICATIONS

The minimum qualifications of persons implementing this SOP are as follow:

- Education – Minimum of a bachelor’s degree in chemistry or related physical/life science.
- Experience requirements include either operational experience with the analytical method or method data review training conducted under the direction of an experienced reviewer and performed on the subject matter data package. A record of the training will not be documented and kept on file but the data validation report produced under training will serve as the record.

4.0 CLP ORGANICS BY GC/MS

4.1 Volatiles (METHOD 8260B)

4.1.1 Applicability

Method 8260B is used to determine volatile organic compounds in most waste matrices including groundwater, sludges, caustic liquors, acid liquors, waste solvents, oily wastes, mousse, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments.

Method 8260B analyte list includes of the volatile Target Compound List (TCL) plus the following compounds:

- Acetonitrile
- Acrolein
- Acrylonitrile
- Allyl chloride
- Chloropropene
- 1,2-Dibromo-3-chloropropane
- 1,2-Dibromoethane
- Dibromomethane
- trans-1,4-Dichloro-2-butene
- Dichlorodifluoromethane
- trans-1,2-Dichloropropane
- Ethyl methacrylate
- Iodomethane
- Methacrylonitrile
- Methyl methacrylate
- 2-Picoline
- Pyridine
- Trichloroethane
- Vinyl acetate

Acetonitrile
Acrolein
Acrylonitrile
Allyl chloride
Chloropropene
1,2-Dibromo-3-chloropropane
1,2-Dibromoethane
Dibromomethane
trans-1,4-Dichloro-2-butene
Dichlorodifluoromethane
* Appendix IX target compounds

Method 8260B is based upon a purge-and-trap, gas chromatographic/mass spectrometric (GC/MS) procedure. Prior to analysis, samples must be prepared by Method 5030.

4.1.2 Interferences

Samples can be contaminated by diffusion of volatile organics (particularly chlorofluorocarbons and methylene chloride) through the sample container septum during shipment and storage. Associated field quality control blanks are analyzed in order to monitor this.

Contamination by carryover can occur whenever high-level and low-level samples are sequentially analyzed. To reduce carryover, the sample syringe or purging device is rinsed out between samples with reagent water. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of reagent water to check for cross contamination.

If sample or matrix interferences are encountered, a secondary or alternate analytical column may be used to resolve the compounds of interest.

4.1.3 General Laboratory Practices

A method blank consisting of organic free water spiked with surrogates and internal standards should be analyzed immediately following each daily calibration and also after the analysis of every high concentration sample.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses should be conducted to determine the effects of sample matrix upon the compounds of interest.

4.1.4 Sample Preparation

Method 5030 is a purge-and-trap procedure performed to prepare and extract volatile compounds from samples and introduce those compounds into the GC/MS.

For highly volatile matrices, direct injection preceded by dilution should be used to prevent gross contamination of the instrumentation. For pastes, dilution of the sample until it becomes free-flowing is used to ensure adequate interfacial area. The success of this method depends on the level of interferences in the sample; results may vary due to the large variability and complicated matrices of solid waste samples.

4.1.5 Data Overview Prior to Validation

Before commencing validation, the reviewer must preview the associated Chain-of-Custody (COC) reports to determine:

a. If the appropriate number of samples are present in the data package and if each sample was correctly analyzed for the parameters and methods specified.

b. The identity of all associated field quality control blanks and field duplicate pairs.

Because many samples may have required dilutions, re-extractions and/or re-analyses, the validator should preview the data package contents to determine which analyses represent the better quality data.
Unless specifically directed by client protocol, never annotate the laboratory data package. Before beginning evaluation, prepare working copies (i.e., photocopies) of all Form I reports (including those for samples, laboratory method blanks and MS/MSD analyses) and all laboratory quality control summary forms (including all initial and continuing calibration summary statistics).

4.1.6 Technical Evaluation Summary

All data evaluations must be conducted in accordance with applicable USEPA Regional protocols and/or specific client contract requirements. The applicable documents must be referenced during the data evaluation process as this S.O.P. is only intended as a general procedure for the data validation tasks.

General parameters such as Data Completeness, Overall System Performance, Chromatographic Quality, Detection Limits and Compound Identification are evaluated concurrently with the parameters discussed in the following subsections.

4.1.6.1 Holding Times and Sample Preservation Criteria

Holding times are evaluated by reviewing the COC reports, the individual sample Form I reports, and the associated laboratory raw data. Holding times are calculated from date of collection to date of analysis.

a. The technical maximum holding time allowance for aqueous samples preserved with hydrochloric acid (HCL) is 14 days.

b. No technical holding times for solid matrices have been promulgated; a 14-day maximum holding time allowance is currently being used.

c. For unpreserved aqueous samples, generally a 7-day maximum holding time allowance for aromatic compounds, along with a 14-day maximum holding time allowance for chlorinated hydrocarbons is used.

4.1.6.2 Holding Time and Sample Preservation Action

a. Positive results in affected samples are generally qualified as estimated (J); non-detects (UJ). These results are biased low.

b. Some USEPA Regions apply the bias qualifiers, L and UL, instead.

c. If the holding times are exceeded by a factor of 2 or more, the holding time exceedance is considered to be gross and positive results are generally qualified as estimated (J); non-detects are generally considered to be unreliable and are qualified (R).

d. Results for which the holding time was grossly exceeded are biased low.

4.1.6.3 GC/MS Tuning Criteria

An analysis of an instrument performance check standard of Bromofluorobenzene must be performed at the beginning of each 12-hour period in which samples and standards are being analyzed.

a. Verify that all ion abundance criteria below are within acceptance ranges on Form V or equivalent summary form:


m/z  Ion abundance criteria
50  8.0 – 40.0% of m/z 95
75  30.0 – 66.0% of m/z 95
95  Base peak, 100%
96  5.0 – 9.0% of m/z 95
173 Less than 2.0% of m/z 174
174 50.0 – 120.0% of m/z 95
175 5.0 – 9.0% of m/z 174
176 93.0 – 101.0% of m/z 174
177 5.0 – 9.0% of m/z 176

b. Verify that all samples and standards were analyzed within the 12-hour period.

4.1.6.4 GC/MS Tuning Action

a. If mass assignment is in error, then reject all associated data (R) or (UR).

b. If ion abundance criteria are not met, professional judgment may be used to determine the extent of data usability and whether qualifications are needed. The most critical abundances are m/z 95/96, 174/175, 174/176, and 176/177.

c. If samples were analyzed beyond the 12-hour period, then qualify positive and non-detected results as estimated, (J) and (UJ) respectively.

d. If the reviewer suspects that improper background subtraction techniques were used to generate a compliant tune, contact the laboratory and ask them to provide supporting evidence of tuning data. If the evidence is suitable, no further action is required. If proper evidence cannot be provided to support the tuning data, then professional judgment should be utilized to determine the usability of the associated data.

4.1.6.5 Calibration Criteria

Verify the following:

a. Verify that an initial calibration was performed for each instrument used for analysis and for each type of medium and that all calibrations were performed at all appropriate concentration levels within 12 hours of the associated instrument tuning.

b. Review the data package Form Vs (tuning) using the applicable USPEA Regional Functional Guidelines, and qualify the data as appropriate.

c. Review initial calibration Form VIs and the associated laboratory raw data to determine which compounds have:
   1. average Relative Response Factors (RRFs) <0.050
   2. Percent Relative Standard Deviations (%RSDs) >30%.

d. Circle noncompliant RRFs and %RSDs on your working copies of these Forms and spot-check (i.e., recalculate) a few of the RRFs and %RSDs to verify the laboratory's computation.

e. Determine which samples are affected by non-compliant RRFs or %RSDs by reviewing the continuing calibration Form VIIIs. Check the instrument identification and the initial calibration date(s) noted in the headings of the Form VIIIs to determine which continuing calibrations are associated with which initial calibrations.
f. Review the sample listings given on the data package Form Vs to match the indicated continuing calibration run with the appropriate Form VII by matching the laboratory file ID numbers.

g. Write the affected samples (those listed on the matched Form V) on your working copies of the appropriate Form VI and VII.

h. Review the continuing calibration Form VIIIs and the associated laboratory raw data to determine which compounds have:
   1. RRFs <0.050
   2. Percent Differences (%Ds) >25%

i. Circle the noncompliant RRFs and %Ds on your working copies of these Forms and spot-check (i.e., recalculate) a few of the RRFs and %Ds to verify the laboratory's computation.

4.1.6.6 Calibration Actions

a. If any RRFs are <0.050, qualify all affected positive as estimated (J); qualify non-detects as non-detected rejected (UR). In accordance with some USEPA Regional protocol, the (L) qualifier may be used instead of (J) when qualifying positive results. Bias for these results is very low.

b. If any %RSD exceeds 30%, qualify affected positive results as estimated (J); qualify non-detects as non-detected estimated (UJ). Check the specific applicable data validation protocol for further guidance as there are some protocols which only estimate non-detects if the %RSD is >50% or reject non-detects if the %RSD is excessive (e.g. >90%). Bias for these results cannot be determined.

c. If any %D exceeds 25%, qualify affected positive results as estimated (J); qualify non-detects as non-detected estimated (UJ). Check the specific applicable data validation protocol for further guidance as there are some protocols which only estimate non-detects if the %D is >50% or reject non-detects if the %RSD is excessive (e.g. >90%). Bias for these results cannot be determined.

4.1.6.7 Blank Contamination Criteria

When using the information given below and in the appropriate USEPA Regional Functional Guidelines, keep in mind that the validation action levels derived are sample specific and must be adjusted for dilution, sample aliquot used for analysis, and sample moisture content (when applicable).

The rules for qualifying data based on the occurrence of blank contamination vary based on regional protocols. The guidelines provided in the appropriate protocol should be followed.

4.1.6.8 Blank Contamination Action

a. If a target compound is detected in any method blank:
   1. Select the maximum concentration of a particular contaminant occurring in the laboratory method blanks. (Do not consider lab blanks run after high concentration samples for purposes of determining carryover as laboratory method blanks!)
   2. Establish action levels for qualification (10X or 5X the maximum contaminant concentration depending upon whether or not the contaminant is a common contaminant). Common laboratory contaminants may vary among protocols.
3. Raise positive results that are less than the established blank action level to the Contract Required Quantitation Limit (CRQL) and qualify them as non-detect (U). In accordance with some USEPA Regional protocol, the (B) qualifier may be used instead of (U) when qualifying positive results. In this case, qualify the results at the concentration detected instead of the CRQL.

b. If a target compound was detected in a field quality control blank, carefully evaluate the associated samples to determine the appropriate action. Typically, field quality control blanks are not used to establish blank action levels but professional judgment may be used. When the reviewer decides to use a field quality control blank to qualify associated environmental samples, the guideline above must be followed.

4.1.6.9 Surrogates Criteria

a. Evaluate surrogate recoveries by reviewing the laboratory data package Form II reports and the laboratory raw data.

b. Verify that the recoveries are within the quality control ranges as given on the laboratory data package Form IIs; circle any non-compliance on your working copies of these Forms.

4.1.6.10 Surrogate Action

a. Results for all compound in an affected sample are qualified if any one of the surrogate spike compounds fail to meet the quality control criteria provided.

b. Generally, for samples having a surrogate recovery <10%, positive results are qualified as estimated (J), non-detects are rejected (UR). These results are biased low.

c. For samples having a surrogate recovery which is low but >10%, positive results are generally qualified as estimated (J); non-detects (UJ). The bias qualifiers (L, UL) may be used instead, depending upon the specific USEPA Regional guidance.

d. For samples having a surrogate recovery which is high, positive results are generally qualified as estimated (J, K) based on regional guidance, non-detects are not qualified based on high surrogate recovery.

4.1.6.11 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Criteria

Verify that matrix spike and matrix spike duplicate recoveries and Relative Percent Differences (RPD) meet quality control limits. Circle outliers on the Form III or equivalent.

4.1.6.12 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Action

a. No action is generally taken on MS/MSD non-compliances alone.

b. If a matrix spike or matrix spike duplicate recovery is <10%, qualify positive results as estimated (J) and qualify non-detects as non-detected rejected (UR) in the unspiked sample.
4.1.6.13  **Internal Standard Criteria**

Internal standards are evaluated by reviewing the data package Form VIIIs and laboratory raw data. The quality control ranges are given on the Form VIIIs. Circle any non-compliance on your working copies of these forms.

4.1.6.14  **Internal Standard Action**

Evaluate and qualify as stipulated in the appropriate data validation protocol.

4.1.6.15  **Tentatively Identified Compounds (TICs) Criteria**

Verify that the laboratory reported TICs in the laboratory data package Form I VOA-TIC reports and the laboratory raw data. The guidance given in the March 1990 National Functional Guidelines for USEPA Region III is very concise; use the information in this document to evaluate and qualify accordingly.

4.1.6.16  **Field Duplicate Precision Criteria**

a. Check samples to determine if field duplicates were included in the data package.

b. The Relative Percent Difference (RPD) between field duplicate results for the aqueous matrix should be <30%; for soil matrix results, <50% for sample results greater than the reporting limit.

4.1.6.17  **Field Duplicate Precision Action**

a. If positive results are greater than the reporting limit, qualify positive results for aqueous or soil media if the RPD exceeds 30% or 50% respectively. Qualification of the sample data is limited to the specific field duplicate pair. Qualify positive results showing imprecision as estimated (J). Bias for these results cannot be determined.

b. If one result is positive and the other is non-detected and the positive result is greater than 2 times the reporting limit, qualify positive and non-detected results as estimated (J) or non-detected estimated (UJ), respectively.

4.1.6.18  **Sample Result Verification Criteria**

Verify and record the quantitation of at least one compound per analytical fraction. If no positive results are reported, use the MS/MSD data to confirm proper computation by the laboratory. Validator and laboratory quantitations must agree within 10 percent.

4.1.6.19  **Sample Result Verification Action**

a. Perform a calculation verification of at least one analyte per fraction and include the re-calculation results in the support documentation section of the validation report. See Appendix A for calculation procedure.

b. If the re-calculation does not agree with the laboratory result within 10%, contact the laboratory to determine whether the reviewer may have used incorrect information or if the laboratory result is incorrect and requires resubmission. A comment on the final outcome is required in the validation report along with the proper calculation verification.
4.1.6.20 Percent Solids Criteria

Check the percent solids for each sample to identify any samples that contain <30% solids.

4.1.6.21 Percent Solids Action

a. If any sample contains <30% solids, qualify positive and non-detected results as estimated (J) or non-detected estimated (UJ), respectively, due to the high moisture content of the sample.

b. If any sample contains <10% solids, qualify positive results as estimated (J); qualify non-detected results as rejected (UR).

4.1.6.22 Laboratory Precision Criteria

Laboratory precision can be evaluated by comparing the unspiked sample results with MS/MSD analyses results for unspiked compounds.

4.1.6.23 Laboratory Precision Action

Consider non-detects and results reported at concentrations less than the Contract Required Quantitation Limit (CRQL) to be in agreement. Use professional judgment in determining whether to qualify sample results based on the comparison.

4.1.7 Deliverables Guidance

In addition to any specific USEPA Regional requirements (e.g. data validation memorandum, data summary spreadsheets, Regional worksheets), all laboratory data package quality control summary forms, sample Form I reports, method blank Form Is, and the Chain-of-Custody report must be given to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements) and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

4.2 Semivolatiles (METHOD 8270C)

4.2.1 Applicability

Methods are applicable to most types of samples, regardless of water content, including groundwater, aqueous sludges, caustic liquors, acid liquors, waste solvents, oily wastes, mousse, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments.

These methods can be used to quantify most neutral, acidic, and basic organic compounds that are soluble in methylene chloride and capable of elution without derivatization as sharp peaks from a gas chromatographic column. Such compounds include polynuclear aromatic hydrocarbons, chlorinated hydrocarbons and pesticides, phthalate esters, organophosphate esters, nitrosamines, haloethers, aldehydes, ethers, ketones, anilines, pyridines, quinolines, aromatic nitro compounds, and phenols, including nitrophenols.

The above methods specifically analyze for the semivolatile Target Compound List (TCL) plus the following compounds*:
Acetophenone  
Aniline  
Benzyl alcohol  
Bis(2-chloroisopropyl)ether  
Chlorobenzilate  
Diallate  
2,6-Dichlorophenol  
Dimethoate  
p-Dimethylaminoazobenzene  
7,12-Dimethylbenz(a)anthracene  
3,3’-Dimethylbenzidine  
a,a-Dimethylphenylamine  
1,3-Dinitrobenezene  
Diphenylamine  
Ethyl methanesulfonate  
Famphur  
Hexachlorophene  
Hexachloropropene  
Isodrin  
Isosafrole  
Kepone  
Methapyrilene  
3-Methylcholanthrene  
Methyl methanesulfonate  
3-Methylphenol  
1,4-Naphthoquinone  
4-Nitroquinoline-1-oxide  
1-Naphthylamine  
2-Naphthylamine  
5-Nitro-o-toluidine  
N-nitrosodiethylamine  
N-nitrosodimethylethylamine  
N-nitroso-di-n-butylamine  
N-nitrosomorpholine  
N-nitrosopiperidine  
Pentachlorobenzene  
Pentachloronitrobenzene  
P-Phenylenediamine  
Phorate  
2-Picoline  
Pronamide  
Safrole  
1,2,4,5-Tetrachlorobenzene  
Thionazin  
0,0,0-Triethylphosphorothioate  
1,3,5-Trinitrobenzene  

* Appendix IX target compounds

The preceding method is based upon solvent extractions followed by gas chromatographic/mass spectrometric (GC/MS) procedures, Method 8270C uses GC/MS capillary column technique.

### 4.2.2 Interferences

Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts that cause elevated baselines and lead to potential misinterpretation of chromatograms. All these materials must be demonstrated to be free from interferences under the conditions of the analysis by running method blanks. The use of high purity reagents and solvents helps to minimize interference problems; purification of solvents by distillation in all-glass systems may be required.

Interferences co-extracted from the samples will vary considerably from source to source depending upon the diversity of the industrial complex or waste being sampled.

### 4.2.3 General Laboratory Practices

An extraction blank should be prepared with each batch of samples extracted.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses should be conducted once per 20 samples of a similar matrix to determine the effects of sample matrix upon the compounds of interest.

### 4.2.4 Sample Preparation

Prior to analysis, the samples must be extracted using the appropriate techniques. Aqueous samples are extracted at the appropriate pH with methylene chloride as a solvent using a separatory funnel (Method 3510) or a continuous liquid-liquid extractor (Method 3520). Both neat and diluted organic liquids may be analyzed by direct injection. Solid samples are extracted at the appropriate pH with methylene chloride using either Soxhlet Extraction (Method 3540) or sonication (Method 3550) procedures.
4.2.5 Data Overview to Validation

Before commencing validation, the reviewer must preview the associated Chain-of-Custody (COC) reports to determine:

a. If the appropriate numbers of samples are present in the data package and if each sample was correctly analyzed for the parameters and methods specified.

b. The identity of all associated field quality control blanks and field duplicate pairs.

c. Because many samples may have required dilutions, re-extraction and/or reanalyses, the data validator should preview the data package contents to determine which analyses represent the better data quality.

d. Prepare working copies of all Form I reports (including those for samples, laboratory method blanks, and MS/MSD analyses) and all laboratory quality control summary forms (including all initial and continuing calibration summary statistics) should be photocopied for use as working copies.

4.2.6 Technical Evaluation Summary

Conduct all data evaluations in accordance with the appropriate USEPA Regional protocols (when applicable) and/or specified client contract requirements. Reference the applicable documents during the data validation process as this S.O.P. is only intended as a general procedure for all data validation tasks.

Evaluate general parameters such as Data Completeness, Overall System Performance, Chromatographic Quality, Detection Limits and Compound Identification concurrently with the parameters discussed in the following subsections.

4.2.6.1 Holding Times and Sample Preservation Criteria

Verify that holding times are evaluated by reviewing the COC reports, the individual sample Form I reports, and the associated laboratory raw data. Calculate holding times for extraction from date of collection to date of extraction. Verify that samples are stored to method requirements. Use the following rules:

a. For aqueous samples, use a 7-day maximum holding time until extraction.

b. For soil samples, use a 14-day maximum holding time until extraction.

c. For sample extracts use a holding time of 40 days from date of extraction to analysis.

4.2.6.2 Holding Times and Sample Preservation Action

a. If holding times are exceeded, qualify positive results in affected samples as estimated (J), non-detects (UJ). These results are usually assumed to be biased low unless prolonged storage causes a concentration increase, e.g., for degradation products which are also target analytes.

b. If holding times are exceeded by a factor of more than two times the required time, qualify positive results as estimated (J), non-detects are rejected (UR). These exceedances are considered to be gross holding time exceedances.
c. Alternatively, the L or UL bias qualifiers may be used dependent upon the applicable USEPA Regional Guidance.

d. Generally, if the holding time until extraction is exceeded, the affected sample results are considered to be biased low. If the holding time until analysis has been exceeded (and potentially, some of the extract may have evaporated), the affected sample results may be considered to be biased high. Follow the qualification guidance given in the appropriate data validation protocol.

### 4.2.6.3 GC/MS Tuning Criteria

An analysis of an instrument performance check standard of Decafluorotriphenylphosphine (DFTPP) must be performed at the beginning of each 12-hour period in which samples and standards are being analyzed.

a. Verify that all ion abundance criteria below are within acceptance ranges on Form V or equivalent summary form:

<table>
<thead>
<tr>
<th>m/z</th>
<th>Ion abundance criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>51</td>
<td>30.0 – 80.0% of m/z 198</td>
</tr>
<tr>
<td>68</td>
<td>Less than 2.0% of m/z 198</td>
</tr>
<tr>
<td>69</td>
<td>Mass 69 relative abundance</td>
</tr>
<tr>
<td>70</td>
<td>Less than 2.0% of m/z 69</td>
</tr>
<tr>
<td>127</td>
<td>25.0 – 75.0% of m/z 198</td>
</tr>
<tr>
<td>197</td>
<td>Less than 1.0% of m/z 198</td>
</tr>
<tr>
<td>198</td>
<td>Base Peak 100%</td>
</tr>
<tr>
<td>199</td>
<td>5.0 – 9.0% of m/z 198</td>
</tr>
<tr>
<td>275</td>
<td>10.0 – 30.0% of m/z 198</td>
</tr>
<tr>
<td>365</td>
<td>Greater than 0.75% of m/z198</td>
</tr>
<tr>
<td>441</td>
<td>Present, but less than m/z 443</td>
</tr>
<tr>
<td>442</td>
<td>40.0 – 110.0% of m/z 198</td>
</tr>
<tr>
<td>443</td>
<td>15.0 – 24.0% of m/z 442</td>
</tr>
</tbody>
</table>

b. Verify that all samples and standards were analyzed within the 12-hour period.

### 4.2.6.4 GC/MS Tuning Action

a. If mass assignment is in error, then reject all associated data (R) or (UR).

b. If ion abundance criteria are not met, professional judgment may be used to determine the extent of data usability and whether qualifications are needed. The most critical abundances are m/z 199/198 and 442/443.

c. If the relative abundance of m/z 365 is low or is zero this is an indication of an unsuitable instrument zero. Detection limits may be affected and non-detected results should be qualified (UJ).

d. If samples were analyzed beyond the 12-hour period, then qualify positive and non-detected results as estimated, (J) and (UJ) respectively.

e. If the reviewer suspects that improper background subtraction techniques were used to generate a compliant tune, contact the laboratory and ask them to provide supporting evidence of tuning.
data. If the evidence is suitable, no further action is required. If proper evidence cannot be provided to support the tuning data, then professional judgment should be utilized to determine the usability of the associated data.

### 4.2.6.5 Calibration Criteria

Verify the following:

a. Verify that an initial calibration was performed for each instrument used for analysis and that all calibrations were performed at all appropriate concentration levels within 12 hours of the associated instrument tuning.

b. Review the data package Form Vs (tuning) using the applicable USEPA Regional Functional Guidelines, and qualify the data as appropriate.

c. Review initial calibration Form VIIs and the associated laboratory raw data to determine which compounds have:
   1. Average Relative Response Factors (RRFs) <0.050
   2. Percent Relative Standard Deviations (%RSDs) >30%.

d. Circle these noncompliant RRFs and %RSDs on your working copies of these Forms and spot-check (i.e., recalculate) a few of the RRFs and %RSDs to verify the laboratory's computation.

e. Determine which samples are affected by non-compliant RRFs or %RSDs by reviewing the continuing calibration Form VIIs. Check the instrument identification and the initial calibration date(s) noted in the headings of the Form VIIs to determine which continuing calibrations are associated with which initial calibrations. Next, review the sample listings given on the data package Form Vs. Match the indicated continuing calibration run with the appropriate Form VII by matching the laboratory file ID numbers.

f. Review the continuing calibration Form VIIs and the associated laboratory raw data to determine which compounds have:
   1. RRFs <0.050
   2. Percent Differences (%Ds) >25%

g. Circle the noncompliant RRFs and %Ds on your working copies of these Forms and spot-check (i.e., recalculate) a few of the RRFs and %Ds to verify the laboratory's computation.

### 4.2.6.6 Calibration Actions

a. If any RRFs are <0.050, qualify all affected positive results as estimated (J), non-detects are rejected (UR). In accordance with some USEPA Regional protocol, the (L) qualifier may be used instead of (J) when qualifying positive results. Bias for these results is very low.

b. If any %RSD exceeds 30%, qualify all affected positive results as estimated (J), non-detects (UJ). Check the specific applicable data validation protocol for further guidance as there are some protocols which only estimate non-detects if the %RSD is >50% or reject non-detects if the %RSD is excessive (e.g. >90%). Bias for these results cannot be determined.

c. If any %D exceeds 25%, qualify all affected positive results as estimated (J), non-detects (UJ). Check the specific applicable data validation protocol for further guidance as there are some
protocols which only estimate non-detects if the \%D is >50% or reject non-detects if the \%RSD is excessive (e.g. >90%). Bias for these results cannot be determined.

4.2.6.7 Blank Contamination Criteria

Note that unlike VOA fraction analyses, a laboratory method blank does not have to be analyzed after every continuing calibration standard. Be very sure, however, that one semivolatile method blank was extracted for each day that associated samples were extracted (with a maximum of 20 samples per batch).

The rules for qualifying data based on the occurrence of blank contamination vary based on regional protocols. The guidelines provided in the appropriate protocol should be followed.

4.2.6.8 Blank Contamination Action

a. If a target compound is detected in any method blank:

1. Select the maximum concentration of a particular contaminant occurring in the laboratory method blanks. (Do not consider lab blanks run after high concentration samples for purposes of determining carryover as laboratory method blanks!)

2. Establish action levels for qualification (10X or 5X the maximum contaminant concentration depending upon whether or not the contaminant is a common contaminant).

3. Raise positive results that are less than the established blank action level to the Contract Required Quantitation Limit (CRQL) and qualify them as non-detect (U). In accordance with some USEPA Regional protocol, the (B) qualifier may be used instead of (U) when qualifying positive results. In this case, qualify results at the concentration detected instead of the CRQL.

b. If a target compound was detected in a field quality control blank, carefully evaluate the associated samples to determine the appropriate action. Typically, field quality control blanks are not used to establish blank action levels but professional judgment may be used. When the reviewer decides to use a field quality control blank to qualify associated environmental samples, the guideline above must be followed.

4.2.6.9 Surrogates Criteria

Semivolatile compounds are divided into two fractions, base-neutral compounds and acid-extractable compounds. Each fraction of compounds has its own associated surrogates.

a. Evaluate surrogate recoveries by reviewing the laboratory data package Form II reports and the laboratory raw data.

b. Verify that the recoveries are within the quality control ranges as given on the laboratory data package Form IIs; circle any non-compliance on your working copies of these Forms.
**4.2.6.10 Surrogate Action**

a. If the recovery is <10% for any one surrogate, positive results for all compounds in that class in the affected sample are qualified as estimated, (J) or (L), and non-detects are rejected (UR). There results are biased low.

b. No qualification actions are taken for samples having any one surrogate recovery which is noncompliant but >10%.

c. If the recoveries for any two surrogates of the same class are noncompliant but above 10%, all sample results for that class of compounds in the affected sample are qualified. If the recoveries are low, positive results are generally qualified as estimated (J); non-detects (UJ). In some Regions, the bias qualifiers, L and UL, may be used instead.

d. If the recoveries for any two surrogates of the same class are high, positive results for all compounds in that class in the affected sample are qualified, J or K, depending upon the appropriate USEPA Regional guidance; non-detects are not qualified based on high surrogate recoveries.

**4.2.6.11 Matrix Spike/Matrix Spike Duplicate Criteria**

Verify that matrix spike and matrix spike duplicate recoveries and Relative Percent Differences (RPD) meet quality control limits. Circle outliers on the Form III or equivalent.

**4.2.6.12 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Action**

a. Take no action based on MS/MSD non-compliances alone.

b. If qualification does occur, generally only the results for that particular noncompliant compound are qualified in the original unspiked sample analysis. Refer to the appropriate validation guidelines for specific procedures for evaluating MS/MSD analyses.

**4.2.6.13 Internal Standard Criteria**

Evaluate internal standards are evaluated by reviewing the data package Form VIIIs and the laboratory raw data. Circle any non-compliance on your working copies of these forms; evaluate and qualify as stipulated in the appropriate protocol.

**4.2.6.14 Internal Standard Action**

Evaluate and qualify as stipulated in the appropriate protocol.

**4.2.6.15 Tentatively Identified Compounds (TICs)**

TICs are evaluated using the laboratory data package Form I BNA-TIC reports and the laboratory raw data. The guidance given in the 3/90 national Functional Guidelines for USEPA Region III is very concise; evaluate and qualify accordingly.

**4.2.6.16 Field Duplicate Precision Criteria**

a. Check samples to determine if field duplicates were included in the data package.
b. The Relative Percent Difference (RPD) between field duplicate results for the aqueous matrix should be <30%; for soil matrix results, <50% for sample results greater than the reporting limit.

4.2.6.17 Field Duplicate Precision Action

a. If positive results are greater than the reporting limit, qualify positive results for aqueous or soil media if the RPD exceeds 30% or 50% respectively. Qualification of the sample data is limited to the specific field duplicate pair. Qualify positive results for compounds showing imprecision are qualified as estimated (J). Bias for these results cannot be determined.

b. If one result is positive and the other is non-detected and the positive result is greater than 2 times the reporting limit, qualify positive and non-detected results as estimated (J) and or non-detected estimated (UJ), respectively.

4.2.6.18 Sample Result Verification Criteria

Verify and record the quantitation of at least one compound per analytical fraction. If no positive results are reported, use the MS/MSD data to confirm proper computation by the laboratory. Validator and laboratory quantitations must agree within 10 percent.

4.2.6.19 Sample Result Verification Action

a. Perform a calculation verification of at least one analyte per fraction and include the re-calculation results in the support documentation section of the validation report. See Appendix A for calculation procedure.

b. If the re-calculation does not agree with the laboratory result within 10%, contact the laboratory to determine whether the reviewer may have used incorrect information or if the laboratory result is incorrect and requires resubmission. A comment on the final outcome is required in the validation report along with the proper calculation verification.

4.2.6.20 Percent Solids Criteria

Check the percent solids for each sample to identify any samples that contain <30% solids.

4.2.6.21 Percent Solids Action

a. If any sample contains <30% solids, qualify positive and non-detected results as estimated (J) and non-detected (UJ), respectively, due to the high moisture content of the sample.

b. If any sample contains <10% solids, qualify positive results as estimated (J); and non-detects are rejected (UR).

4.2.6.22 Laboratory Precision Criteria

Laboratory precision can be evaluated by comparing MS/MSD sample results for unspiked compounds with the unspiked sample results.
4.2.6.23 Laboratory Precision Action

Consider non-detects and results reported at concentration levels less than the Contract Required Quantitation Limit (CRQL) to be in agreement. Use professional judgment in determining whether to qualify sample results based on the comparison.

4.2.7 Deliverables Guidance

In addition to any specific USEPA Regional requirements (e.g., data validation memorandum, data summary spreadsheets, USEPA Regional worksheets), all laboratory data package quality control summary forms, sample Form I reports, method blank Form Is, and the Chain-of-Custody report, must be given to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements) and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

5.0 SW-846 NON-CLP ORGANICS BY GAS CHROMATOGRAPHY

5.1 Volatiles (SW 5030/SW 8011/8051B/8021A/8031)

5.1.1 Applicability

Method 8011 is used to determine the concentration of the following halogenated volatile organic compounds in groundwater, liquid, and solid matrices:

- 1,2-Dibromoethane (EDB)
- 1,2-Dibromo-3-chloropropane (DBCP)

Method 8021A is used to determine the concentration of the following halogenated volatile organic compounds in groundwater, liquid, and solid matrices:

<table>
<thead>
<tr>
<th>Allyl chloride</th>
<th>4-Chlorotoluene</th>
<th>Methyl iodide</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzyl chloride</td>
<td>Dibromochloromethane</td>
<td>1,1,2,2-Tetrachloroethane</td>
</tr>
<tr>
<td>Bis (2-chlooroethoxy)methane</td>
<td>1,2-Dibromo-3-chloropropane</td>
<td>1,1,1,2-Tetrachloroethane</td>
</tr>
<tr>
<td>Bis (2-chloroisopropyl)ether</td>
<td>Dibromomethane</td>
<td>Tetrachloroethylene</td>
</tr>
<tr>
<td>Bromoacetone</td>
<td>1,2-Dichlorobenzene</td>
<td>1,1,1-Trichloroethane</td>
</tr>
<tr>
<td>Bromobenzene</td>
<td>1,3-Dichlorobenzene</td>
<td>1,1,2-Trichloroethane</td>
</tr>
<tr>
<td>Bromochloromethane</td>
<td>1,4-Dichlorobenzene</td>
<td>Trichloroethylene</td>
</tr>
<tr>
<td>Bromoform</td>
<td>Dichlorodifluoromethane</td>
<td>Trichlorofluoromethane</td>
</tr>
<tr>
<td>Bromomethane</td>
<td>1,1-Dichloroethane</td>
<td>1,2,3-Trichloropropane</td>
</tr>
<tr>
<td>Carbon tetrachloride</td>
<td>1,2-Dichloroethane</td>
<td>Vinyl chloride</td>
</tr>
<tr>
<td>Chlorobenzene</td>
<td>1,1-Dichloroethylene (Vinylidene chloride)</td>
<td>Benzene</td>
</tr>
<tr>
<td>Chloroethane</td>
<td>trans-1,2-Dichloroethylene</td>
<td>Chlorobenzene</td>
</tr>
<tr>
<td>2-Chloroethanol</td>
<td>Dichloromethane</td>
<td>1,2-Dichlorobenzene</td>
</tr>
<tr>
<td>Chloroform</td>
<td>1,2-Dichloroethane</td>
<td>1,3-Dichlorobenzene</td>
</tr>
<tr>
<td>1-Chlorohexane</td>
<td>1,3-Dichloro-2-propanol</td>
<td>1,4-Dichlorobenzene</td>
</tr>
<tr>
<td>2-Chloroethyl vinyl ether</td>
<td>cis-1,3-Dichloropropene</td>
<td>Toluene</td>
</tr>
<tr>
<td>Chloromethane</td>
<td>trans-1,3-Dichloropropene</td>
<td>Ethyl benzene</td>
</tr>
<tr>
<td>Chloromethyl methyl ether</td>
<td>Epichlorhydrin</td>
<td>Xylenes (Dimethyl benzenes)</td>
</tr>
<tr>
<td>Chloroprene</td>
<td>Ethylene dibromide</td>
<td></td>
</tr>
</tbody>
</table>
Method 8015B is used to determine the concentration of the following nonhalogenated volatile organic compounds in groundwater, liquid, and solid matrices:

- Diethyl ether
- Ethanol
- Methyl ethyl ketone (MEK)
- Methyl isobutyl ketone (MIBK)
- Acrolein
- Acetonitrile
- Acetone
- Allyl Alcohol
- n-butyl Alcohol
- t-butyl Alcohol
- Methanol
- 1,4-Dioxane

Method 8031 is used to determine the concentration of the following volatile organic compound in groundwater, liquid, and solid matrices:

- Acrylonitrile

All of the above Methods are gas chromatographic (GC) only (i.e., no mass spectrometer detector is employed). Method 8021A analyzes for halogenated and aromatic volatile organics via GC/HECP and GC/PID (Electro Conductivity Detector and Photoionization detector), Method 8015B analyzes for non-halogenated volatile organics via GC/FID (Flame Ionization Detector), and Method 8031 analyzes for the compounds acrylonitrile using GC/FID. Samples can be analyzed by these methods using direct injection, the headspace method (Method 5021) or the purge-and-trap method (Method 5030B and 5035). Groundwater samples should be determined using Method 5030B.

5.1.2 Interferences

Samples can be contaminated by diffusion of volatile organics (particularly chlorofluorocarbons and methylene chloride) through the sample container septum during shipment and storage. Associated field quality control blanks are analyzed in order to monitor this.

Contamination by carryover can occur whenever high-level and low-level samples are sequentially analyzed. To reduce carryover, the sample syringe or purging device is rinsed with reagent water between samples. Whenever an unusually concentrated sample is encountered, it should be followed by an analysis of reagent water to check for cross contamination.

If sample or matrix interferences are encountered, a secondary or alternate analytical column may be used to resolve the compounds of interest.

5.1.3 General Laboratory Practices

A method blank consisting of organic free water spiked with surrogates and internal standards should be analyzed immediately following each daily calibration, and also after the analysis of every high concentration sample.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses should be conducted to determine the effects of sample matrix upon the compounds of interest.

5.1.4 Sample Preparation

Method 5020 is a static headspace technique for extracting volatile organic compounds in pastes, solids, and liquids. Because of the large variability and complicated matrices of waste samples detection limits for this method may vary widely among samples.
Method 5030 is a purge-and-trap method applicable to nearly all types of samples, regardless of water content, including aqueous sludges, caustic liquors, acid liquors, waste solvents, oily wastes, groundwater, mousses, tars, fibrous wastes, polymeric emulsions, filter cakes, spent carbons, spent catalysts, soils, and sediments.

Method 5035 is a purge-and-trap method applicable to nearly all types of soil samples, regardless of water content, including oily wastes, soils, and sediments.

For highly volatile matrices, direct injection preceded by dilution should be used to prevent gross contamination of the instrumentation. For pastes, dilution of the sample until it becomes free-flowing is used to ensure adequate interfacial area. The success of this method depends on the level of interferences in the sample; results may vary due to the large variability and complicated matrices of solid waste samples.

### 5.1.5 Data Overview Prior to Validation

Before commencing validation, the reviewer must preview the associated Chain-of-Custody (COC) reports to determine:

- If the appropriate number of samples are present in the data package and if each sample was correctly analyzed for the parameters and methods specified.
- The identity of all associated field quality control blanks and field duplicate pairs.
- Because many samples may have required dilutions, re-extractions and/or re-analyses, the validator should preview the data package contents to determine which analyses represent the better quality data.
- Unless specifically directed by client protocol, never annotate the laboratory data package. Before beginning evaluation, prepare working copies (i.e. photocopies) of all Form I reports (including those for samples, laboratory method blanks and MS/MSD analyses) and all laboratory quality control summary forms (including all initial and continuing calibration summary statistics).

### 5.1.6 Technical Evaluation Summary

All data evaluations must be conducted in accordance with applicable USEPA Regional protocols and/or specific client contract requirements. The applicable documents must be referenced during the data evaluation process as this S.O.P. is only intended as a general procedure for the data validation tasks.

General parameters such as Data Completeness, Overall System Performance, Chromatographic Quality, Detection Limits and Compound Identification are evaluated concurrently with the parameters discussed in the following subsections.

### 5.1.6.1 Holding Times and Sample Preservation Criteria

Holding times are evaluated by reviewing the COC reports, the individual sample Form I reports, and the associated laboratory raw data. Holding times are calculated from date of collection to date of analysis.

- The technical maximum holding time allowance for aqueous samples preserved with hydrochloric acid (HCL) is 14 days.
- No technical holding times for solid matrices have been promulgated; a 14-day maximum holding time allowance is currently being used.
c. For unpreserved aqueous samples, generally a 7-day maximum holding time allowance for aromatic compounds, along with a 14-day maximum holding time allowance for chlorinated hydrocarbons is used.

5.1.6.2 Holding Time and Sample Preservation Action

a. Positive results in affected samples are generally qualified as estimated (J); non-detects (UJ). These results are biased low. Some USEPA Regions apply the bias qualifiers, L and UL, instead.

b. If the holding times are exceeded by a factor of 2 or more, the holding time exceedance is considered to be gross and positive results are generally qualified as estimated (J); non-detects are generally considered to be unreliable and are qualified (UR).

c. Results for which the holding time was grossly exceeded are biased low.

5.1.6.3 Calibration Criteria

Verify the following:

a. Check than an initial calibration was performed for each instrument used for analysis and that all calibrations were performed at all appropriate concentration levels.

b. In general, either the correlation coefficient (R) or the Percent Relative Standard Deviation (%RSD) is evaluated in the data validation. If the correlation coefficient is chosen by the laboratory, the calibration curve should be checked for linearity.

c. If the %RSD is used, determine which compounds have Percent Relative Standard Deviations (%RSDs) >20%. Circle these non-compliances on you working copies of these Forms. Spot check (i.e., recalculate) a few of the %RSDs to verify the laboratory’s computation.

d. Determine which samples are affected by reviewing the continuing calibration forms. Determine which continuing calibrations are associated with which initial calibrations. Write the affected samples on your working copies of the appropriate continuing calibration forms. Spot-check (i.e., recalculate) a few of the %Ds to verify the laboratory’s computation.

e. Review the continuing calibration form and the associated laboratory raw data. Determine which compounds have Percent Differences (%Ds) >30% and between 15%-30%; circle the non-compliances on your working copies of these forms.

5.1.6.4 Calibration Actions

a. Generally, associated sample data are qualified as estimated (J), non-detects (UJ) if the calibration curve correlation coefficient is <0.995. Professional judgment should be used to qualify sample data in cases when sample results fall outside the linear portion of the calibration curve.

b. Generally, positive results for compounds for which %RSD or %D exceeds 20% or 15%, respectively, are qualified as estimated (J), non-detects (UJ). Check the specific applicable data validation protocol for further guidance as there are some protocols which reject non-detects if the %RSD or %D is excessive. Bias for these results cannot be determined.
5.1.6.5 Blank Contamination Criteria

When using the information given below and in the appropriate USEPA Regional Functional Guidelines, keep in mind that the validation action levels derived are sample-specific and must be adjusted for dilution, sample aliquot used for analysis, and sample moisture content (when applicable).

The rules for qualifying data based on the occurrence of blank contamination vary based on regional protocols; the guidelines provided in the appropriate protocol should be followed.

Generally the blank contamination review process is completed by first considering the maximum amount of a particular contaminant occurring in the laboratory method blanks. (Do not consider lab blanks run after high concentration samples for purposes of determining carryover as laboratory method blanks.) Then repeat the process for contaminants occurring in the associated field quality control blanks.

5.1.6.6 Blank Contamination Action

a. Action levels for qualification (10X or 5X depending upon whether or not the contaminant is a common contaminant) are then set. The list of common contaminants may vary amount protocols.

b. Some hierarchy among the field quality control blanks apply and the manner in which the qualifiers are applied vary [i.e. use of (U) or (B); replacement by CRQL, etc.]. Refer to appropriate protocol for specific guidance.

5.1.6.7 Surrogates Criteria

Surrogates are evaluated by reviewing the laboratory data package Form II reports and the laboratory raw data. The quality control ranges are given on the laboratory data package Form IIs; circle any non-compliance on your working copies of these Forms.

5.1.6.8 Surrogates Action

All results for all compounds in an affected sample are qualified if any one of the surrogate spike compounds fails to meet the quality control criteria provided.

a. For samples having a surrogate recovery <10%, positive results are qualified as estimated (J), non-detects are rejected (UR). These results are biased low.

b. Samples having a surrogate recovery which is low but >10%, positive results are generally qualified as estimated (J); non-detects (UJ). The bias qualifiers (L, UL) may be used instead, depending upon the specific USEPA Regional guidance.

c. For samples having a surrogate recovery which is high, positive results are generally qualified as estimated (J, K) based on regional guidance; these results are biased high. Non-detects are not qualified based on high surrogate recoveries.

5.1.6.9 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Criteria

Verify that matrix spike and matrix spike duplicate recoveries and Relative Percent Differences (RPD)
meet quality control limits. Circle outliers on the Form III or equivalent.

5.1.6.10 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Action
   
a. No action is generally taken on MS/MSD non-compliances alone.
   
b. If a matrix spike or matrix spike duplicate recovery is <10%, qualify positive results as estimated (J) and qualify non-detects as non-detected rejected (UR) in the unspiked sample.

5.1.6.11 Field Duplicate Precision Criteria

Compare the positive compound results with the results from the field duplicate samples. Generally, the Relative Percent Difference (RPD) between field duplicate results for the aqueous matrix should be <30%; for soil matrix results, <50%.

5.1.6.12 Field Duplicate Precision Action

Qualification of the sample data is limited to the specific field duplicate pair. Positive results for compounds showing imprecision are qualified as estimated (J); non-detects (UJ). Bias for these results cannot be determined.

5.1.6.13 Laboratory Precision Criteria

Laboratory precision can be evaluated by comparing the unspiked sample results with MS/MSD analyses results for unspiked compounds.

5.1.6.14 Laboratory Precision Action

Consider non-detects and results reported at concentrations less than the Contract Required Quantitation Limit (CRQL) to be in agreement. Use professional judgment in determining whether to qualify sample results based on the comparison.

5.1.6.15 Sample Result Verification Criteria

Verify and record the quantitation of at least one compound per analytical fraction. If no positive results are reported, use the MS/MSD data to confirm proper computation by the laboratory. Validator and laboratory quantitations must agree within 10 percent.

5.1.6.16 Sample Result Verification Action
   
a. Perform a calculation verification of at least one analyte per fraction and include the re-calculation results in the support document section of the validation report. See Appendix A for calculation procedure.
   
b. If the re-calculation does not agree with the laboratory results within 10%, contact the laboratory to determine whether the reviewer may have used incorrect information or if the laboratory results is incorrect and requires resubmission. A comment on the final outcome is required in the validation report along with the proper calculation verification.
5.1.6.17 Percent Solids Criteria

In some USEPA Regions a “Percent Solids” rule applies where each sample is analyzed to identify any samples that contain <30% solids.

5.1.6.18 Percent Solids Action

If any samples contain <30% solids, qualify positive and non-detected results as estimated (J) or non-detects (UJ) due to high moisture content of the sample.

5.1.7 Deliverable Guidance

In addition to any specific USEPA Regional requirements (e.g. data validation memorandum, data summary spreadsheets, Regional worksheets), all laboratory data package quality control summary forms, sample Form I reports, method blank Form Is, and the Chain-of-Custody report must be given to the Data validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements) and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

5.2 Semivolatiles (SW8041/801A/8091/8310)

5.2.1 Applicability

Method 8041 is used to determine the concentration of the following phenolic compounds in groundwater, liquid, and solid matrices:

- Phenol
- 2-Chlorophenol
- 2,4-Dichlorophenol
- 2,6-Dichlorophenol
- Trichlorophenols
- Tetrachlorophenols
- Pentachlorophenol
- Cresols (methyl phenols)

Method 8061A is used to determine the concentration of the following phthalate esters in groundwater, liquid, and solid sample matrices:

- Benzyl butyl phthalate
- Bis(2-ethylhexyl)phthalate
- Di-n-butyl phthalate
- Di-n-octyl phthalate
- Diethyl phthalate
- Dimethyl phthalate

Method 8091 is used to determine the concentration of the following nitroaromatic and cyclic ketone compounds in groundwater, liquid, and solid sample matrices:

- Nitrobenzene
- Dinitrobenzene
Method 8310 is used to determine the concentration of the following polynuclear aromatic hydrocarbons (PAHs) in liquid and solid sample matrices:

- Acenaphthene
- Acenaphthylene
- Anthracene
- Benzo(a)anthracene
- Benzo(a)pyrene
- Benzo(b)fluoranthene
- Benzo(ghi)perylene
- Benzo(k)fluoranthene
- Chrysene
- Dibenzo(a,h)anthracene
- Fluoranthe
- Fluorene
- Indeno(1,2,3-cd)pyrene
- Naphthalene
- Phenanthrene
- Pyrene

All of the above methods are gas chromatographic (GC), with the exception of Method 8310 which is a High Performance Liquid Chromatography (HPLC) technique, only (i.e., no mass spectrometer detector is employed). These methods use either an electron capture detector (ECD), a flame ionization detector (FID), an ultraviolet detector (UV), or a fluorescence detector.

### 5.2.2 Interferences

Solvents, reagents, glassware, and other sample-processing hardware may yield discrete artifacts and/or elevated baselines causing misinterpretation of gas chromatograms. All these materials must be demonstrated to be free from interferences under the conditions of the analysis by running method blanks. Specific selection of reagents and purification of solvents by distillation in all-glass systems may be required.

Interferences co-extracted from samples will vary considerably from source to source depending upon the waste being sampled. While general cleanup techniques such as Method 3530 are provided as part of these methods, unique samples may require additional cleanup.

If sample or matrix interferences occur, a secondary column may be employed in addition to the primary column so as to resolve any questionable compound results.

### 5.2.3 General Laboratory Practices

An extraction blank should be prepared with each batch of samples extracted.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses should be conducted to determine the effects of sample matrix upon the compounds of interest.

### 5.2.4 Sample Preparation

Prior to analysis, the samples must be extracted using the appropriate techniques. Aqueous samples are extracted at the appropriate pH with methylene chloride as a solvent using Method 3510 (separatory funnel extraction) or Method 3520 (continuous liquid-liquid extraction). Both neat and diluted organic liquids may be analyzed by direct injection. Solid samples are extracted at the appropriate pH with...
methylen chloride using either Soxhlet Extraction (Method 3540) or Sonication (Method 3550) procedures.

5.2.5 Data Overview Prior to Validation

Before commencing validation the reviewer must preview the associated Chain-of-Custody (COC) reports to determine:

a. If the appropriate number of samples are present in the data package and if each sample was correctly analyzed for the parameters and methods specified.

b. The identity of all associated field quality control blanks and field duplicate pairs.

Because many samples may have required dilutions, re-extractions and/or reanalyses, the data validator should preview the data package contents to determine which analyses represent the better quality data.

The data package should never be annotated unless specifically directed by client protocol. All Form I reports (including those for samples, laboratory method blanks, and MS/MSD analyses) and all laboratory quality control summary forms (including all initial and continuing calibration summary statistics) should be photocopied for use as working copies.

5.2.6 Technical Evaluation Summary

All data evaluations must be conducted in accordance with the appropriate USEPA Regional protocols and/or specified client contract requirements. The applicable documents must be referenced during the data validation process as this S.O.P. is only intended as a general procedure for the data validation tasks.

General parameters such as Data Completeness, Overall System Performance, Chromatographic Quality, Detection Limits and Compound Identification are evaluated concurrently with the parameters discussed in the following subsections.

5.2.6.1 Holding Times and Sample Preservation Criteria

Holding times are evaluated by reviewing COC reports, the individual sample Form I reports, and the associated laboratory raw data. Holding times for extraction are calculated from date of collection to date of extraction.

a. For aqueous samples, use a 7-day maximum holding time until extraction.

b. For soil samples, use a 14-day maximum holding time until extraction.

c. For sample extracts use a holding time of 40 days from date of extraction to analysis.

5.2.6.2 Holding Times and Sample Preservation Action

a. Positive results affected by non-compliance are qualified as estimated (J); non-detects (UJ). These results are considered to be biased low. Alternatively, the bias qualifiers L and UL may be used.

b. Non-detects may be rejected (UR) when the sample was extracted (and potentially, some of the extract may have evaporated), the affected sample results may be considered to be biased high.
Refer to the appropriate data validation protocol for specific guidance.

**5.2.6.3 Calibration Criteria**

a. Check that an initial calibration was performed for each instrument used for analysis and that all calibrations were performed at all appropriate concentration levels.

b. In general, either the correlation coefficient (R) of the Percent Relative Standard Deviation (%RSD) is evaluated in the data validation. If the correlation coefficient is chosen by the laboratory, the calibration curve should be checked for linearity.

c. If the %RSD is used, determine which compounds have Percent Relative Standard Deviations (%RSDs) >20%. Circle these non-compliances on your working copies of these Forms. Spot-check (i.e., recalculate) a few of the %RSDs to verify the laboratory’s computation.

d. Determine which samples are affected by reviewing the continuing calibration forms. Determine which continuing calibrations are associated with initial calibrations. Write the affected samples on your working copies of these forms.

e. Review the continuing calibration form and the associated laboratory raw data. Determine which compounds have Percent Differences (%Ds) >15%; circle the non-compliances on your working copies of these forms.

**5.2.6.4 Calibration Action**

a. Generally, associated sample data are qualified as estimated (J, UJ) if the calibration curve correlation coefficient is <0.995. Professional judgment should be used to qualify sample data in cases when sample results fall outside the linear portion of the calibration curve.

b. Positive results for compounds for which %RSD or %D exceeds 20% or 15%, respectively, are qualified as estimated (J); non-detects (UJ). Check the specific applicable data validation protocol for further guidance as there are some protocols which reject non-detects if the %RSD or %D is excessive. Bias for these results cannot be determined.

**5.2.6.5 Blank Contamination Criteria**

When using the information given below and in the appropriate USEPA Regional Functional Guidelines, keep in mind that the validation action levels derived are sample-specific and must be adjusted for dilution, sample aliquot used for analysis, and sample moisture content (when applicable).

The rules for qualifying data based on the occurrence of blank contamination vary based on regional protocols; the guidelines provided in the appropriate protocol should be followed.

Generally the blank contamination review process is completed by first considering the maximum amount of a particular contaminant occurring in the laboratory method blanks. (Do not consider lab blanks run after high concentration samples for purposes of determining carryover as laboratory method blanks.) Then repeat the process for contaminants occurring in the associated field quality control blanks.

**5.2.6.6 Blank Contamination Action**

a. Action levels for qualification (10X or 5X depending upon whether or not the contaminant is a
common contaminant) are then set. The list of common contaminants may vary among protocols.

b. Additionally, some hierarchy among the field quality control blanks apply and the manner in which the qualifiers are applied vary [i.e. use of (U) or (B); replacement by CRQL, etc.]. Refer to appropriate protocol for specific guidance.

5.2.6.7 Surrogate Criteria

Surrogates are evaluated by reviewing the laboratory data package Form II reports and the laboratory raw data. The quality control ranges are given on the laboratory data package Form IIs; circle any non-compliance on your working copies of these Forms.

5.2.6.8 Surrogate Action

All results for all compounds in an affected sample are qualified if any one of the surrogate spike compounds fails to meet the quality control criteria provided.

a. For samples having a surrogate recovery <10%, positive results are qualified as estimated (J), non-detects are rejected (UR). These results are biased low.

b. Samples having a surrogate recovery which is low but >10%, positive results are generally qualified as estimated (J); non-detects (UJ). The bias qualifiers (L, UL) may be used instead, depending upon the specific USEPA Regional guidance.

c. For samples having a surrogate recovery which is high, positive results are generally qualified as estimated (J, K) based on regional guidance; these results are biased high. Non-detects are not qualified based on high surrogate recovery.

5.2.6.9 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Criteria

Verify that matrix spike and matrix spike duplicate recoveries and Relative Percent Differences (RPD) meet quality control limits. Circle outliers on the Form III or equivalent.

5.2.6.10 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Action

a. Take no action based on MS/MSD non-compliances alone.

b. If a matrix spike or matrix spike duplicate recovery is <10%, qualify positive results in the unspiked sample as estimated (J) and qualify non-detects as rejected (UR).

5.2.6.11 Field Duplicate Precision Criteria

Compare the positive compound results with the results from the field duplicate samples. Generally, the Relative Percent Difference (RPD) between field duplicate results for the aqueous matrix should be <30%; for soil matrix results, <50%.

5.2.6.12 Field Duplicate Precision Action

Qualification of the sample data is limited to the specific field duplicate pair. Positive results for compounds showing imprecision are qualified as estimated (J); non-detects (UJ). Bias for these results cannot be determined.
### 5.2.6.13 Sample Result Verification Criteria

Verify and record the quantitation of at least one compound per analytical fraction. If no positive results are reported, use the MS/MSD data to confirm proper computation by the laboratory. Validator and laboratory quantitations must agree within 10 percent.

### 5.2.6.14 Sample Result Verification Action

- **a.** Perform a calculation verification of at least one analyte per fraction and include the re-calculation result in the support documentation section of the validation report. See Appendix A for calculation procedure.
- **b.** If the re-calculation does not agree with the laboratory result within 10%, contact the laboratory to determine whether the reviewer may have used incorrect information or if the laboratory result is incorrect and requires resubmission. A comment on the final outcome is required in the validation report along with the proper calculation verification.

### 5.2.6.15 Percent Solids Criteria

Check the percent solids for each sample to identify any samples that contain <30% solids.

### 5.2.6.16 Percent Solids Action

- **a.** If any sample contains <30% solids, qualify positive and non-detected results as estimated (J); non-detects (UJ) due to high moisture content of the sample.
- **b.** If any sample contains <10% solids, qualify positive results as estimated (J); non-detects rejected (UR).

### 5.2.6.17 Laboratory Precision Criteria

Laboratory precision can be evaluated by comparing the unspiked sample results with MS/MSD analyses results for unspiked compounds.

### 5.2.6.18 Laboratory Precision Action

Consider non-detects and results reported at concentrations less than the Contract Required Quantitation Limit (CRQL) to be in agreement. Use professional judgment in determining whether to qualify sample results based on the comparison.

### 5.2.7 Deliverable Guidance

In addition to any specific USEPA Regional requirements (e.g. data validation memorandum, data summary spreadsheets, Regional worksheets), all laboratory data package quality control summary forms, sample Form I reports, method blank Form Is, and the Chain-of-Custody report, must be given to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements), and that the validation...
narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

5.3 Organochlorine Pesticides and Polychlorinated Biphenyls (PCBs), Organophosphorous Pesticides, Chlorinated Herbicides (SW 8081A/8082/8141A/8151A)

5.3.1 Applicability

Methods 8081A/8082 are used to determine the concentration of the following organochlorine pesticides and polychlorinated biphenyls (PCBs) in groundwater, liquid, and solid sample matrices:

- Aldrin
- alpha-BHC
- beta-BHC
- delta-BHC
- gamma-BHC (Lindane)
- Chlordane
- 4,4'-DDD
- 4,4'-DDE
- 4,4'-DDT
- Dieldrin
- Endosulfan I
- Endosulfan II
- Endosulfan sulfate
- Methoxychlor
- Heptachlor epoxide
- Toxaphene
- Aroclor-1016
- Aroclor-1221
- Aroclor-1232
- Aroclor-1242
- Aroclor-1248
- Aroclor-1254
- Aroclor-1260

Similarly, Method 8141A is used to determine the following pesticides in groundwater and waste samples:

- Azinphos methyl
- Bolstar (Sulprofos)
- Chlorpyrifos
- Coumaphos
- Demeton-O
- Demeton-S
- Diazinon
- Dichlorvos
- Disulfoton
- Ethoprop
- Ethion
- Fensulfothion
- Fenthion
- Merphos
- Mevinphos
- Naled
- Parathion methyl
- Phorate
- Ronnel
- Stirophos (Tetrachlorvinphos)
- Tokuthion (Prothiofos)
- Trichloronate
- Trichlorfon
- Trichloronate

Note that when Method 8141A is used to analyze unfamiliar samples, compound identifications should be supported by at least one additional qualitative technique if mass spectroscopy is not employed.

Method 8151A is used to determine the following chlorinated acid herbicides in groundwater and waste samples:

- 2,4-D
- 2,4-DB
- 2,4,5-T
- 2,4,5-TP (Silvex)
- Dichlorprop
- Dinoseb
- MCPA
- MCPP
Dalapon 4-Nitrophenol
Dicamba Pentachlorophenol

Since these compounds are produced and used in various forms (i.e., acid, salt, ester, etc.), Method 8151A includes a hydrolysis step to convert the herbicide to the acid form prior to analysis. When Method 8151A is used to analyze unfamiliar samples, compound identifications should be supported by at least one additional qualitative technique. This method describes analytical conditions for a second gas chromatographic column that can be used to confirm measurements made with the primary column; alternately, the compounds of interest can be confirmed by detection via a mass spectrometer.

All of the above Methods are Gas Chromatographic (GC) in which sample extracts are analyzed by direct injection. Methods 8081A and 8082 analyze for organochlorine pesticide compounds and PCBs via GC/ECD (Electron Capture Detector; an equivalent Halogen-Specific Detector may also be used). Method 8141A analyzes for organophosphorous pesticide compounds via GC/FID (Flame Ionization Detector), and Method 8151A analyzes for chlorinated herbicide compounds via GC/ECD (alternately, a Microcoulometric Detector or Hall Electrolytic Conductivity Detector may be used).

5.3.2 Interferences

The sensitivity of these methods usually depends on the level of interferences rather than on instrumental limitations. Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or elevated baselines causing misinterpretation of gas chromatograms. The use of high purity reagents and solvents helps to minimize these interference problems. Extraction blanks are analyzed as method blanks in order to monitor the occurrences of interferences.

Interferences co-extracted from the sample will vary considerably, and will dictate the nature and extent of clean-up procedures used. Phthalate esters are a common interference to organochlorine pesticide analyses; phenols and organic acids may act as interferents when analyzing for chlorinated herbicides.

5.3.3 General Laboratory Practices

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses should be conducted to determine the effects of sample matrix upon the compounds of interest.

Standard quality assurance practices such as the analyses of field replicate and laboratory duplicates should also be employed.

Note that herbicides, being strong organic acids, react readily with alkaline substances and may be lost during analysis. Therefore, when performing Method 8151A, glassware and glass wool must be acid-rinsed and sodium sulfate must be acidified with sulfuric acid prior to use to avoid this possibility.

5.3.4 Sample Preparation

Prior to the use of Methods 8081, 8082, and 8141A, aqueous samples are extracted at a neutral pH with methylene chloride as a solvent using a separatory funnel (Method 3510) or a continuous liquid-liquid extractor (Method 3520). Solid samples are extracted with hexane:acetone (1:1) using either the Soxhlet extraction (Method 3540) or sonication (Method 3550) procedures.

Method 8151A provides its own specific preparation procedures for aqueous and solid samples which include extraction with acetone and diethyl ether followed by esterification using diazomethane as a derivatizing agent.
5.3.5 Data Overview Prior to Validation

Before commencing validation, the reviewer must preview the associated Chain-of-Custody (COC) reports to determine:

a. If the appropriate number of samples are present in the data package and if each sample was correctly analyzed for the parameters and methods specified.

b. The identity of all associated field quality control blanks and field duplicate pairs.

Because many samples may have required dilutions, re-extractions and/or re-analyses, the validator should preview the data package contents to determine which analyses represent the better quality data.

Unless specifically directed by client protocol, never annotate the laboratory data package. Before beginning evaluation, prepare working copies (i.e., photocopies) of all Form I reports (including those for samples, laboratory method blanks and MS/MSD analyses) and all laboratory quality control summary forms.

5.3.6 Technical Evaluation Summary

All data evaluations must be conducted in accordance with applicable USEPA Regional protocols and/or specific client contract requirements. The applicable documents must be referenced during the data evaluation process as this S.O.P. is only intended as a general procedure for the data validation tasks.

General parameters such as Data Completeness, Overall System Performance, Chromatographic Quality, Detection Limits, and Compound Identification are evaluated concurrently with the parameters discussed in the following subsections.

5.3.6.1 Holding Times and Sample Preservation Criteria

Holding times are evaluated by reviewing the COC reports, the individual sample Form I reports, and the associated laboratory raw data. Holding times for extraction are calculated from date of collection to date of extraction.

a. For aqueous samples, use a 7-day maximum holding time until extraction.

b. For soil samples, use a 14-day maximum holding time until extraction.

c. For sample extracts use a holding time of 40 days from date of extraction to analysis.

5.3.6.2 Holding Times and Sample Preservation Action

a. If holding times are exceeded, qualify positive results in affected samples as estimated (J); qualify non-detects (UJ). These results are usually assumed to be biased low unless prolonged storage causes a concentration increase, e.g., for degradation products which are also target analytes.

b. If holding times are exceeded by a factor of more than two times the required time, qualify positive results as estimated (J); qualify non-detects rejected (UR). These exceedances are considered to be gross holding time exceedances.
c. If EPA Regional requirements apply, as in EPA Region III, apply the appropriate bias qualifiers as required; for example, detections and nondetects biased low (L) or (UL), respectively.

5.3.6.3 Calibration Criteria

a. Data pertaining to the initial calibration (i.e., evaluation check for linearity) is found on the data package Form Vis or equivalent. Check that an initial calibration was performed for each instrument used and at all appropriate concentration levels.

b. Either the correlation coefficient (R) or the Percent Relative Standard Deviation (%RSD) is evaluated in the data validation. If the correlation coefficient is chosen by the laboratory, the calibration curve should be checked for linearity.

c. If the %RSD is used, determine which compounds have Percent Relative Standard Deviations (%RSDs) >20%. Circle these non-compliances on your working copies of these Forms. Spot-check (i.e., recalculate) a few of the %RSDs to verify the laboratory’s computation.

d. Determine which samples are affected by reviewing the continuing calibration forms. Determine which continuing calibrations are associated with which initial calibrations. Write the affected samples on your working copies of the appropriate continuing calibration forms. Spot-check (i.e., recalculate) a few of the %Ds to verify the laboratory’s computation.

e. Review the continuing calibration form and the associated laboratory raw data. Determine which compounds have Percent differences (%Ds) 15%; circle the non-compliance on your working copies of these forms.

f. Method 8081A requires analysis of a DDT/Endrin breakdown check standard. The DDT/Endrin Breakdown should not exceed 20%.

5.3.6.4 Calibration Action

a. Associated sample data are qualified as estimated (J, UJ) if the calibration curve correlation coefficient is <0.995. Professional judgment should be used to qualify sample data in cases when sample results fall outside the linear portion of the calibration curve.

b. Positive results for compounds for which %RSD or %D exceeds 20% or 15%, respectively, are qualified as estimated (J); non-detects (UJ). Check the specific applicable data validation protocol for further guidance as there are some protocols which reject non-detects if the %RSD or %D is excessive. Bias for these results cannot be determined.

c. For Method 8081A if % breakdown for DDT exceeds 20%, estimate (J) all positive results for DDT, DDE, and DDD following the in-last control standard until the next in-control standard (see analytical sequence). If there are no positive results for DDT but there are positive results for DDD or DDE then reject (R) non-detects for DDT in associated samples.

d. If Endrin % Breakdown exceeds 20%, estimate (J) positive results for Endrin, Endrin Aldehyde, and Endrin Ketone in all samples following the last in-control standard until the next acceptable standard. If there are positive results for Endrin Aldehyde or Endrin Ketone but none for Endrin, reject (R) non-detect Endrin results.
### 5.3.6.5 Blank Contamination

When using the information given below and in the appropriate USEPA Regional Functional Guidelines, keep in mind that the validation action levels derived are sample specific and must be adjusted for dilution, sample aliquot used for analysis, and sample moisture content (when applicable).

The rules for qualifying data based on the occurrence of blank contamination vary based on regional protocols. The guidelines provided in the appropriate protocol should be followed. Verify the following:

#### 5.3.6.6 Blank Contamination Action

An action level of 5X the maximum amount of contaminant found is used to evaluate the sample data. The manner in which the qualifiers are applied vary [i.e. use of (U) or (B); replacement by CRQL, etc.]. Refer to appropriate validation protocol for specific guidance.

#### 5.3.6.8 Surrogate Criteria

Evaluate surrogate recoveries by reviewing the laboratory data package Form II reports and the laboratory raw data.

- a. Verify that the recoveries are within the quality control ranges as given on the laboratory data package Form IIs; circle any non-compliance on your working copies of these Forms.

- b. Verify that the decachlorobiphenyl (DCB) and tetrachloro-m-xylene (TCX) retention times found on data package Form VIII are within +/- 0.10 for DCB and 0.05 for TCX. If DCB and TCX retention time criteria are not met, the raw data must be checked for misidentified GC peaks.

#### 5.3.6.9 Surrogate Action

- a. No qualifications are made for surrogates which show zero recoveries because they were “diluted out.”

- b. Positive results affected by low surrogate recovery are qualified as estimated (J) or the (L) bias qualifier is used when applicable; non-detects are qualified (UJ) or (UL), accordingly.

- c. If a positive sample result is affected by high surrogate recovery, the result is qualified as estimated (J) or the (K) bias qualifier is used when applicable; non-detects are not qualified based on high surrogate recovery.

- d. Because the surrogate recovery limits for these fractions are advisory, generally no results are rejected.

#### 5.3.6.10 Matrix Spike/Matrix Spike Duplicates

Verify that matrix spike and matrix spike duplicate recoveries and Relative Percent Differences (RPD) meet quality control limits. Circle outliers on the Form III or equivalent.

#### 5.3.6.11 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Action

- a. Take no action based on MS/MSD non-compliances alone.
b. If a matrix spike or matrix spike duplicate recovery is <10%, qualify positive results in the unspiked sample as estimated (J) and non-detects as rejected (UR).

### 5.3.6.12 Field Duplicate Precision Criteria

a. Check samples to determine if field duplicates were included in the data package.

b. The Relative Percent Difference (RPD) between field duplicate results for the aqueous matrix should be <30%; for soil matrix results, <50% for sample results greater than the reporting limit.

### 5.3.6.13 Field Duplicate Precision Action

a. If positive results are greater than the reporting limit, qualify positive results for aqueous or soil media if the RPD exceeds 30% or 50% respectively. Qualification of the sample data is limited to the specific field duplicate pair. Positive results for compounds showing imprecision are qualified as estimated (J). Bias for these results cannot be determined.

b. If one result is positive and the other is non-detected and the positive result is greater than 2 times the reporting limit, qualify positive and non-detected results as estimated (J) or (UJ), respectively.

### 5.3.6.14 Sample Result Verification Criteria

Verify and record the quantitation of at least one compound per analytical fraction. If no positive results are reported, use the MS/MSD data to confirm proper computation by the laboratory. Validator and laboratory quantitations must agree within 10 percent.

### 5.3.6.15 Sample Result Verification Action

a. Perform a calculation verification of at least one analyte per fraction and include the re-calculation results in the support documentation section of the validation report. See Appendix A for calculation procedure.

b. If the re-calculation does not agree with the laboratory result within 10%, contact the laboratory to determine whether the reviewer may have used incorrect information or if the laboratory result is incorrect and requires resubmission. A comment on the final outcome is required in the validation report along with the proper calculation verification.

### 5.3.6.16 Percent Solids Criteria

Check the percent solids for each sample to identify any samples that contain <30% solids.

### 5.3.6.17 Percent Solids Action

a. If any sample contains <30% solids, qualify positive and non-detected results as estimated (J) or non-detects (UJ), respectively, due to the high moisture content of the sample.
b. If any sample contains <10% solids, qualify positive results as estimated (J); qualify non-detected results as rejected (UR).

5.3.6.18 Laboratory Precision Criteria

Laboratory precision can be evaluated by comparing the unspiked sample results with MS/MSD analyses results for unspiked compounds.

5.3.6.19 Laboratory Precision Action

Consider non-detects and results reported at concentrations less than the Contract Required Quantitation Limit (CRQL) to be in agreement. Use professional judgment in determining whether to qualify sample results based on this comparison.

5.3.7 Deliverables Guidance

In addition to any specific USEPA Regional requirements (e.g. data validation memorandum, data summary spreadsheets, USEPA Regional worksheets), all laboratory data package quality control summary forms, sample Form I reports, method blank Form Is, and the Chain-of-Custody report, must be given to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements), and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.

5.4 Explosives/Nitroaromatics/Nitroamines(SW 8330)

5.4.1 Applicability

Method 8330 is used to determine the concentration of the following explosives, nitroaromatics, and nitroamines in water, soil, or sediment matrices:

<table>
<thead>
<tr>
<th>Compound</th>
<th>Concentration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)</td>
<td>2,4-Dinitrotoluene (2,4-DNT)</td>
</tr>
<tr>
<td>Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)</td>
<td>2,6-Dinitrotoluene (2,6-DNT)</td>
</tr>
<tr>
<td>1,3,5-Trinitrobenzene (1,3,5-TNB)</td>
<td>2-Nitrotoluene (2-NT)</td>
</tr>
<tr>
<td>1,3-Dinitrobenzene (1,2-DNB)</td>
<td>3-Nitrotoluene (3-NT)</td>
</tr>
<tr>
<td>Methyl-2,4,6-trinitrophenylnitramine (Tetryl)</td>
<td>4-Nitrotoluene (4-NT)</td>
</tr>
<tr>
<td>Nitrobenzene (NB)</td>
<td>Nitroguanidine</td>
</tr>
<tr>
<td>2,4,6-Trinitrotoluene (2,4,6-TNT)</td>
<td>Nitroglycerin</td>
</tr>
<tr>
<td>4-Amino-2,6-dinitrotoluene (4-Am-DNT)</td>
<td>Pentaerythritol Tetranitrate (PETN)</td>
</tr>
<tr>
<td>2-Amino-4,6-dinitrotoluene (2-Am-DNT)</td>
<td></td>
</tr>
</tbody>
</table>

The analysis of the compounds listed above is conducted by High Performance Liquid Chromatography equipped with a 254 nm Ultra Violet (UV) detector. This method is capable of determining part per billion (ppb) detection levels in water and soil matrices.

The method requires the use of both a primary (C-18 reverse phase) and a confirmation (CN reverse phase) column.
5.4.2 Interferences

The sensitivity of this method usually depends on the level of interferences rather than on instrumental limitations. Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or elevated baselines causing misinterpretation of gas chromatograms. The use of high purity reagents and solvents helps to minimize these interference problems. Extraction blanks are analyzed as method blanks in order to monitor the occurrences of interferences.

2,4-Dinitrotoluene and 2,6-dinitrotoluene may co-elute. High concentrations of one of the two isomers may cause interference of the other isomer. In instances where this is applicable, both isomers should be reported as one. Baseline resolution should be present for all compounds.

Decomposition of Tetryl occurs rapidly and when exposed to heat. Samples expected to contain Tetryl should not be exposed to temperatures above room temperature.

5.4.3 General Laboratory Practices

Method blanks and instrumentation blanks should be conducted to access laboratory contamination.

Matrix spike/Matrix Spike Duplicate (MS/MSD) analyses should be conducted to determine the effects of sample matrix upon the compounds of interest.

Standard quality assurance practices such as the analyses of field and laboratory duplicates may also be employed.

5.4.4 Sample Preparation

Method 8330 provides its own specific preparation procedures for aqueous and solid samples which include extraction with acetonitrile and a salting-out procedure for aqueous samples. Soil samples are air dried prior to preparation, thus percent moisture is not a consideration when calculating compound concentrations.

5.4.5 Data Overview Prior to Validation

Before commencing validation, the reviewer must preview the associated Chain-of-Custody (COC) reports to determine:

a. If the appropriate number of samples are present in the data package.

b. If each sample was correctly analyzed and identified for the specified parameters.

c. The identity of all associated field quality control blanks and field duplicate pairs.

Because many samples may have required dilutions, re-extractions and/or re-analyses, the validator should preview the data package contents to determine which analyses represent the best data quality.

Unless specifically directed by the client, never annotate the laboratory data package. Before beginning evaluation, prepare working copies (i.e. photocopies) of all Form I reports (including those for samples, laboratory method blanks and MS/MSD analyses) and all laboratory quality control summary forms.
5.4.6 Technical Evaluation Summary

All data evaluations must be conducted in accordance with applicable USEPA Regional protocols, method requirements, and/or specific client contract requirements. The applicable documents must be referenced during the data evaluation process as this SOP is only intended as a general procedure for the data validation task.

Deficiencies, omissions, and/or other anomalies noted during the review require the data validator to contact the laboratory.

General parameters such as Data Completeness, Overall System Performance, Chromatographic Quality, Detection Limits, and Compound Identification are evaluated concurrently with the parameters discussed in the following subsections.

5.4.6.1 Holding Times and Sample Preservation Criteria

Holding times are evaluated by reviewing the COC reports, the individual sample Form I reports, and the associated laboratory raw data. Holding times for extraction are calculated from the date of collection to the date of extraction.

The technical holding times for aqueous and solid matrices are as follows:

a. For aqueous samples use a 7-day holding time until extractions.

b. For solid samples use a 14-day holding time until extractions.

c. For sample extracts use a holding time of 40 days from date of extraction to analysis.

5.4.6.2 Holding Times and Sample Preservation Action

a. When the holding times criteria are not met, positive results in affected samples are generally qualified as estimated, (J); non-detected results, (UJ). These results are considered biased low. Some USEPA Regions apply the bias qualifiers, L and UL, instead.

b. If the holding times are exceeded by a factor of two or more, the holding time exceedance is considered to be gross and positive results are generally qualified as estimated (J); non-detects are generally considered to be unreliable and are rejected, (R). These results are considered to be biased very low.

5.4.6.3 Calibrations Criteria

a. Data pertaining to the initial calibration (i.e. evaluation check for linearity) is found on the data package Form Vis or equivalent. Check that an initial calibration was performed for each instrument used and at all appropriate concentration levels. The initial calibration should consist of a minimum of five concentration levels for each compound of interest.

b. Either the correlation coefficient (R) or the Percent Relative Standard Deviation (%RSD) is evaluated in the data validation. If the correlation coefficient is chosen the laboratory, the calibration curve should be checked for linearity.

c. If the %RSD is used, determine which compounds have %RSD greater than 20%. Circle these non-compliances on working copies of calibration forms.
d. Determine which samples are affected by reviewing the continuing calibration forms. Determine which continuing calibrations are associated with each initial calibration by instrument. Write the affected samples on working copies of the appropriate continuing calibration forms. Spot-check (i.e. recalculate) a few of the %Ds to verify the laboratory’s computation.

e. A continuing calibration or daily calibration must be performed at the beginning, midpoint and end of the analytical sequence. The continuing calibration response factor for each analyte must be compared to the response factor of the initial calibration. The continuing calibration response factor must agree within 15% of the initial response factor.

5.4.6.4 Calibrations Action

a. Associated sample data is qualified as estimated (J, UJ) if the calibration curve correlation coefficient is < 0.995. Professional judgment should be used to qualify sample data in cases when sample results fall outside the linear portion of the calibration curve.

b. Usually, associated data is qualified as estimated (J/UJ) if the calibration %RSD is >20%.

c. Positive and non-detected results are qualified as estimated (J/UJ) if the Percent Difference (%D) is >15%.

5.4.6.5 Blank Contamination Criteria

A review of all method and instrument blanks (if provided) is conducted to evaluate laboratory contaminants. An additional review of all relevant field quality control blanks is also conducted. Contaminants, if present, are summarized and the maximum concentration of each contaminant is selected and used to establish blank action levels.

5.4.6.6 Blank Contamination Action

An action level of 5X the maximum amount of each contaminant is used to evaluate sample data. Blank action levels must consider the aliquot used for analysis and sample dilution. Positive results less than the action level are qualified as false positives. The manner in which the qualifiers are applied varies [i.e., use of (U) or (B); replacement by the Reporting Limit]. General regional guidance procedures dictate the most appropriate validation action qualification.

5.4.6.7 Surrogates Criteria

Surrogates are evaluated by reviewing the laboratory data package Form II or equivalent and the associated laboratory raw data. The advisory limits are given on the laboratory data package Form IIs. Circle any recoveries outside these limits on working copies.

5.4.6.8 Surrogates Action

a. Positive results affected by low surrogate recoveries are estimated, (J) or (L), indicating low bias; non-detected results are qualified, (UJ) or (UL), accordingly.

b. If a positive sample result is affected by high surrogate recovery, the result is qualified as estimated (J), or the bias qualifier (K), is used when applicable.

c. Non-detected results are not qualified based upon high surrogate recoveries.
d. It should be noted that consideration of interferences may affect surrogate recoveries. If a trend of non-compliance is noted, an evaluation of sample chromatograms should be conducted when surrogate recoveries are noncompliant and a matrix effect is suspected.

e. No qualifications are made for surrogates which have been diluted out.

f. Positive results associated with surrogate recoveries <10% are qualified as estimated, (J) or biased low (L). Non-detected results associated with surrogate recoveries <10% are considered unreliable and are qualified rejected (R).

5.4.6.9 Matrix Spike/Matrix Spike Duplicates (MS/MSD) Criteria

Verify that matrix spike and matrix spike duplicate recoveries and Relative Percent Differences (RPD) meet quality control limits. Circle outliers on the Form III or equivalent.

5.4.6.10 Matrix Spike/Matrix Spike Duplicates (MS/MSD) Action

a. Take no action based on MS/MSD non-compliance alone.

b. If a matrix spike or matrix spike duplicate recovery is <10%, qualify positive results in the unspiked sample as estimated (J) and qualify non-detects as rejected (UR).

5.4.6.11 Field Duplicate Criteria

Compare positive compound results with MS/MSD analyses result for unspiked compounds. Generally, an RPD between field duplicate results for the aqueous matrix should be <30%; for soil matrix results <50%.

5.4.6.12 Field Duplicate Action

Qualification of the sample data is limited to specific field pair. Positive results for compounds showing imprecision are qualified as estimated (J); non-detects (UJ).

5.4.6.13 Sample Result Verification Criteria

Verify and record the quantitation of at least one compound per fraction. If no positive results are reported, use the MS/MSD data to confirm proper computation by the laboratory. The validator and laboratory quantitations must agree within 10%. If quantitation differences are significant, the laboratory must be contacted to investigate and resolve the discrepancy.

5.4.6.14 Sample Result Verification Action

a. Perform a calculation verification of at least one analyte per fraction and include the re-calculation results in the support documentation section of the validation report. See Appendix A for calculation procedure.

b. If the re-calculation does not agree with the laboratory result within 10%, contact the laboratory to determine whether the reviewer may have used incorrect information or if the laboratory result is incorrect and requires resubmission. A comment on the final outcome is required in the validation report along with the proper calculation verification.
5.4.6.15 Laboratory Precision Criteria

Laboratory precision can be evaluated by comparing the unspiked samples results with MS/MSD analyses result for unspiked compounds.

5.4.6.16 Laboratory Precision Action

Consider non-detected results and results reported at concentrations less than the reporting limit to be in agreement. Use professional judgment in determining whether to qualify sample results based upon the comparison. The comparison may be presented in terms of a %RSD or an RPD.

5.4.7 Deliverable Guidance

In addition to any specific USEPA Regional requirements (i.e., data validation memorandum, data summary spreadsheets, USEPA Regional Worksheets), all laboratory data package quality summary forms, sample Form I reports method blank results and the Chain of Custody records must be included in the validation report.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements) and that the narrative is free of transcription and typographical errors before submitting all requested items for quality assurance review.
APPENDIX A, SAMPLE CALCULATIONS

Exhibit D Low/Medium Volatiles -- Section 11
Data Analysis and Calculations (Cont’t)

11.2.1.2 Water

Eq. 7 Water Concentration Calculation

\[
\text{Concentration (µg/L)} = \frac{(A_x)(I_x)(DF)}{(A_{in})(RRF)(V_o)}
\]

Where,

- \( A_x \) = Area of the characteristic ion (EICP) for the compound to be measured. The primary quantitation ions for the target compounds, internal standards, and IMCs are listed in Table 2.
- \( A_{in} \) = Area of the characteristic ion (EICP) for the internal standard. The target compounds are listed with their associated internal standards in Table 3.
- \( I_x \) = Amount of internal standard added, in ng.
- \( RRF \) = Mean Relative Response Factor from the initial calibration.
- \( V_o \) = Total volume of water purged, in mL.
- \( DF \) = Dilution Factor. The DF for analysis of water samples for volatiles by this method is defined as the ratio of the number of mL of water purged (i.e., \( V_o \) above) to the number of mL of the original water sample used for purging. For example, if 2.0 mL of sample is diluted to 5.0 mL with reagent water and purged, \( DF = 5.0 \text{ mL} / 2.0 \text{ mL} = 2.5 \). If no dilution is performed, \( DF = 1.0 \).

11.2.1.3 Low-Level Soil/Sediment

Eq. 8 Low-Level Soil/Sediment Concentration Calculation

\[
\text{Concentration (µg/Kg) (dry weight basis)} = \frac{(A_x)(I_x)(DF)}{(A_{in})(RRF)(W_s)(D)}
\]

Where,

- \( A_x, I_x, A_{in}, \) and \( DF \) are as given for water, Equation 7.
- \( RRF \) = Mean Relative Response Factor from the heated purge of the initial calibration.
- \( D = \frac{100 - \%\text{Moisture}}{100} \)
- \( W_s \) = Weight of sample added to the purge tube, in g.

11.2.1.4 Medium-Level Soil/Sediment

D-41/LOW-MED VOA SOM01.1 (5/2005)
Exhibit D Low/Medium Volatiles -- Section 11
Data Analysis and Calculations (Cont’)

EQ. 9 Medium-Level Soil/Sediment Concentration Calculation

\[
\text{Concentration } \mu\text{g/Kg (dry weight basis) } = \frac{(A_d)(I_d)(AV_i)(1000)(DF)}{(A_{ur})(RRF)(V_i)(W_0)(D)}
\]

Where,

\( A_{ur} \), \( I_d \), \( A_{ur} \) are as given for water, Equation 7.

RRF = Mean Relative Response Factor from the ambient temperature purge of the initial calibration.

\( AV_i \) = Adjusted total volume of the methanol extract plus soil water in milliliters (mL) determined by:

\[ AV_i = V_i + (W_s - [W_s(D)]) \]

Where \( V_i \) = total volume of methanol extract in milliliters (mL). This volume is typically 10 mL, even though only 1.0 mL is transferred to the vial in Section 10.1.5.5. The quantity derived from \( [W_s - [W_s(D)] \) is the soil water volume and is expressed in mL.

\( V_s \) = Volume of the aliquot of the sample methanol extract [i.e., sample extract not including the methanol added to equal 100 μL], in microliters (μL) added to reagent water for purging.

\( W_s \) = Weight of soil/sediment extracted, in g.

\( D = \frac{100 - %\text{Moisture}}{100} \)

DF = Dilution Factor. The DF for analysis of soil/sediment samples for volatiles by the medium-level method is defined as:

\[
\mu\text{L most conc. extract used to make dilution} + \mu\text{L clean solvent} = \mu\text{L most conc. extract used to make dilution}
\]

11.2.1.5 For water, low-level and medium-level soil/sediment samples, xylene is to be reported as "m-p-xylene" and "o-xylene". Because m- and p-xylene isomers coelute, special attention must be given to the quantification of the xylene. In quantitating sample concentrations, be sure to use the correct corresponding Relative Response Factor (RRF) values.

NOTE: The area of each peak (i.e., the peaks for o-xylene and m-p-xylene) must appear on the complete quantitation report.

11.2.1.6 The stereoisomers, trans-1,2-dichloroethene, and cis-1,2-dichloroethene are to be reported separately.

11.2.1.7 Secondary ion quantitation is allowed only when there are sample matrix interferences with the primary ion. If secondary ion quantitation is performed, document the reasons in the SPD Narrative. A secondary ion cannot be used unless an RRF is calculated using the secondary ion.

SOM01.1 (5/2005) D-42/LOW-MED VOA
compound coelution, baseline noise, or matrix interferences. In these circumstances, the Contractor must perform a manual quantitation. Manual quantitations are performed by integrating the area of the quantitation ion of the compound. This integration shall only include the area attributable to the specific TCL compound. The area integrated shall not include baseline background noise. The area integrated shall not extend past the point where the sides of the peak intersect with the baseline noise. Manual integration is not to be used solely to meet Quality Control (QC) criteria, nor is it to be used as a substitute for corrective action on the chromatographic system. Any instance of manual integration must be documented in the SDG Narrative.

11.2.1.3 In all instances where the data system report has been edited or where manual integration or quantitation has been performed, the GC/MS Operator must identify such edits or manual procedures by initializing and dating the changes made to the report, and shall include the integration scan range. The GC/MS Operator shall also mark each integrated area with the letter “M” on the quantitation report. In addition, a hardcopy printout of the EICP of the quantitation ion displaying the manual integration shall be included in the raw data. This applies to all compounds listed in Exhibit C (Semi-quantitatives), internal standards, and DOMs.

11.2.1.4 The requirements listed in Sections 11.2.1.1 - 11.2.1.3 apply to all standards, samples, and blanks.

11.2.1.5 The Mean Relative Response Factor (MRF) from the initial calibration is used to calculate the concentration in the sample. Secondary ion quantitation is allowed only when there are sample interferences with the primary ion. If secondary ion quantitation is performed, document the reason in the SDG Narrative. The area of a secondary ion cannot be used for the area of a primary ion unless a MRF is calculated using the secondary ion.

11.2.1.6 Calculate the concentration in the sample using the MRF and Equations 5 and 6.

11.2.1.6.1 Water

EQ. 5 Concentration of Water Sample

\[
\text{Concentration} \, \mu g/L = \frac{(A_w)(I_p)(V_o)(DF)(GCF)}{(A_{cs})(RFF)(V_p)(V_t)}
\]

Where,

- \(A_w\) = Area of the characteristic ion for the compound to be measured.
- \(A_{cs}\) = Area of the characteristic ion for the internal standard.
- \(I_p\) = Amount of internal standard injected in ng.
- \(V_o\) = Volume of water extracted in mL.
- \(V_t\) = Volume of extract injected in \(\mu L\).

019611/P Tetra Tech NUS, Inc.
Exhibit D Semivolatiles -- Section 11
Data Analysis and Calculations (Cont')

\[ V_t = \text{Volume of the concentrated extract in } \mu\text{L (If GFC Cleanup is performed, } V_t = V_{out}). \]

\[ \text{RRF} = \text{Mean Relative Response Factor determined from the initial calibration standard.} \]

\[ \text{GPC} = \frac{V_m}{V_{in}} = \text{GPC factor. (If no GPC is performed, GPC = 1).} \]

\[ V_{in} = \text{Volume of extract loaded onto GPC column.} \]

\[ V_{out} = \text{Volume of extract collected after GPC cleanup.} \]

\[ \text{DF} = \text{Dilution Factor. The DF for analysis of water samples for semivolatiles by this method is defined as follows:} \]

\[ \text{DF} = \frac{\mu\text{L most conc. extract used to make dilution} + \mu\text{L clean solvent}}{\mu\text{L most conc. extract used to make dilution}} \]

If no dilution is performed, DF = 1.0.

11.2.1.6.2 Soil/Sediment

Eq. 6 Concentration of Soil/Sediment Sample

\[ \text{Concentration } \mu\text{g/Kg (Dry weight basis)} = \frac{(A_s) (I_s) (V_e) (DF) (GPC)}{(A_{ts}) (RRF) (V_1) (W_s) (D)} \]

Where,

\[ A_s, I_s, A_{ts}, V_{in}, \text{ and } V_{out} \text{ are as given for water, above.} \]

\[ V_t = \text{Volume of the concentrated extract in } \mu\text{L (If no GFC Cleanup is performed, then } V_t = 1000 \mu\text{L. If GFC Cleanup is performed, then } V_t = V_{out}).} \]

\[ V_1 = \text{Volume of the extract injected in } \mu\text{L.} \]

\[ D = \frac{100 - \% \text{ Moisture}}{100} \]

\[ W_s = \text{Weight of sample extracted in g.} \]

\[ \text{GPC} = \frac{V_m}{V_{in}} = \text{GPC Factor} \]

\[ \text{RRF} = \text{Mean Relative Response Factor determined from the initial calibration standard.} \]
DF = Dilution Factor. The DF for analysis of soil/sediment samples for semivolatiles by this method is defined as follows:

\[
DF = \frac{\mu L \text{ most conc. extract used to make dilution} + \mu L \text{ clean solvent}}{\mu L \text{ most conc. extract used to make dilution}}
\]

If no dilution is performed, DF = 1.0.

A GPC factor of 2.0 is used to account for the amount of extract that is not recovered from the mandatory use of GPC cleanup. Concentrating the extract collected after GPC to 0.5 mL maintains the sensitivity of the soil/sediment method.

11.2.2 Non-Target Compound

An estimated concentration for non-target compounds tentatively identified shall be quantitated by the internal standard method. For quantitation, the nearest internal standard free of interferences shall be used. The equations for calculating concentration are the same as Equations 5 and 6. Total area counts (or peak heights) from the total ion chromatograms are to be used for both the compounds to be measured and the internal standard. An RRF of 1 is to be assumed. The resulting concentration shall be qualified as "Y" (estimated, due to lack of a compound specific response factor), and "N" (presumptive evidence of presence), indicating the quantitative and qualitative uncertainties associated with this non-target component. An estimated concentration should be calculated for all TICs as well as those identified as unknowns.

11.2.3 CRQL Calculations

11.2.3.1 Water Samples

\[
\text{Adjusted CRQL} = \frac{(V_s) (V_c)}{(V_s) (V_c) (DF)}
\]

Where,

\(V_s\) = DF, and \(V_v\) are as given in Equation 5.

\(V_s\) = Contract sample volume (1000 mL).

\(V_v\) = Contract concentrated extract volume (1000 μL if GPC is not performed. If GPC was performed, then \(V_v = V_{con}\)).
11.2.1.4 The Contractor must quantitate Toxaphene based on the Mean Calibration Factors (CFs) from the most recent initial calibration.

11.2.1.5 The chromatograms of all samples (including Laboratory Control Samples (LCSs), Matrix Spikes and Matrix Spike Duplicates (MS/MSDs)), standards, and required blanks must be reviewed by a qualified pesticide analyst before they are reported.

11.2.1.6 Calculate the sample concentration and on-column concentration of the single component pesticides and surrogates by using the following equations.

11.2.1.6.1 Water

**EQ. 14 Concentration Calculation of Target Compounds in Water Samples**

\[
\text{Concentration \( \mu g / L = \frac{(A_s) (V_{int}) (DF) (GPC)}{(CF) (V_j) (V_t)} \)}
\]

- \(A_s\) – Response (peak area or height) of the compound to be measured.
- \(CF\) – Mean Calibration Factor from the initial calibration (area/µg).
- \(V_{int}\) – Volume of extract loaded onto GPC column.
- \(V_{col}\) – Volume of extract collected after GPC cleanup.
- \(V_i\) – Volume of concentrated extract (µL). (If GPC is not performed, then \(V_i = 10,000 \mu L\). If GPC is performed, then \(V_i = V_{col}\).
- \(V_j\) – Volume of extract injected (µL). (If a single injection is made onto two columns, use \(V_j\) the volume in the syringe as the volume injected onto each column).
- \(GPC\) – Gel Permeation Chromatography factor. (If no GPC is performed, GPC = 1.0)
- \(V_w\) – Volume of water extracted (mL). (NOTE: for instrument blanks and sulfur cleanup blanks, assume a 1,000 mL volume).
- \(DF\) – Dilution Factor. The DF is defined as follows:

  - µL most concentrated extract used to make dilution + µL clean solvent
  - µL most concentrated extract used to make dilution

If no dilution is performed, \(DF = 1.0\).

The CFs used in Equations 14 - 17 are those from the most recent initial calibration. If the CFs used to determine the linearity of the initial calibration were based on peak area, then the concentration of the analyte in the sample...
Exhibit D Pesticides -- Section 11
Data Analysis and Calculations (Cont’d)

must be based on peak area. Similarly, if peak height was used to determine linearity, use peak height to determine the concentration in the sample.

11.2.1.6.1.2 EQ. 15 On-Column Concentration of Water Sample Extract

\[
\text{On-Column Concentration (ng/µL)} = \frac{(A_w)}{(CF)} \left(\frac{V_i}{W_s}\right)
\]

Where,
- \(A_w\) = Same as Eq. 14.
- \(CF\) = Same as Eq. 14.
- \(V_i\) = Volume of extract injected (µL). (If a single injection is made onto two columns, use ½ the volume in the syringe as the volume injected onto each column).

11.2.1.6.2 Soil/Sediment

11.2.1.6.2.1 EQ. 16 Concentration of Target Compounds in Soil/Sediment Samples

\[
\text{Concentration µg/Kg (Dry weight basis)} = \frac{(A_w) \left(\frac{V_i}{W_s}\right) (DF) (GFC)}{(CF) \left(\frac{V_i}{W_s}\right) (W_s) (D)}
\]

Where,
- \(A_w\) = Same as Eq. 14.
- \(CF\) = Same as Eq. 14.
- \(V_i\) = Volume of extract injected (µL). (If a single injection is made onto two columns, use ½ the volume in the syringe as the volume injected onto each column).
- \(W_s\) = Weight of sample extracted (g).
- \(DF\) = Same as Eq. 14.
- \(D\) = % dry weight or \(100 - \%\) moisture
- \(GFC\) = Same as Eq. 14.
Exhibit D Pesticides -- Section 11
Data Analysis and Calculations (Con’t)

11.2.1.6.2.2 EQ. 17 On-Column Concentration of Soil Sample Extract

On-Column Concentration (ng/µL) = \( \frac{(A_i)}{(CF) (V_i)} \)

Where,
- \( A_i \) = Same as EQ. 14.
- \( CF \) = Same as EQ. 14.
- \( V_i \) = Volume of extract injected (µL). (If a single injection is made onto two columns, use is the volume in the syringe as the volume injected onto each column).

11.2.1.7 The lower of the two concentrations calculated for each single component pesticide is reported on Form I. In addition, the concentrations calculated for both the GC columns are reported on Form X, along with a Percent Difference (% Difference) comparing the two concentrations. The Percent Difference is calculated according to Equation 18.

EQ. 18 Percent Difference Between Concentrations on Both GC Columns

\[ \%D = \frac{\text{Conc}_2 - \text{Conc}_1}{\text{Conc}_1} \times 100 \]

Where,
- \( \text{Conc}_2 \) = The higher of the two concentrations for the target compound in question.
- \( \text{Conc}_1 \) = The lower of the two concentrations for the target compound in question.

NOTE: Using this equation will result in Percent Difference values that are always positive.

11.2.1.8 The quantitation of Toxaphene must be accomplished by comparing the heights or areas of each of the three or four major peaks of in the sample with the CF for the same peaks established during the initial calibration sequence. The concentration of Toxaphene is calculated by using Equations 14 and 16, where \( A_i \) is the area for each of the major peaks. The concentration of each peak is determined and then a mean concentration for the three or four major peaks is determined on each column.

11.2.1.9 The reporting requirement for Toxaphene is similar to that for the single component analytes, except that the lower mean concentration (from three or four peaks) is reported on Form I, and the two mean concentrations reported on Form X. The two mean concentrations are compared by calculating the Percent Difference using Equation 18.
Exhibit D Aroclors -- Section 11
Data Analysis and Calculations (Con’t)

11.1.2.9 If the identification of the analyte cannot be confirmed by any of the GC/MS procedures above, and the concentration calculated from the GC/ECD analysis is greater than or equal to the concentration of the reference standard analyzed by GC/MS, then report the analyte as undetected, adjust the sample quantitation limit (the value associated with the "U" qualifier) to a sample concentration equivalent to the concentration of the GC/MS reference standard, and specify the results on Form I with one of the laboratory-defined qualifiers ("X", "y", or "z"). In this instance, define the qualifier explicitly in the Sample Delivery Group (SDG) Narrative, and describe the steps taken to confirm the analyte in the SDG Narrative.

11.1.2.10 For GC/MS confirmation of Aroclors, spectra of three characteristic peaks are required for both the sample component and the reference standard.

11.1.2.11 The purpose of the GC/MS analysis for the Aroclors is to confirm the presence of chlorinated biphenyl in Aroclors. The GC/MS analytical results for the Aroclors shall not be used for quantitation and the GC/MS results shall not be reported on Form I and Form X. The exception noted in Section 11.1.2.9 applies only to analytes that cannot be confirmed above the reference standard concentration.

11.2 Calculations
11.2.1 Aroclor Concentrations
11.2.1.1 Water

11.2.1.1.1 Eq. 7 Concentration Calculation for Water Samples

\[
\text{Concentration} \, \mu g/L = \frac{(A_s) \, (V_s) \, (DF) \, (GPC)}{(CF) \, (V_e) \, (V_i)}
\]

Where,

- $A_s$ = Area or height of the peak for the compound to be measured.
- $CF$ = Mean Calibration Factor from the specific five-point calibration (area/µg).
- $V_s$ = Volume of water extracted in mL (Note: for instrument and sulfur blanks assume a volume of 1000 mL).
- $V_i$ = Volume of extract injected in µL. (If a single injection is made onto two columns, use one half the volume in the syringe as the volume injected onto each column).
- $V_e$ = Volume of the concentrated extract in µL. (If GFC is not performed, then $V_e = 10000$ µL. If GFC is performed, then $V_e = V_{sp}$).
Exhibit D Aroclors -- Section 11
Data Analysis and Calculations (Con’t)

DF = Dilution Factor. The DF for analysis of water samples by this method is defined as follows:

μL most concentrated extract used to make dilution + μL clean solvent
μL most concentrated extract used to make dilution

If no dilution is performed, DF = 1.0.

\[ \frac{V_m}{V_{act}} = \text{GFC factor. (If no GPC is performed, } \frac{V_m}{V_{act}} = 1.0). \]

\[ V_m = \text{Volume of extract loaded onto GPC column.} \]

\[ V_{act} = \text{Volume of extracted collected after GPC cleanup.} \]

11.2.1.1.2 EQ. 8 On-Column Concentration of Water Sample Extract

\[ \frac{\text{On-Column Concentration (ng/μL)}}{\text{(CF)} \cdot (V_i)} = \frac{(A_n)}{(CF)} = \left( \frac{(V_i)}{(CF)} \cdot (V_i) \right) \]

Where,

\[ A_n = \text{Same as EQ. 7.} \]

\[ CF = \text{Same as EQ. 7.} \]

\[ V_i = \text{Volume of extract injected (μL). (If a single injection is made onto two columns, use the volume in the syringe as the volume injected onto each column.)} \]

11.2.1.2 Soil/Sediment

11.2.1.2.1 EQ. 9 Concentration Calculation for Soil Samples

\[ \frac{\text{Concentration μg/Kg (Dry weight basis)}}{\text{(CF)} \cdot (V_i)} = \frac{(A_n)}{(CF)} \cdot (V_i) \cdot (w_i) \cdot (n) \]

Where,

\[ A_n, V_i, CF, \text{ and GPC are as given for water in EQ 7.} \]

\[ V_i = \text{Volume of extract injected in μL. (If a single injection is made onto two columns, use one half the volume in the syringe as the volume injected onto each column.)} \]

SOM01.1 (5/2005) D-48/ARO
Exhibit D Aroclors -- Section 11
Data Analysis and Calculations (Cont’d)

\[ D = \frac{100 - \% \text{Moisture}}{100} \]

\( w_s \) = Weight of sample extracted in g.

\( DF \) = Dilution Factor. The DF for analysis of soil/sediment samples by this method is defined as follows:

\[ \frac{\mu\text{L most concentrated extract used to make dilution} + \mu\text{L clean solvent}}{\mu\text{L most concentrated extract used to make dilution}} \]

If no dilution is performed, \( DF = 1.0 \).

11.2.1.2.2 EQ. 10 On-Column Concentration of Soil Sample Extract

\[ \text{On-Column Concentration (ng/\mu\text{L})} = \frac{(A_w)}{(\text{CF})(V_i)} \]

Where,

\( A_w \) = Same as EQ. 7.

\( \text{CF} \) = Same as EQ. 7.

\( V_i \) = Volume of extract injected (\mu\text{L}). (If a single injection is made onto two columns, use \( \frac{1}{2} \) the volume in the syringe as the volume injected onto each column).

11.2.2 Target Compounds

The quantitation of Aroclors must be accomplished by comparing the heights or the areas of each of a minimum of 3 major peaks of the Aroclor in the sample with the \( \text{CF} \) for the same peaks established during the specific five-point calibration. The concentration of multi-component analytes is calculated by using Equations 7 and 9, where \( A_w \) is the area for each of the major peaks of the Aroclor. The concentration of each peak is determined and then a mean concentration for a minimum of 3 major peaks is determined on each column.

11.2.2.1 Note that the \( \text{CFs} \) used for the quantitation of Aroclors are the \( \text{CFs} \) from the concentration of the specific five-point calibration.

11.2.2.2 The lower mean concentration (from a minimum of 3 peaks) is reported on Form I, and the two mean concentrations reported on Form X. The two mean concentrations are compared by calculating the Percent Difference (%Difference) using Equation 11.
TABLE OF CONTENTS

SECTION                                      PAGE

1.0   PURPOSE ................................................................. 2

2.0   APPLICABILITY .......................................................... 2

3.0   PERSONNEL QUALIFICATIONS ........................................ 2

4.0   INORGANICS (SW-846 6010B/7470A7471A/9010A&amp;/7470/9010)  ........................................ 2

   4.1   APPLICABILITY ......................................................... 2

   4.2   INTERFERENCES ....................................................... 3

   4.3   GENERAL LABORATORY PRACTICES ............................. 3

   4.4   SAMPLE PREPARATION ............................................. 3

   4.5   DATA OVERVIEW PRIOR TO VALIDATION ..................... 3

   4.6   TECHNICAL EVALUATION SUMMARY .......................... 4

   4.7   DELIVERABLES GUIDANCE ........................................ 10

5.0   REFERENCE ................................................................. 11

APPENDIX

A   SAMPLE CALCULATIONS
1.0 PURPOSE

This SOP governs the validation of data generated by inorganics analytical methods (SW-846 6010B/7470A/7471A/9010A/7470/9010). As additional inorganic quantification methods are developed, the corresponding validation protocols may be added to this SOP.

2.0 APPLICABILITY

The applicability of these validation criteria is described in the appropriate sections below.

3.0 PERSONNEL QUALIFICATIONS

The minimum qualifications of persons implementing this SOP are as follow:

- Education – Minimum of a bachelor’s degree in chemistry or related physical/life science.

- Experience requirements include either operational experience with the analytical method or method data review training conducted under the direction of an experienced reviewer and performed on the subject matter data package. A record of the training will not be documented and kept on file but the data validation report produced under training will serve as the record.

4.0 INORGANICS SW-846

4.1 Applicability

This method is applicable to a large number of matrices including EP extracts, TCLP extracts, industrial wastes, soils, groundwater, aqueous samples, sludges, sediments, and other solid wastes. All matrices require digestion prior to analysis.

The following analytes have been determined satisfactorily by this method:

Inductively Coupled Plasma Emission Spectroscopy (ICP):

- Aluminum
- Antimony
- Arsenic
- Barium
- Beryllium
- Cadmium
- Calcium
- Chromium
- Cobalt
- Copper
- Iron
- Lead
- Magnesium
- Manganese
- Nickel
- Sodium
- Silver
- Selenium
- Thallium
- Vanadium
- Zinc
- Potassium

Cold Vapor Methodology:
- Mercury

Automated Colorimetric Technique:
- Cyanide
4.2 **Interferences**

Solvents, reagents, glassware, and other sample processing hardware may yield artifacts and/or interferences to sample analysis. All of these materials must be demonstrated to be free from interferences under the conditions of the analysis by analyzing method blanks. Specific selection of reagents and purification of solvents by distillation in all-glass systems may be necessary.

4.3 **General Laboratory Practices**

A method blank consisting of deionized water spiked with internal standard should be analyzed immediately following each daily calibration, and also after the analysis of every high concentration sample.

Matrix Spike/Matrix Spike Duplicate (MS/MSD) analyses should be conducted to determine the effects of sample matrix upon the compounds of interest.

4.4 **Sample Preparation**

The data reviewer must initially verify that samples being prepared for ICP, and color vapor methodologies are prepared using acid extraction. Samples being prepared for analysis of cyanide by an automatic colorimetric technique are prepared using distillation. Additionally, the data reviewer must verify that prior to analysis, MS and LCS aqueous and soil samples are spiked with internal standard. The samples are filtered and the extract is ready for analysis.

4.5 **Data Overview Prior to Validation**

The data reviewer must initially verify that all Forms are present and complete (i.e., CLP Forms 1 through 14, or comparable forms, must be provided). Areas of special attention when accounting for required Forms will include:

a. Verify at least one Initial and Continuing Calibration Verification (ICV/CCV) Percent Recovery (%R) calculation as noted on calibration summary Form 2A.

b. Verify that a matrix-specific laboratory generated preparation blank has been analyzed for each respective matrix as noted on the Form 3 (note that filtered and unfiltered aqueous matrices are to be treated as distinctly different matrices).

c. Verify that all ICP analytes are present in both ICSA and ICSAB solutions. Also verify from the raw data that the laboratory reported all analytes present in solution A to the nearest whole number. It is not uncommon for laboratories to incorrectly report "zeros" or simply leave blank the appropriate solution A columns. Furthermore, %Rs for solution AB are to be reported to one decimal place on the Form 4.

d. Check that one matrix spike was analyzed for each particular matrix per analytical batch. Laboratories typically will not include an aqueous matrix for waters if the only aqueous samples contained in the SDG are field quality control blanks (i.e., equipment rinsate blanks and/or field blanks). This is generally accepted without data validation letter text comment at the validator’s discretion. Additionally, the data reviewer may want to verify spiking levels.

e. Verify that laboratory duplicate analyses were performed for each matrix. **NOTE:** Field quality control blanks are never to be designated for quality control analyses.
f. Check that one Laboratory Control Sample (LCS) was analyzed for each batch of samples per matrix within an SDG. **NOTE:** An aqueous LCS is not required for mercury and cyanide analysis.

g. The Method of Standard Additions (MSA) Form 8 may or may not be present as dictated by Post Digestion Spike (PDS) %Rs. See Section 4.6.13 for further details.

h. Verify that at least one ICP serial dilution analysis was performed for each matrix within an SDG. **NOTE:** Typically one serial dilution will serve to monitor a given set of samples within an SDG. However, special contractual requirements may necessitate one serial dilution analysis per sample. Ascertain atypical serial dilution frequency requirements through the project manager.

i. Verify that the Form 11 ICP Interelement Correction Factors (Annually) is present.

j. Verify that all ICP analytical results fall within the ICP Quarterly Linear Ranges provided on the Form 12.

k. Verify that the Form 13 Preparation Log accounts for aqueous/soil ICP, mercury, and cyanide digestions/distillations as applicable.

l. Examine the Form 14s to verify that one and only one "X" flag has been used to signify each reported field sample result or quality control sample result. Laboratories are often careless when entering the "X" flag. An incorrectly entered "X" flag can lead to reporting errors for the sample and its associated QC. The validator must verify reported results in instances of discrepancies, amend appropriate forms, and mention in letter text.

Actions - Notify the appropriate laboratory contact of required resubmittals when discrepancies are noted on the forms discussed above.

### 4.6 Technical Evaluation Summary

All data evaluations must be conducted in accordance with current and applicable USEPA Regional protocols and/or specific client contractual requirements and obligations. The applicable documents must be referenced to during the data evaluation process as this Standard Operating Procedure (SOP) is intended as proprietary in-house guidance for general inorganic validation practices only.

General parameters such as Data Completeness, Overall System Performance, and Detection Limits must be evaluated concurrently with the parameters discussed below.

#### 4.6.1 Holding Times and Sample Preservation Criteria

Holding times are calculated from date of sample collection to date of sample analysis. The date of sample collection must be obtained from the Chain-of-Custody (COC) form. The date of sample analysis is best retrieved from the raw data but may also be obtained from the Form 14.

Sample preservation and holding time requirements are as follows:

a. Metals - 6 months; pH <2

b. Mercury - 28 days; pH <2

c. Cyanide - 14 days; pH >12

Preservation requirements as noted above are applicable to aqueous samples only; solid samples do not receive preservative, but require maintenance at 4°C (±2°C) during shipment and storage.
The above holding times do not apply to leachate analyses. The data reviewer shall refer to SW-846 method 1311 for any questions regarding TCLP quality control requirements and analytical procedural requirements; these very significantly from non-TCLP analyses.

4.6.2 Holding Time and Sample Preservation Action

a. If holding times are exceeded, qualify reported detections in affected samples as estimated (J); nondetects (UJ). These results are biased low.

b. If holding times are exceeded by a factor of more than two times the required time, qualify detections as estimated (J); qualify nondetects as nondetected rejected (UR). These exceedances are considered to be gross holding time exceedances.

c. If samples are received above the required temperature, use professional judgment to qualify the results. Consider the length of time outside the prescribed storage temperature range and other relevant factors.

4.6.3 Initial and Continuing Calibration Requirements

Verify the following (results less than the low value of an acceptance range are considered to be low and values greater than the high value of a range are considered to be high):

a. ICP analyses - must employ a blank and at least one standard. Review initial and continuing calibrations Form 2As and associated new data. The initial and continuing calibration %R quality control limits are 90-110%.

b. Mercury analyses - must employ a blank and at least four standards (r = 0.995 or greater). The initial and continuing calibration %R quality control limits are 80-120%.

c. Cyanide analyses - must employ a blank and at least three standards (r = 0.995 or greater). NOTE: The midpoint standard for cyanide analyses must be distilled; verify this via distillation logs. The initial and continuing calibration %R quality control limits are 85-115%.

4.6.4 Calibration Actions

a. If ICV/CCV %Rs are low, qualify all affected detections as estimated (J); qualify nondetects as estimated (UJ). In accordance with some USEPA regional protocol, the (L) and (UL) qualifiers may be used when qualifying results. Bias for these results is low.

b. If ICV/CCV %Rs are high, qualify all affected detections as estimated (J); nondetects are not affected. In accordance with some USEPA regional protocol the (K) qualifier may be used when qualifying results. Bias for these results.

c. Gross exceedance >150% or < 75%, as defined by applicable data validation protocol, may require rejection (UR) of results.

NOTE: Qualify results of only those samples associated with the noncompliant ICB or CCV (generally, those samples immediately preceding or following the noncompliant standard until the nearest in-control standard).
4.6.5 Blank Contamination Criteria

Verify that a preparation blank was analyzed for each matrix and for each batch of 20 samples or each sample batch digested, whichever is more frequent. Continuing Calibration Blanks (CCBs) must be analyzed at a frequency of 10% or every 2 hours whichever is more frequent.

The data reviewer shall select the maximum contaminant level for each analyte in a particular matrix from which shall be calculated an "action level." The action level shall be established as 5 times (5X) the maximum contaminant level but must be adjusted for dilution factor, moisture content, and sample weight prior to application.

ICB/CCB contamination shall be applied to all samples within an SDG. Preparation blank contamination shall be applied to samples of the same matrix and analytical batch only. Common practice shall be to qualify as nondetected (U) any blank contaminant present in sample which is considered a laboratory artifact (i.e. < 5X action level). Professional judgment must be employed when discerning the validity of a concentration present in a field quality control blank. In many instances, contamination present in these blanks can be attributable to poor laboratory practice and not actual field contaminant conditions.

Negative concentrations detected in the laboratory method blanks are indicative of instrumental problems and base-line drifting. Generally, any negative concentration > IDL shall warrant review of the associated sample data regardless of matrix. Action levels shall not be established for negative concentration levels with exception for EPA Region I. Any blank that contains a negative result whose value is ≤ (-IDL) but ≥ [-Contract Required Detection Limit (CRDL) or -Reporting Limit (RL)] must be carefully evaluated using professional judgment.

4.6.6 Blank Contamination Action

a. Qualify as nondetected (U) any reported detection within the action level. In accordance with USEPA regional protocol, the (B) qualifier may be used instead of (U) when qualifying detections.

b. In accordance with some USEPA regional protocol results are qualified based on negative blank results. If any blank contains a negative result whose value is ≤ (-CRDL or -RL), qualify reported detections < 5X CRDL or RL as estimated (J) and nondetects as estimated (UJ). Region III requires if any negative blank concentrations are < (-CRDL or -RL), then all reported detections < 5X CRDL or RL are qualified as biased low (L) and nondetected results are qualified as biased low (UL). Check the last compliant calibration blank in the analytical sequence to determine the affected samples.

c. In accordance with USEPA Region I protocol, qualify based on negative blank results. If negative concentrations are reported in any blank and the value is ≤ (-IDL), establish an action level 5X IDL and qualify reported detections < 5X IDL and < the CRDL or RL as estimated (J) and nondetects as estimated (UJ). Detections > CRDL or RL are receive no data qualifying flag. Check the last compliant calibration blank in the analytical sequence to determine the affected samples.

4.6.7 ICP Interference Check

Sample Form 4 and associated raw data. Verify that all recoveries for the ICP ICS solution fall within the 80-120% quality control window established for the ICS AB solution.

Actions - For ICS %Rs <80%, qualify as estimated (J) any reported detections and (UJ) nondetects in affected samples. For ICS %Rs >120%, qualify as estimated (J) any reported detections in affected samples; nondetects are unaffected by high ICS solution AB recovery. NOTE: Affected samples include all samples analyzed between the initial and final solutions (or within the eight hour working shift,
whichever occurs more frequently) which contain Al, Ca, Fe, or Mg at levels >50% of the respective concentration of Al, Ca, Fe, or Mg in the ICS True Solution A.

Next, review concentrations of the four common interfering analytes (aluminum, calcium, iron, and magnesium) in the environmental samples. Any aforementioned interferent present in the environmental samples at concentrations which exceed 50% of those present in the ICS solution for that same analyte will require calculation of estimated elemental interference stemming from high interfering analyte concentration. If the previous condition is met; review the ICP/ICS Form 4 and note any analytes present in the ICS solution A at levels which exceed the IDL and which are not present in the ICS True solution A. Reported detections in the ICS solution A indicate potentially elevated results for this analyte in the affected sample while negative results (algebraically negative) in the ICS solution A indicate potentially suppressed results for this analyte in the affected sample.

Next, an estimated elemental interference must be calculated for each analyte > IDL present in the ICS solution A which is not present in the ICS True solution A. The following equation shall be employed:

\[
\text{Estimated elemental inf.} = \frac{\text{Conc. affected analyte in ICS Soln A} \times \text{Interferent concentration in ICS A}}{\text{Conc. in Sample}}
\]

It is advisable, although not necessary, to routinely choose the lowest concentration for the interferent level in the ICS so as to calculate the highest estimated interference possible. This method lends itself to a more conservative overall data quality review.

Estimated interferences for each affected analyte > IDL in the ICSA solution must now be compared to the reported environmental sample result for that particular analyte.

### 4.6.8 ICP Interference Check Actions

a. For ICS %R <80%, qualify as estimated (J) any reported detections and (UJ) nondetects in affected samples. In accordance with some USEPA regional protocol, if ICS %Rs are low reported detections are qualified as biased low (L) and nondetects (UL).

b. For ICS %Rs >120%, qualify as estimated (J) any reported detections in affected samples; nondetects are unaffected by high ICS solution AB recovery. In accordance with some USEPA regional protocol, if ICS %Rs are high, reported detections are qualified as biased high (K).

NOTE: Affected samples including all samples analyzed between the initial and final solutions (or within the eight hour working shift, whichever occurs more frequently) which contain Al, Ca, Fe, or Mg at levels >50% of the respective concentration of Al, Ca, Fe, or Mg in the ICS True Solution A.

c. For estimated interferences <10% of the reported sample concentration for a particular affected analyte, take no action; interference is considered negligible.

d. For estimated interferences >10% of the reported sample concentration for a particular affected analyte, qualify (J) detections and/or (UJ) nondetect for affected analyte in affected sample.

(NOTE: Calculation of an estimated positive (potentially elevated) interference will have no effect on a reported nondetect; thus, no action is necessary).

### 4.6.9 Matrix Spike/Matrix Spike Duplicate (MS/MSD)

Review Spike Sample Recovery Form 5A and associated raw data. Verify that at least one matrix spike was performed for each matrix for a given set of samples within an SDG. NOTE: Filtered and unfiltered
samples are to be treated as distinctly different sample matrices and qualified accordingly. Refer to ILM03.0, 3/90 Inorganic SOW, Table 3, "SPIKING LEVELS FOR SPIKING SAMPLE ANALYSIS," page 20, Section E, for proper analyte spiking concentrations and requirements. Any deviations from the SOW shall be noted and require laboratory contact for correction.

Aqueous and soil Matrix Spike (MS) recoveries must be within the 75-125% quality control window in instances where the initial sample result is <4X amount spiked. If the initial sample result is >4X the amount spiked and the MS %R is noncompliant; no actions shall be taken.

4.6.10 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Action

a. For MS %Rs <30%, qualify as estimated (J) any reported detections and reject (UR) nondetects in affected samples.

b. For MS %Rs <75% but >30%, qualify as estimated (J) any reported detections and (UJ) nondetects in affected samples.

c. For MS %Rs >125%, qualify as estimated (J) any reported detections in affected samples; nondetects are not compromised by high MS recovery; thus, no actions are warranted.

4.6.11 Laboratory Control Sample (LCS)

Review Laboratory Control Sample Form 7 and associated raw data. Verify that an LCS was analyzed for each matrix and for each batch of twenty samples or batch of samples digested (whichever is more frequent) within an SDG. The quality control criteria established for evaluation of aqueous LCS analyses are 80-120%. NOTE: An aqueous LCS is not required for mercury and cyanide analysis, and silver and antimony are not subject to quality control criteria. Verify that all solid "found values" fall within the EPA established control limits for soils.

4.6.12 Laboratory Control Sample (LCS) Action

a. Aqueous
1. In instances where aqueous LCS %R <80%, qualify as estimated (J) any reported detections and (UJ) nondetects.
2. If aqueous LCS %R >120, qualify as estimated (J) any reported detections.

b. Solids
1. In instances where solid found value is below lower quality control limit, qualify as estimated (J) any reported detections and (UJ) nondetects.
2. If solid LCS found value exceeds EPA upper limit for soils, qualify as estimated (J) any reported detections.

4.6.13 Method of Standard Additions (MSA)

Review MSA Form 8 and verify instrument linearity by checking that all calibration correlation coefficients (r) are greater than or equal to 0.995. MSAs for a particular analyte in a particular sample may be analyzed more than once. Check reanalyses in instances where initial MSA analysis yields (r) <0.995. It is good practice to review one or two GFAA post-digestion spike (PDS) %Rs via reviewing unspiked and spiked sample concentrations and associated PDS recovery to verify that the Furnace Atomic Absorption Analysis Scheme has been followed as per directional guidance noted on page E-28, document ILM03.0

a. If calibration correlation coefficient (r) <0.995, qualify as estimated (J) any reported detections and/ or (UJ) nondetect in affected sample.
NOTE: The "Q" column on the Form 1 of the affected sample should contain an "S" flag for that particular analyte to indicate that the result was obtained using MSA. A "+" flag should also be recorded when the MSA correlation coefficient (r) <0.995. Review the appropriate Form I and amend if necessary.

4.6.14 ICP Serial Dilution Analysis Criteria

Review ICP Serial Dilutions Form 9 and associated raw data. Verify that a serial dilution was performed for each matrix and that all ICP analytes are included on the Form 9 with corresponding recovery calculations. Check the calculated Percent Difference (%D) column in instances where the diluted sample result is nondetected. In this situation, the laboratory should report a %D of 100% and not simply list the %D as noncalculable. Overlooking this minor point may result in incomplete sample data qualification in some instances. Amend the Form 9 if necessary. All %Ds for ICP serial dilution analyses should be <10% when concentrations of corresponding analytes in the original (undiluted) sample are minimally a factor of 50X IDL.

4.6.15 ICP Serial Dilution Actions

a. If %D >10% for an analyte, and the corresponding sample concentration is >50x IDL, qualify as estimated (J) any reported detections for that analyte in all samples of the same matrix. NOTE: The possibility of negative interference exists when the ICP serial dilution %D >10% and the diluted sample result is significantly > original (undiluted) sample result. Qualify as estimated (J) any reported detections and (UJ) nondetects in such instances.

4.6.16 PA Analysis Run Logs Form 14s

The Form 14 serves several useful functions. It can be used to obtain sample analysis dates as noted in the heading of the page. Secondly, it is used to record any dilutions as applicable to ICP, GFAA, mercury, and cyanide analyses. And finally, it can be used to verify that GFAA PDS percent recoveries are within the 85-115% quality control limits. Additionally, the data reviewer should be careful to note that one and only one "X" flag has been used to indicate each reported field sample result or quality control sample result; this can be an area of frequent laboratory error.

a. If the PDS %R is <85%, qualify as estimated (J) the corresponding detection and/or (UJ) nondetect in affected sample.

b. If the PDS %R is >115%, qualify as estimated (J) the corresponding detection in the affected sample; nondetects are not qualified based on high PDS %R.

4.6.17 Field Duplicate Precision Criteria

Field duplicates can be determined via Project Manager informational documents (i.e., sampling logs) or obtained from Chain-of-Custody (COC) forms. Field duplicates are generally identified as samples having identical sample collection times and dates. In instances were field duplicate samples are included with the sample data set, the following control criteria are generally used to evaluate aqueous field duplicates:

a. An upper control limit of30% for relative percent difference when sample and duplicate results are >5X CRDL or RL

b. An upper control limit of2X CRDL or RL for the difference between the sample values when sample and/or duplicate results are <5X CRDL or RL

Similarly, the following control criteria are generally used to evaluate solid field duplicates:
a. An upper control limit of 50% for the relative percent difference when sample and duplicate results are >5X CRDL or RL

b. An upper control limit of 4X CRDL or RL for the difference between the sample values when sample and/or duplicate results are <5X CRDL or RL

**NOTE:** The %RPD should reflect a difference of 200% and should not simply be recorded as noncalculable in instances where the sample result is a detection but the field duplicate result is nondetect. Overlooking this minor point may result in incomplete sample data qualification in some instances.

### 4.6.18 Field Duplicate Precision Action

a. For any situation involving field duplicate imprecision, qualify as estimated (J) reported detections and (UJ) nondetects in affected samples.

**NOTE:** It is important to note in the letter text the cause of field duplicate imprecision (i.e., noncompliant %RPD or noncompliant difference between sample and duplicate results). Furthermore, laboratory duplicate data qualifications, as per Tetra Tech, NUS convention, shall be matrix-specific but otherwise "across-the-board" for TAL inorganic analyses.

### 4.6.19 Percent Solids Criteria

a. Check the percent solids for each sample to identify any samples that contain <30% solids.

### 4.6.20 Percent Solids Action

a. If any sample contains <30% solids, qualify detections and nondetected results as estimated (J) or nondetected estimated (UJ), respectively, due to the high moisture content of the sample.

### 4.7 DELIVERABLES GUIDANCE

In addition to any specific USEPA Regional requirements (e.g. data validation memorandum, data summary spreadsheets, USEPA Regional worksheets), all laboratory data package quality control summary forms, sample Form I reports, method blank Form Is, and the Chain-of-Custody report must be given to the Data Validation Quality Assurance Officer (DV/QAO) for quality assurance review.

The validator should ensure that the format of the data validation deliverable is complete and correct (in accordance with the appropriate USEPA Regional or client requirements) and that the validation narrative is free of transcription and typographical errors before submitting all requested items for DV/QAO review.
5.0 REFERENCES


APPENDIX A

SAMPLE CALCULATIONS

\[ \% R = \frac{\text{Found}(\text{value})}{\text{True}(\text{value})} \times 100 \]

Where,

**Found(value)** = Concentration (in µg/L) of each analyte measured in the analysis of the ICV, CCV, or CRI solution

**True(value)** = Concentration (in µg/L) of each analyte in the ICV, CCV, or CRI source

\[ \text{RPD} = \left| \frac{S - D}{(S+D)/2} \right| \times 100 \]

Where,

**RPD** = Relative Percent Difference

**S** = Sample Result (original)

**D** = Duplicate Result

\[ \% \text{ Difference} = \left| \frac{I - S}{I} \right| \times 100 \]

Where,

**I** = Initial Sample Result (instrument reading)

**S** = Serial Dilution Result (instrument reading x5)
Inorganic Data Review

Calculations for ICP-AES

Aqueous Samples by Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES):

The concentrations determined in the digestate are to be reported in units of μg/L:

\[
\text{Concentration (μg/L)} = C \times \frac{V_f}{V_i} \times DF
\]

Where,

\[
\begin{align*}
C &= \text{Instrument value in μg/L} \\
V_f &= \text{Final digestion volume (mL)} \\
V_i &= \text{Initial digestion volume (mL)} \\
DF &= \text{Dilution Factor}
\end{align*}
\]

Soil Samples by ICP-AES:

The concentrations determined in the digestate are to be reported on the basis of the dry weight of the sample, in units of mg/kg:

\[
\text{Concentration (dry wt.) (mg/kg)} = \frac{C \times V}{W \times S} \times DF
\]

Where,

\[
\begin{align*}
C &= \text{Concentration (mg/L)} \\
V &= \text{Final sample volume in Liters (L)} \\
W &= \text{Wet sample weight (kg)} \\
S &= \% \text{ Solids/100 (see SOW ILM05.3 Exhibit D - Introduction to Analytical Methods, Section 1.6)} \\
DF &= \text{Dilution Factor}
\end{align*}
\]

Adjusted Method Detection Limit (MDL)/Adjusted Contract Required Quantitation Limit (CRQL) Calculation:

To calculate the adjusted MDL or adjusted CRQL for water/aqueous samples, substitute the value of the MDL (μg/L) or CRQL (μg/L) into the “C” term in the equation above.

Calculate the adjusted MDL or adjusted CRQL for soil samples as follows:
Inorganic Data Review

ICP-AES

Adjusted Concentration (dry wt.)(mg/kg) = C \times \frac{W_M}{W_R} \times \frac{V_R}{V_M} \times \frac{1}{S} \times DF

Where,

C = MDL or CRQL concentration (mg/kg)

W_M = Minimum method required wet sample weight (g)

W_R = Reported wet sample weight (g)

V_M = Method required final sample volume (mL)

V_R = Reported final sample volume (mL)

S = % Solids/100 (see Exhibit D - Introduction to Analytical Methods, Section 1.6)

DF = Sample Dilution Factor
Calculations for Mercury

Aqueous Samples:

\[
\text{Hg Concentration (µg/L)} = \frac{\text{µg Hg, curve}}{\text{aliquot volume, mL}} \times \frac{1000 \text{ mL}}{1 \text{ L}}
\]

Soil Samples:

\[
\text{Hg Concentration (mg/kg)} = \frac{\text{Hg µg/g}}{W \times S} \times (0.1 \text{L})
\]

Where,

\[
\begin{align*}
C &= \text{Concentration from curve (µg/L)} \\
W &= \text{Wet sample weight (g)} \\
S &= \% \text{Solids/100 (see Exhibit D - Introduction to Analytical Methods, Section 1.6)}
\end{align*}
\]

Adjusted Method Detection Limit (MDL)/Adjusted Contract Required Quantitation Limit (CRQL) Calculation:

To calculate the adjusted MDL or adjusted CRQL for water/aqueous samples, multiply the value of the MDL (µg/L) or CRQL (µg/L) by the Dilution Factor (DF). Calculate the adjusted MDL or adjusted CRQL for soil samples as follows:

\[
\text{Adjusted Concentration (dry wt)(mg/kg)} = C \times \frac{W_M}{W_R} \times \frac{1}{S} \times DF
\]

Where,

\[
\begin{align*}
C &= \text{MDL or CRQL concentration (mg/kg)} \\
W_M &= \text{Method required wet sample weight (g)} \\
W_R &= \text{Reported wet sample weight (g)} \\
S &= \% \text{Solids/100 (see Exhibit D - Introduction to Analytical Methods, Section 1.6)} \\
DF &= \text{Dilution Factor}
\end{align*}
\]
Calculations for Cyanide

Aqueous Sample Concentration (Manual):

\[
\text{CN Concentration (\(\mu g/L\))} = \frac{A \times 1000 \text{ mL/L}}{B} \times \frac{50 \text{ mL}}{C}
\]

Where,

\(A\) = \(\mu g\) cyanide read from standard curve (per 250 mL)

\(B\) = mL of original sample for distillation (see Exhibit D - Analytical Methods for Total Cyanide Analysis, Section 10.2.2.1.1)

\(C\) = mL taken for colorimetric analysis (see Exhibit D - Analytical Methods for Total Cyanide Analysis, Section 10.3.1.1)

50 mL = Standard volume taken for colorimetric determination (see Exhibit D - Analytical Methods for Total Cyanide Analysis, Section 10.3.1.1)

1000 mL/L = Conversion mL to L

NOTE: The minimum value that can be substituted for \(A\) is the Method Detection Limit (MDL) value adjusted for volume.

Soil Sample Concentration (Manual):

\[
\text{CN Concentration (mg/kg)} = \frac{A \times \frac{50 \text{ mL}}{B}}{C \times \frac{\% \text{ solids}}{100}}
\]

Where,

\(A\) = \(\mu g\) cyanide read from standard curve (per 250 mL)

\(B\) = mL of distillate taken for colorimetric determination (see Exhibit D - Analytical Methods for Total Cyanide Analysis, Section 10.3.1.1)

\(C\) = Wet weight of original sample in g (see Exhibit D - Analytical Methods for Total Cyanide Analysis, Section 10.2.4.1.1)

50 mL = Standard volume taken for colorimetric determination (see Exhibit D - Analytical Methods for Total Cyanide Analysis, Section 10.3.1.1)

\(\% \text{ solids}\) = \(\%\) Solids (see Exhibit D - Introduction to Analytical Methods, Section 1.6)
Soil Sample Concentration (Midi):

\[
\text{CN Concentration (mg/kg)} = \frac{A \times D \times F}{B \times E}
\]

Where,

- \( A \) = \( \mu g/L \) Cyanide of sample from regression analysis curve
- \( B \) = Wet weight of original sample (see Exhibit D - Analytical Methods for Total Cyanide Analysis, Section 10.2.4.2.2)
- \( D \) = Any dilution factor necessary to bracket sample value within standard values
- \( E \) = % Solids/100 (see Exhibit D - Introduction to Analytical Methods, Section 1.6)
- \( F \) = Sample receiving solution volume (0.050 L)

NOTE: The minimum value that can be substituted for \( A \) is the MDL value.

Adjusted Method Detection Limit (MDL)/Adjusted Contract Required Quantitation Limit (CRQL) Calculation:

To calculate the adjusted aqueous MDL or adjusted aqueous CRQL for the manual colorimetric method, multiply the MDL (\( \mu g/L \)) or CRQL (\( \mu g/L \)) by 0.25 and substitute the result for the “\( A \)” term in the appropriate equation above. To calculate the adjusted aqueous MDL or adjusted aqueous CRQL for all other methods, follow the instructions in Exhibit D - Data Analysis and Calculations, Section 11.1.1, or substitute the MDL (\( \mu g/L \)) or CRQL (\( \mu g/L \)) for the “\( A \)” term in the appropriate equation above.

The adjusted soil MDL or adjusted soil CRQL for all methods shall be calculated as follows:

\[
\text{Adjusted Concentration (mg/kg)} = C \times \frac{W_M}{W_R} \times \frac{1}{S}
\]

Where,

- \( C \) = MDL or CRQL concentration (mg/kg)
- \( W_M \) = Minimum method required wet sample weight (g)
- \( W_R \) = Reported wet sample weight (g)
- \( S \) = % Solids/100 (see Exhibit D - Introduction to Analytical Methods, Section 1.6)

NOTE: For the midi-distillation, multiply the adjusted concentration value (mg/kg) obtained in the appropriate equation above by any applicable DF.
# STANDARD OPERATING PROCEDURES

TETRA TECH NUS, INC.

### Subject

GROUNDWATER SAMPLE ACQUISITION AND ONSITE WATER QUALITY TESTING

<table>
<thead>
<tr>
<th>TABLE OF CONTENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SECTION</strong></td>
</tr>
<tr>
<td>1.0 PURPOSE</td>
</tr>
<tr>
<td>2.0 SCOPE</td>
</tr>
<tr>
<td>3.0 GLOSSARY</td>
</tr>
<tr>
<td>4.0 RESPONSIBILITIES</td>
</tr>
<tr>
<td>5.0 PROCEDURES</td>
</tr>
<tr>
<td>5.1 GENERAL</td>
</tr>
<tr>
<td>5.2 SAMPLING, MONITORING, AND EVACUATION EQUIPMENT</td>
</tr>
<tr>
<td>5.3 CALCULATIONS OF WELL VOLUME</td>
</tr>
<tr>
<td>5.4 EVACUATION OF STATIC WATER (PURGING)</td>
</tr>
<tr>
<td>5.4.1 General</td>
</tr>
<tr>
<td>5.4.2 Evacuation Devices</td>
</tr>
<tr>
<td>5.5 ONSITE WATER QUALITY TESTING</td>
</tr>
<tr>
<td>5.5.1 Measurement of pH</td>
</tr>
<tr>
<td>5.5.2 Measurement of Specific Conductance</td>
</tr>
<tr>
<td>5.5.3 Measurement of Temperature</td>
</tr>
<tr>
<td>5.5.4 Measurement of Dissolved Oxygen</td>
</tr>
<tr>
<td>5.5.5 Measurement of Oxidation-Reduction Potential</td>
</tr>
<tr>
<td>5.5.6 Measurement of Turbidity</td>
</tr>
<tr>
<td>5.5.7 Measurement of Salinity</td>
</tr>
<tr>
<td>5.6 SAMPLING</td>
</tr>
<tr>
<td>5.6.1 Sampling Plan</td>
</tr>
<tr>
<td>5.6.2 Sampling Methods</td>
</tr>
<tr>
<td>5.7 LOW FLOW PURGING AND SAMPLING</td>
</tr>
<tr>
<td>5.7.1 Scope &amp; Application</td>
</tr>
<tr>
<td>5.7.2 Equipment</td>
</tr>
<tr>
<td>5.7.3 Purging and Sampling Procedure</td>
</tr>
<tr>
<td>6.0 REFERENCES</td>
</tr>
</tbody>
</table>

### ATTACHMENTS

- A. PURGING EQUIPMENT SELECTION .................................................................................. 21
- B. GROUNDWATER SAMPLE LOG SHEET ........................................................................ 24
- C. LOW FLOW PURGE DATA SHEET ............................................................................... 25
1.0 PURPOSE

The purpose of this procedure is to provide general reference information regarding the sampling of groundwater wells.

2.0 SCOPE

This procedure provides information on proper sampling equipment, onsite water quality testing, and techniques for groundwater sampling. Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling techniques. The techniques described shall be followed whenever applicable, noting that site-specific conditions or project-specific plans may require modifications to methodology.

3.0 GLOSSARY

**Conductivity** – Conductivity is a numerical expression of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions, their total concentration, mobility, valence, and relative concentrations, and on temperature of measure. Conductivity is highly dependent on temperature and should be reported at a particular temperature, i.e., 20.2 mS/cm at 14°C.

**Dissolved Oxygen (DO)** – DO levels in natural and wastewater depend on the physical, chemical, and biochemical activities in the water sample.

**Oxidation-Reduction Potential (ORP)** - A measure of the activity ratio of oxidizing and reducing species as determined by the electromotive force developed by a noble metal electrode, immersed in water, as referenced against a standard hydrogen electrode.

**pH** - The negative logarithm (base 10) of the hydrogen ion activity. The hydrogen ion activity is related to the hydrogen ion concentration, and, in a relatively weak solution, the two are nearly equal. Thus, for all practical purposes, pH is a measure of the hydrogen ion concentration.

**pH Paper** - Indicator paper that turns different colors depending on the pH of the solution to which it is exposed. Comparison with color standards supplied by the manufacturer will then give an indication of the solution’s pH.

**Salinity** – The measurement of dissolved salts in a given mass of solution. Note: most field meters determined salinity automatically from conductivity and temperature. The displayed value will be displayed in either parts per thousand (ppt) or % (e.g., 35 ppt will equal 3.5%).

**Turbidity** – Turbidity in water is caused by suspended matter, such as clay, silt, fine organic and inorganic matter. Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through the sample.

4.0 RESPONSIBILITIES

**Project Hydrogeologist** - Responsible for selecting and detailing the specific groundwater sampling techniques, onsite water quality testing (type, frequency, and location), and equipment to be used, and providing detailed input in this regard to the project plan documents. The project hydrogeologist is also responsible for properly briefing and overseeing the performance of the site sampling personnel.
Project Geologist/Field Sample Technician is primarily responsible for the proper acquisition of the groundwater samples. He/she is also responsible for the actual analyses of onsite water quality samples, as well as instrument calibration, care, and maintenance. When appropriate, such responsibilities may be performed by other qualified personnel (e.g., field technicians).

5.0 PROCEDURES

5.1 General

To be useful and accurate, a groundwater sample must be representative of the particular zone of the water being sampled. The physical, chemical, and bacteriological integrity of the sample must be maintained from the time of sampling to the time of analysis in order to keep any changes in water quality parameters to a minimum.

Methods for withdrawing samples from completed wells include the use of pumps, compressed air, bailers, and various types of samplers. The primary considerations in obtaining a representative sample of the groundwater are to avoid collection of stagnant (standing) water in the well and to avoid physical or chemical alteration of the water due to sampling techniques. In a non-pumping well, there will be little or no vertical mixing of water in the well pipe or casing, and stratification will occur. The well water in the screened section will mix with the groundwater due to normal flow patterns, but the well water above the screened section will remain isolated and become stagnant. To safeguard against collecting non-representative stagnant water in a sample, the following approach shall be followed prior to sample acquisition:

1. All monitoring wells shall be purged prior to obtaining a sample. Evacuation of three to five volumes is recommended prior to sampling. In a high-yielding groundwater formation and where there is no stagnant water in the well above the screened section, extensive evacuation prior to sample withdrawal is not as critical.

2. For wells that can be purged dry, the well shall be evacuated and allowed to recover to 75% full capacity prior to sample acquisition. If the recovery rate is fairly rapid, evacuation of more than one volume of water is required.

3. For high-yielding monitoring wells which cannot be evacuated to dryness, there is no absolute safeguard against contaminating the sample with stagnant water. One of the following techniques shall be used to minimize this possibility:
   - A submersible pump or the intake line of a surface pump or bailer shall be placed just below the water surface when removing the stagnant water and lowered as the water level drops. Three to five volumes of water shall be removed to provide reasonable assurance that all stagnant water has been evacuated. Once this is accomplished, a bailer or other approved device may be used to collect the sample for analysis.
   - The intake line of the sampling pump (or the submersible pump itself) unless otherwise directed shall be placed near the center of the screened section, and approximately one casing volume of water shall be pumped from the well at a low purge rate, equal to the well’s recovery rate (low flow sampling).

Stratification of contaminants may exist in the aquifer. Concentration gradients as a result of mixing and dispersion processes, layers of variable permeability, and the presence of separate-phase product (i.e.,
floating hydrocarbons) may cause stratification. Excessive pumping or improper sampling methods can dilute or increase the contaminant concentrations in the recovered sample compared to what is representative of the integrated water column as it naturally occurs at that point, thus the result is the collection of a non-representative sample.

5.2 Sampling, Monitoring, and Evacuation Equipment

Sample containers shall conform with the guidelines expressed in SOP SA-6.1.

The following equipment shall be on hand when sampling groundwater wells (reference SOPs SA-6.1 and SA-7.1):

- **Sample packaging and shipping equipment** - Coolers for sample shipping and cooling, chemical preservatives, appropriate sampling containers and filler, ice, labels and chain-of-custody documents.

- **Field tools and instrumentation** - Multi-parameters water quality meter capable of measuring ORP, pH, temperature, DO, specific conductance, turbidity and salinity or individual meters (as applicable), pH paper, camera and film (if appropriate), appropriate keys (for locked wells), water level indicator.

- **Pumps**
  - Shallow-well pumps: Centrifugal, bladder, suction, or peristaltic pumps with droplines, air-lift apparatus (compressor and tubing) where applicable.
  - Deep-well pumps: Submersible pump and electrical power-generating unit, or bladder pumps where applicable.

- **Other sampling equipment** - Bailers and inert line with tripod-pulley assembly (if necessary).

- **Pails** - Plastic, graduated.

- **Decontamination solutions** - Deionized water, potable water, laboratory detergents, 10% nitric acid solution (as required), and analytical-grade solvent (e.g., pesticide-grade isopropanol), as required.

Ideally, sample withdrawal equipment shall be completely inert, economical, easily cleaned, cleaned prior to use, reusable, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for well purging and sample collection.

5.3 Calculations of Well Volume

To insure that the proper volume of water has been removed from the well prior to sampling it is first necessary to know the volume of standing water in the well pipe. This volume can be easily calculated by the following method. Calculations shall be entered in the site logbook or field notebook or on a sample log sheet form (see SOP SA-6.3):

- Obtain all available information on well construction (location, casing, screens, etc.).
- Determine well or inner casing diameter.
- Measure and record static water level (depth below ground level or top of casing reference point).
- Determine depth of well by sounding using a clean, decontaminated, weighted tape measure.
• Calculate number of linear feet of static water (total depth or length of well pipe minus the depth to static water level).

• Calculate one static well volume in gallons

\[ V = \left( 0.163 \right) \left( T \right) \left( r^2 \right) \]

where:
- \( V \) = Static volume of well in gallons.
- \( T \) = Thickness of water table in the well measured in feet (i.e., linear feet of static water).
- \( r \) = Inside radius of well casing in inches.
- 0.163 = A constant conversion factor which compensates for the conversion of the casing radius from inches to feet, the conversion of cubic feet to gallons, and \( \pi \).

• Per evacuation volumes discussed above, determine the minimum amount to be evacuated before sampling.

5.4 **Evacuation of Static Water (Purging)**

5.4.1 **General**

The amount of purging a well shall receive prior to sample collection will depend on the intent of the monitoring program and the hydrogeologic conditions. Programs to determine overall quality of water resources may require long pumping periods to obtain a sample that is representative of a large volume of that aquifer. The pumped volume may be specified prior to sampling so that the sample can be a composite of a known volume of the aquifer. Alternately the well can be pumped until the parameters such as temperature, specific conductance, pH, and turbidity (as applicable), have stabilized. Onsite measurements of these parameters shall be recorded in the site logbook, field notebook, or on standardized data sheets.

5.4.2 **Evacuation Devices**

The following discussion is limited to those devices commonly used at hazardous waste sites. Attachment A provides guidance on the proper evacuation device to use for given sampling situations. Note that all of these techniques involve equipment which is portable and readily available.

**Bailers**

Bailers are the simplest evacuation devices used and have many advantages. They generally consist of a length of pipe with a sealed bottom (bucket-type bailer) or, as is more useful and favored, with a ball check-valve at the bottom. An inert line is used to lower the bailer and retrieve the sample.

Advantages of bailers include:

• Few limitations on size and materials used for bailers.
• No external power source needed.
• Bailers are inexpensive, and can be dedicated and hung in a well to reduce the chances of cross-contamination.
• Bailers are relatively easy to decontaminate.

Limitations on the use of bailers include the following:
It is time consuming to remove stagnant water using a bailer. Transfer of sample may cause aeration. Use of bailers is physically demanding, especially in warm temperatures at protection levels above Level D.

**Suction Pumps**

There are many different types of inexpensive suction pumps including centrifugal, diaphragm, and peristaltic pumps. Centrifugal and diaphragm pumps can be used for well evacuation at a fast pumping rate and for sampling at a low pumping rate. The peristaltic pump is a low volume pump that uses rollers to squeeze a flexible tubing, thereby creating suction. This tubing can be dedicated to a well to prevent cross contamination.

These pumps are all portable, inexpensive and readily available. However, because they are based on suction, their use is restricted to areas with water levels within 20 to 25 feet of the ground surface. A significant limitation is that the vacuum created by these pumps can cause significant loss of dissolved gases and volatile organics.

**Air-Lift Samplers**

This group of pump samplers uses gas pressure either in the annulus of the well or in a venturi to force the water up a sampling tube. These pumps are also relatively inexpensive. Air (or gas)-lift samplers are more suitable for well development than for sampling because the samples may be aerated, leading to pH changes and subsequent trace metal precipitation, or loss of volatile organics.

**Submersible Pumps**

Submersible pumps take in water and push the sample up a sample tube to the surface. The power sources for these samplers may be compressed gas or electricity. The operation principles vary and the displacement of the sample can be by an inflatable bladder, sliding piston, gas bubble, or impeller. Pumps are available for 2-inch-diameter wells and larger. These pumps can lift water from considerable depths (several hundred feet).

Limitations of this class of pumps include:

- They may have low delivery rates.
- Many models of these pumps are expensive.
- Compressed gas or electric power is needed.
- Sediment in water may cause clogging of the valves or eroding the impellers with some of these pumps.
- Decontamination of internal components can be difficult and time-consuming.

5.5 **Onsite Water Quality Testing**

This section describes the procedures and equipment required to measure the following parameters of an aqueous sample in the field:

- pH
- Specific Conductance
- Temperature
- Dissolved Oxygen (DO)
- Oxidation-Reduction Potential (ORP)
• Turbidity
• Salinity

This section is applicable for use in an onsite groundwater quality monitoring program to be conducted at a hazardous or nonhazardous site. The procedures and equipment described are applicable to groundwater samples and are not, in general, subject to solution interferences from color, turbidity, and colloidal material or suspended matter.

This section provides general information for measuring the parameters listed above with instruments and techniques in common use. Since instruments from different manufacturers may vary, review of the manufacturer's literature pertaining to the use of a specific instrument is required before use. Most meters used to measure field parameters require calibration on a daily basis. Refer to SOP 6.3 for example equipment calibration log.

5.5.1 Measurement of pH

5.5.1.1 General

Measurement of pH is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and wastewater treatment such as acid-base neutralization, water softening, and corrosion control is pH dependent. Likewise, the pH of leachate can be correlated with other chemical analyses to determine the probable source of contamination. It is therefore important that reasonably accurate pH measurements be taken.

Two methods are given for pH measurement: the pH meter and pH indicator paper. The indicator paper is used when only a rough estimate of the pH is required, and the pH meter when a more accurate measurement is needed. The response of a pH meter can be affected to a slight degree by high levels of colloidal or suspended solids, but the effect is usually small and generally of little significance. Consequently, specific methods to overcome this interference are not described. The response of pH paper is unaffected by solution interferences from color, turbidity, colloidal or suspended materials unless extremely high levels capable of coating or masking the paper are encountered. In such cases, use of a pH meter is recommended.

5.5.1.2 Principles of Equipment Operation

Use of pH papers for pH measurement relies on a chemical reaction caused by the acidity or alkalinity of the solution created by the addition of the water sample reacting with the indicator compound on the paper. Various types of pH papers are available, including litmus (for general acidity or alkalinity determination) and specific pH range hydrion paper.

Use of a pH meter relies on the same principle as other ion-specific electrodes. Measurement relies on establishment of a potential difference across a glass or other type of membrane in response to (in this instance, hydrogen) ion concentration across that membrane. The membrane is conductive to ionic species and, in combination with a standard or reference electrode, a potential difference proportional to the ion concentration is generated and measured.

5.5.1.3 Equipment

The following equipment is needed for taking pH measurements:

• Stand-alone portable pH meter, or combination meter (e.g., Horiba U-10), or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
• Combination electrode with polymer body to fit the above meter (alternately a pH electrode and a reference electrode can be used if the pH meter is equipped with suitable electrode inputs).

• Buffer solutions, as specified by the manufacturer.

• pH indicator paper, to cover the pH range 2 through 12.

• Manufacturer's operation manual.

5.5.1.4 Measurement Techniques for Field Determination of pH

pH Meter

The following procedure is used for measuring pH with a pH meter (meter standardization is according to manufacturer's instructions):

• Inspect the instrument and batteries prior to initiation of the field effort.

• Check the integrity of the buffer solutions used for field calibration. Buffer solutions need to be changed often as a result of degradation upon exposure to the atmosphere.

• If applicable, make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).

• Calibrate on a daily use basis (or as recommended by manufacturer) following manufacturer's instructions. Record calibration data on an equipment calibration log sheet.

• Immerse the electrode(s) in the sample. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a physical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. This must be clearly noted in the logbook.

• Read and record the pH of the sample. pH shall be recorded to the nearest 0.01 pH unit. Also record the sample temperature.

• Rinse the electrode(s) with deionized water.

• Store the electrode(s) in an appropriate manner when not in use.

Any visual observation of conditions which may interfere with pH measurement, such as oily materials, or turbidity, shall be noted.

pH Paper

Use of pH paper is very simple and requires no sample preparation, standardization, etc. pH paper is available in several ranges, including wide-range (indicating approximately pH 1 to 12), mid-range (approximately pH 0 to 6, 6 to 9, 8 to 14) and narrow-range (many available, with ranges as narrow as 1.5 pH units). The appropriate range of pH paper shall be selected. If the pH is unknown the investigation shall start with wide-range paper and proceed with successively narrower range paper until the sample pH is adequately determined.
5.5.2 Measurement of Specific Conductance

5.5.2.1 General

Conductance provides a measure of dissolved ionic species in water and can be used to identify the direction and extent of migration of contaminants in groundwater or surface water. It can also be used as a measure of subsurface biodegradation or to indicate alternate sources of groundwater contamination.

Conductivity is a numerical expression of the ability of a water sample to carry an electric current. This value depends on the total concentration of the ionized substances dissolved in the water and the temperature at which the measurement is made. The mobility of each of the various dissolved ions, their valences, and their actual and relative concentrations affect conductivity.

It is important to obtain a specific conductance measurement soon after taking a sample, since temperature changes, precipitation reactions, and absorption of carbon dioxide from the air all affect the specific conductance. Most conductivity meters in use today display specific conductance (SC); units of milliSiemens per centimeter, which is the conductivity normalized to temperature @ 25°C. This format (SC) is the required units recorded on the groundwater sample log field form (Attachment B).

5.5.2.2 Principles of Equipment Operation

An aqueous system containing ions will conduct an electric current. In a direct-current field, the positive ions migrate toward the negative electrode, while the negatively charged ions migrate toward the positive electrode. Most inorganic acids, bases and salts (such as hydrochloric acid, sodium carbonate, or sodium chloride, respectively) are relatively good conductors. Conversely, organic compounds such as sucrose or benzene, which do not dissociate in aqueous solution, conduct a current very poorly, if at all.

A conductance cell and a Wheatstone Bridge (for the measurement of potential difference) may be used for measurement of electrical resistance. The ratio of current applied to voltage across the cell may also be used as a measure of conductance. The core element of the apparatus is the conductivity cell containing the solution of interest. Depending on ionic strength of the aqueous solution to be tested, a potential difference is developed across the cell which can be converted directly or indirectly (depending on instrument type) to a measurement of specific conductance.

5.5.2.3 Equipment

The following equipment is needed for taking specific conductance (SC) measurements:

- Stand alone portable conductivity meter, or combination meter (e.g., Horiba U-10), or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Calibration solution, as specified by the manufacturer.
- Manufacturer's operation manual.

A variety of conductivity meters are available which may also be used to monitor salinity and temperature. Probe types and cable lengths vary, so equipment must be obtained to meet the specific requirement of the sampling program.

5.5.2.4 Measurement Techniques for Specific Conductance

The steps involved in taking specific conductance measurements are listed below (standardization is according to manufacturer's instructions):
• Check batteries and calibrate instrument before going into the field.

• Calibrate on a daily use basis (or as recommended by manufacturer), according to the manufacturer's instructions and record all pertinent information on an equipment calibration log sheet. Potassium chloride solutions with a SC closest to the values expected in the field shall be used for calibration.

• Rinse the cell with one or more portions of the sample to be tested or with deionized water.

• Immerse the electrode in the sample and measure the conductivity.

• Read and record the results in a field logbook or sample log sheet.

• Rinse the electrode with deionized water.

If the specific conductance measurements become erratic, recalibrate the instrument and see the manufacturer's instructions for details.

5.5.3 Measurement of Temperature

5.5.3.1 General

In combination with other parameters, temperature can be a useful indicator of the likelihood of biological action in a water sample. It can also be used to trace the flow direction of contaminated groundwater. Temperature measurements shall be taken in-situ, or as quickly as possible in the field. Collected water samples may rapidly equilibrate with the temperature of their surroundings.

5.5.3.2 Equipment

Temperature measurements may be taken with alcohol-toluene, mercury filled, dial-type thermometers or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22). In addition, various meters such as specific conductance or dissolved oxygen meters, which have temperature measurement capabilities, may also be used. Using such instrumentation along with suitable probes and cables, in-situ measurements of temperature at great depths can be performed.

5.5.3.3 Measurement Techniques for Water Temperature

If a thermometer is used to determine the temperature for a water sample:

• Immerse the thermometer in the sample until temperature equilibrium is obtained (1-3 minutes). To avoid the possibility of cross-contamination, the thermometer shall not be inserted into samples which will undergo subsequent chemical analysis.

• Record values in a field logbook or sample log sheet.

If a temperature meter or probe is used, the instrument shall be calibrated according to manufacturer's recommendations.
5.5.4 Measurement of Dissolved Oxygen

5.5.4.1 General

Dissolved oxygen (DO) levels in natural water and wastewater depend on the physical, chemical and biochemical activities in the water body. Conversely, the growth of many aquatic organisms as well as the rate of corrosivity, are dependent on the dissolved oxygen concentration. Thus, analysis for dissolved oxygen is a key test in water pollution and waste treatment process control. If at all possible, DO measurements shall be taken in-situ, since concentration may show a large change in a short time if the sample is not adequately preserved.

The monitoring method discussed herein is limited to the use of dissolved oxygen meters only. Chemical methods of analysis (i.e., Winkler methods) are available, but require more equipment and greater sample manipulation. Furthermore, DO meters, using a membrane electrode, are suitable for highly polluted waters, because the probe is completely submersible, and is not susceptible to interference caused by color, turbidity, colloidal material or suspended matter.

5.5.4.2 Principles of Equipment Operation

Dissolved oxygen probes are normally electrochemical cells that have two solid metal electrodes of different nobility immersed in an electrolyte. The electrolyte is retained by an oxygen-permeable membrane. The metal of highest nobility (the cathode) is positioned at the membrane. When a suitable potential exists between the two metals, reduction of oxygen to hydroxide ion \((\text{OH}^-)\) occurs at the cathode surface. An electrical current is developed that is directly proportional to the rate of arrival of oxygen molecules at the cathode.

Since the current produced in the probe is directly proportional to the rate of arrival of oxygen at the cathode, it is important that a fresh supply of sample always be in contact with the membrane. Otherwise, the oxygen in the aqueous layer along the membrane is quickly depleted and false low readings are obtained. It is therefore necessary to stir the sample (or the probe) constantly to maintain fresh solution near the membrane interface. Stirring, however, shall not be so vigorous that additional oxygen is introduced through the air-water interface at the sample surface. To avoid this possibility, some probes are equipped with stirrers to agitate the solution near the probe, while leaving the surface of the solution undisturbed.

Dissolved oxygen probes are relatively unaffected by interferences. Interferences that can occur are reactions with oxidizing gases (such as chlorine) or with gases such as hydrogen sulfide, which are not easily depolarized from the indicating electrode. If a gaseous interference is suspected, it shall be noted in the field log book and checked if possible. Temperature variations can also cause interference because probes exhibit temperature sensitivity. Automatic temperature compensation is normally provided by the manufacturer.

5.5.4.3 Equipment

The following equipment is needed to measure dissolved oxygen concentration:

- Stand alone portable dissolved oxygen meter, or combination meter (e.g., Horiba U-10), or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Sufficient cable to allow the probe to contact the sample.
- Manufacturer's operation manual.
5.5.4.4 Measurement Techniques for Dissolved Oxygen Determination

Probes differ as to specifics of use. Follow the manufacturer’s instructions to obtain an accurate reading. The following general steps shall be used to measure the dissolved oxygen concentration:

- The equipment shall be calibrated and have its batteries checked before going to the field.
- The probe shall be conditioned in a water sample for as long a period as practical before use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.
- The instrument shall be calibrated in the field according to manufacturer’s recommendations or in a freshly air-saturated water sample of known temperature.
- Record all pertinent information on an equipment calibration sheet.
- Rinse the probe with deionized water.
- Immerse the probe in the sample. Be sure to provide for sufficient flow past the membrane by stirring the sample. Probes without stirrers placed in wells can be moved up and down.
- Record the dissolved oxygen content and temperature of the sample in a field logbook or sample log sheet.
- Rinse the probe with deionized water.
- Recalibrate the probe when the membrane is replaced, or as needed. Follow the manufacturer’s instructions.

Note that in-situ placement of the probe is preferable, since sample handling is not involved. This however, may not always be practical.

Special care shall be taken during sample collection to avoid turbulence which can lead to increased oxygen solubilization and positive test interferences.

5.5.5 Measurement of Oxidation-Reduction Potential

5.5.5.1 General

The oxidation-reduction potential (ORP) provides a measure of the tendency of organic or inorganic compounds to exist in an oxidized state. The ORP parameter therefore provides evidence of the likelihood of anaerobic degradation of biodegradable organics or the ratio of activities of oxidized to reduced species in the sample.

5.5.5.2 Principles of Equipment Operation

When an inert metal electrode, such as platinum, is immersed in a solution, a potential is developed at that electrode depending on the ions present in the solution. If a reference electrode is placed in the same solution, an ORP electrode pair is established. This electrode pair allows the potential difference between the two electrodes to be measured and is dependent on the concentration of the ions in solution. By this measurement, the ability to oxidize or reduce species in solution may be determined. Supplemental
measurements, such as dissolved oxygen, may be correlated with ORP to provide a knowledge of the quality of the solution, water, or wastewater.

5.5.5.3 Equipment

The following equipment is needed for measuring the oxidation-reduction potential of a solution:

- Combination meters with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Reference solution as specified by the manufacturer.
- Manufacturer's operation manual.

5.5.5.4 Measurement Techniques for Oxidation-Reduction Potential

The following procedure is used for measuring oxidation-reduction potential:

- The equipment shall be checked using the manufacturer's recommended reference solution and have its batteries checked before going to the field.

- Thoroughly rinse the electrode with deionized water.

- If the probe does not respond properly to the recommended reference solution, then verify the sensitivity of the electrodes by noting the change in millivolt reading when the pH of a test solution is altered. The ORP will increase when the pH of a test solution decreases, and the ORP will decrease if the test solution pH is increased. Place the sample in a clean container and agitate the sample. Insert the electrodes and note the ORP drops sharply when the caustic is added (i.e., pH is raised) thus indicating the electrodes are sensitive and operating properly. If the ORP increases sharply when the caustic is added, the polarity is reversed and must be corrected in accordance with the manufacturer's instructions or the probe should be replaced.

- Record all pertinent information on an equipment calibration log sheet.

5.5.6 Measurement of Turbidity

5.5.6.1 General

Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through the sample. Turbidity in water is caused by suspended matter, such as clay, silt, finely divided organic and inorganic matter, soluble colored organic compounds, and microscopic organisms, including plankton.

It is important to obtain a turbidity reading immediately after taking a sample, since irreversible changes in turbidity may occur if the sample is stored too long.

5.5.6.2 Principles of Equipment Operation

Turbidity is measured by the Nephelometric Method. This method is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. The higher the scattered light intensity, the higher the turbidity.

Formazin polymer is used as the reference turbidity standard suspension because of its ease of preparation combined with a higher reproducibility of its light-scattering properties than clay or turbid
natural water. The turbidity of a specified concentration of formazin suspension is defined as 40 nephelometric units. This same suspension has an approximate turbidity of 40 Jackson units when measured on the candle turbidimeter. Therefore, nephelometric turbidity units (NTU) based on the formazin preparation will approximate units derived from the candle turbidimeter but will not be identical to them.

5.5.6.3 **Equipment**

The following equipment is needed for turbidity measurement:

- Light meter (e.g., LaMotte 2020) which calibrates easily using test cells with standards of 0.0 NTUs, and 10 NTUs, or combination meter (e.g., Horiba U-10), or combination meter equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).

- Calibration solution, as specified by the manufacturer.

- Manufacturer's operation manual.

5.5.6.4 **Measurement Techniques for Turbidity**

The steps involved in taking turbidity measurements utilizing an electrode (e) or light meter (I) are listed below (standardization is according to manufacturer's instructions):

- Check batteries and calibrate instrument before going into the field.

- Check the expiration date (etc.) of the solutions used for field calibration.

- Calibrate on a daily use basis, according to the manufacturer's instructions and record all pertinent information on an equipment calibration log sheet.

- Rinse the electrode with one or more portions of the sample to be tested or with deionized water (applies to "e").

- Fill the light meters glass test cell with ~5 ml of sample, screw on cap, wipe off glass, place test cell in light meter and close the lid (applies to "I").

- Immerse the electrode in the sample and measure the turbidity (applies to "e").

- The reading must be taken immediately as suspended solids will settle over time resulting in a lower, inaccurate turbidity reading.

- Read and record the results in a field logbook or sample log sheet. Include a physical description of the sample, including color, qualitative estimate of turbidity, etc.

- Rinse the electrode or test cell with deionized water.

5.5.7 **Measurement of Salinity**

5.5.7.1 **General**

Salinity is a unitless property of industrial and natural waters. It is the measurement of dissolved salts in a given mass of solution. Note: Most field meters determined salinity automatically from conductivity and
temperature. The displayed value will be displayed in either parts per thousand (ppt) or % (e.g., 35 ppt will equal 3.5%).

5.5.7.2 Principles of Equipment Operation

Salinity is determined automatically from the meter’s conductivity and temperature readings according to algorithms (found in Standard methods for the Examination of Water and Wastewater). Depending on the meter, the results are displayed in either ppt or %. The salinity measurements are carried out in reference to the conductivity of standard seawater (corrected to $S = 35$).

5.5.7.3 Equipment

The following equipment is needed for Salinity measurements:

- Multi-parameter water quality meter capable of measuring conductive, temperature and converting them to salinity (e.g., Horiba U-10 or YSI 600 series).
- Calibration Solution, as specified by the manufacturer.
- Manufacturer’s operation manual.

5.5.7.4 Measurement Techniques for Salinity

The steps involved in taking Salinity measurements are listed below (standardization is according to manufacturer’s instructions):

- Check batteries and calibrate before going into the field.
- Check the expiration date (etc.) of the solutions used for field calibration.
- Calibrate on a daily use basis, according to the manufacturer’s instructions and record all pertinent information on an equipment calibration log sheet.
- Rinse the cell with the sample to be tested.
- Immerse the multi-probe in the sample and measure the salinity. Read and record the results in a field logbook or sample log sheet.
- Rinse the probes with deionized water.

5.6 Sampling

5.6.1 Sampling Plan

The sampling approach consisting of the following, shall be developed as part of the project plan documents which are approved prior to beginning work in the field:

- Background and objectives of sampling.
- Brief description of area and waste characterization.
- Identification of sampling locations, with map or sketch, and applicable well construction data (well size, depth, screened interval, reference elevation).
• Intended number, sequence volumes, and types of samples. If the relative degrees of contamination between wells is unknown or insignificant, a sampling sequence which facilitates sampling logistics may be followed. Where some wells are known or strongly suspected of being highly contaminated, these shall be sampled last to reduce the risk of cross-contamination between wells as a result of the sampling procedures.

• Sample preservation requirements.

• Work schedule.

• List of team members.

• List of observers and contacts.

• Other information, such as the necessity for a warrant or permission of entry, requirement for split samples, access problems, location of keys, etc.

5.6.2 Sampling Methods

The collection of a groundwater sample consists of the following steps:

1. The site Health & Safety Officer (or designee) will first open the well cap and use volatile organic detection equipment (PID or FID) on the escaping gases at the well head to determine the need for respiratory protection.

2. When proper respiratory protection has been donned, sound the well for total depth and water level (using clean equipment) and record these data on a groundwater sampling log sheet (see Attachment B); then calculate the fluid volume in the well pipe (as previously described in this SOP).

3. Calculate well volume to be removed as stated in Section 5.3.

4. Select the appropriate purging equipment (see Attachment A). If an electric submersible pump with packer is chosen, go to Step 10.

5. Lower the purging equipment or intake into the well to a short distance below the water level and begin water removal. Collect the purged water and dispose of it in an acceptable manner (as applicable). Lower the purging device, as required, to maintain submergence.

6. Measure the rate of discharge frequently. A graduated bucket or cylinder and stopwatch are most commonly used.

7. Observe the peristaltic pump intake for degassing "bubbles." If bubbles are abundant and the intake is fully submerged, this pump is not suitable for collecting samples for volatile organics.

8. Purge a minimum of three to five casing volumes before sampling. In low-permeability strata (i.e., if the well is pumped to dryness), one volume will suffice. Purged water shall be collected in a designated container and disposed in an acceptable manner.

9. If sampling using a pump, lower the pump intake to midscreen (or the middle of the open section in uncased wells) and collect the sample. If sampling with a bailer, lower the bailer to just below the water surface.
10. (For pump and packer assembly only). Lower the assembly into the well so that the packer is positioned just above the screen or open section. Inflate the packer. Purge a volume equal to at least twice the screened interval (or unscreened open section volume below the packer) before sampling. Packers shall always be tested in a casing section above ground to determine proper inflation pressures for good sealing.

11. In the event that recovery time of the well is very slow (e.g., 24 hours or greater), sample collection can be delayed until the following day. If the well has been purged early in the morning, sufficient water may be standing in the well by the day's end to permit sample collection. If the well is incapable of producing a sufficient volume of sample at any time, take the largest quantity available and record this occurrence in the site logbook.

12. Fill sample containers (preserve and label as described in SOP SA-6.1).

13. Replace the well cap and lock as appropriate. Make sure the well is readily identifiable as the source of the samples.


15. Decontaminate equipment as described in SOP SA-7.1.

5.7 **Low Flow Purging and Sampling**

5.7.1 **Scope & Application**

Low flow purging and sampling techniques are sometimes required for groundwater sampling activities. The purpose of low flow purging and sampling is to collect groundwater samples that contain "representative" amounts of mobile organic and inorganic constituents in the vicinity of the selected open well interval, at or near natural flow conditions. The minimum stress procedure emphasizes negligible water level drawdown and low pumping rates in order to collect samples with minimal alterations in water chemistry. This procedure is designed primarily to be used in wells with a casing diameter of 1 inch or more and a saturated screen, or open interval, length of ten feet or less. Samples obtained are suitable for analyses of common types of groundwater contaminants (volatile and semi-volatile organic compounds, pesticides, PCBs, metals and other inorganic ions [cyanide, chloride, sulfate, etc.]). This procedure is not designed to collect non-aqueous phase liquids samples from wells containing light or dense non-aqueous phase liquids (LNAPLs or DNAPLs), using the low flow pumps.

The procedure is flexible for various well construction types and groundwater yields. The goal of the procedure is to obtain a turbidity level of less than 10 NTU and to achieve a water level drawdown of less than 0.3 feet during purging and sampling. If these goals cannot be achieved, sample collection can take place provided the remaining criteria in this procedure are met.

5.7.2 **Equipment**

The following equipment is required (as applicable) for low flow purging and sampling:

- Adjustable rate, submersible pump (e.g., centrifugal or bladder pump constructed of stainless steel or Teflon).
- Disposable clear plastic bottom filling bailers may be used to check for and obtain samples of LNAPLs or DNAPLs.
Tubing - Teflon, Teflon-lined polyethylene, polyethylene, PVC, Tygon, or stainless steel tubing can be used to collect samples for analysis, depending on the analyses to be performed and regulatory requirements.

- Water level measuring device, 0.01 foot accuracy, (electronic devices are preferred for tracking water level drawdown during all pumping operations).
- Interface probe, if needed.
- Flow measurement supplies.
- Power source (generator, nitrogen tank, etc.), If a gasoline generator is used, it must be located downwind and at a safe distance from the well so that the exhaust fumes do not contaminate the samples.
- Indicator parameter monitoring instruments - pH, turbidity, specific conductance, and temperature. Use of a flow-through cell is recommended. Optional indicators - ORP, salinity, and dissolved oxygen, flow-through cell is required. Standards to perform field calibration of instruments.
- Decontamination supplies.
- Logbook(s), and other forms (see Attachments B and C).
- Sample Bottles.
- Sample preservation supplies (as required by the analytical methods).
- Sample tags and/or labels.
- Well construction data, location map, field data from last sampling event (if available).
- Field Sampling Plan.
- PID or FID instrument for measuring VOCs (volatile organic compounds).

### 5.7.3 Purging and Sampling Procedure

Open monitoring well, measure head space gases using PID/FID. If there is an indication of off gassing when opening the well, wait 3-5 minutes to permit water level an opportunity to reach equilibrium.

Measure and record the water level immediately prior to placing the pump in the well.

Lower pump or tubing slowly into the well so that the pump intake is located at the center of the saturated screen length of the well. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of sediment that may be present in the bottom of the well. Collection of turbidity-free water samples may be difficult if there is three feet or less of standing water in the well.

Start with the initial pump rate set at approximately 0.1 liters/minute. Use a graduated cylinder and stopwatch to measure the pumping rate. Adjust pumping rates as necessary to prevent drawdown from exceeding 0.3 feet during purging. If no drawdown is noted, the pump rate may be increased (to a max of 0.4 liters/minute) to expedite the purging and sampling event. The pump rate will be reduced if turbidity is greater than 10 NTUs after all other field parameters have stabilized. If groundwater is drawn down below...
the top of the well screen, purging will cease or the well will be pumped to dryness and the well will be allowed to recover before purging continues. Slow recovering wells will be identified and purged at the beginning of the workday. If possible, samples will be collected from these wells within the same workday and no later than 24 hours after the start of purging.

Measure the well water level using the water level meter every 5 to 10 minutes. Record the well water level on the Low-Flow Purge Data Form (Attachment C).

Record on the Low-Flow Purge Data Form every 5 to 10 minutes the water quality parameters (pH, specific conductance, temperature, turbidity, oxidation-reduction potential, dissolved oxygen and salinity or as specified by the approved site specific work plan) measured by the water quality meter and turbidity meter. If the cell needs to be cleaned during purging operations, continue pumping (allow the pump to discharge into a container) and disconnect the cell. Rinse the cell with distilled/deionized water. After cleaning is completed, reconnect the flow-through cell and continue purging. Document the cell cleaning on the Low-Flow Purge Data Form.

Measure the flow rate using a graduated cylinder. Remeasure the flow rate any time the pump rate is adjusted.

During purging, check for the presence of bubbles in the flow-through cell. The presence of bubbles is an indication that connections are not tight. If bubbles are observed, check for loose connections.

After stabilization is achieved, sampling can begin when a minimum of two saturated screen volumes have been removed and three consecutive readings, taken at 5 to 10 minute intervals, are within the following limits:

- pH ±0.2 standard units
- Specific conductance ±10%
- Temperature ±10%
- Turbidity less than 10 NTUs
- Dissolved oxygen ±10%

If the above conditions have still not been met after the well has been purged for 4 hours, purging will be considered complete and sampling can begin. Record the final well stabilization parameters from the Low-Flow Purge Data Form onto the Groundwater Sample Log Form.

VOC samples are preferably collected first, directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the water column in the pump tubing collapses (water does not completely fill the tubing) before exiting the tubing, use one of the following procedures to collect VOC samples: (1) Collect the non-VOCs samples first, then increase the flow rate incrementally until the water column completely fills the tubing, collect the sample and record the new flow rate; (2) reduce the diameter of the existing tubing until the water column fills the tubing either by adding a connector (Teflon or stainless steel), or clamp which should reduce the flow rate by constricting the end of the tubing; (3) insert a narrow diameter Teflon tube into the pump's tubing so that the end of the tubing is in the water column and the other end of the tubing protrudes beyond the pump's tubing, collect sample from the narrow diameter tubing.

Prepare samples for shipping as per SOP SA-6.1.
6.0 REFERENCES


# ATTACHMENT A

## PURGING EQUIPMENT SELECTION

<table>
<thead>
<tr>
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<td>6-Inch</td>
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<td>Manufacturer</td>
<td>Model Name/Number</td>
<td>Principle of Operation</td>
<td>Maximum Outside Diameter/Length (Inches)</td>
<td>Construction Materials (w/lines and Tubing)</td>
<td>Lift Range (ft)</td>
<td>Delivery Rates or Volumes</td>
<td>1982 Price (Dollars)</td>
<td>Comments</td>
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<td>BarCad Systems, Inc.</td>
<td>BarCad Sampler</td>
<td>Dedicated; gas drive (positive displacement)</td>
<td>1.5/16</td>
<td>PE, brass, nylon, aluminum oxide</td>
<td>0-150 with std. tubing</td>
<td>1 liter for each 10-15 feet of submergence</td>
<td>$220-350</td>
<td>Requires compressed gas; custom sizes and materials available; acts as piezometer.</td>
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<tr>
<td>Cole-Parmer Inst. Co.</td>
<td>Master Flex 7570 Portable Sampling Pump</td>
<td>Portable; peristaltic (suction)</td>
<td>&lt;1.0/NA</td>
<td>(not submersible) Tygon®, silicone Viton®</td>
<td>0-30</td>
<td>670 mL/min with 7015-20 pump head</td>
<td>$500-600</td>
<td>AC/DC; variable speed control available; other models may have different flow rates.</td>
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<tr>
<td>ECO Pump Corp.</td>
<td>SAMPLifier</td>
<td>Portable; venturi</td>
<td>&lt;1.5 or &lt;2.0/NA</td>
<td>PP, PE, PVC, SS, Teflon®, Tefzel®</td>
<td>0-100</td>
<td>0-500 mL/min depending on lift</td>
<td>$400-700</td>
<td>AC, DC, or gasoline-driven motors available; must be primed.</td>
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<td>Geitek Corp.</td>
<td>Bailer 219-4</td>
<td>Portable; grab (positive displacement)</td>
<td>1.66/38</td>
<td>Teflon®</td>
<td>No limit</td>
<td>1,075 mL</td>
<td>$120-135</td>
<td>Other sizes available.</td>
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<td>GeoEngineering, Inc.</td>
<td>GEO-MONITOR</td>
<td>Dedicated; gas drive (positive displacement)</td>
<td>1.5/16</td>
<td>PE, PP, PVC, Viton®</td>
<td>Probably 0-150</td>
<td>Approximately 1 liter for each 10 feet of submergence</td>
<td>$185</td>
<td>Acts as piezometer; requires compressed gas.</td>
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<td>Industrial and Environmental Analysts, Inc. (IEA)</td>
<td>Aquarius</td>
<td>Portable; bladder (positive displacement)</td>
<td>1.75/43</td>
<td>SS, Teflon®, Viton®</td>
<td>0-250</td>
<td>0-2,800 mL/min</td>
<td>$1,500-3,000</td>
<td>Requires compressed gas; other models available; AC, DC, manual operation possible.</td>
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<td>IEA</td>
<td>Syringe Sampler</td>
<td>Portable; grab (positive displacement)</td>
<td>1.75/43</td>
<td>SS, Teflon®</td>
<td>No limit</td>
<td>850 mL sample volume</td>
<td>$1,100</td>
<td>Requires vacuum and/or pressure from hand pump.</td>
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<td>Instrument Specialties Co. (ISCO)</td>
<td>Model 2600 Well Sampler</td>
<td>Portable; bladder (positive displacement)</td>
<td>1.75/50</td>
<td>PC, silicone, Teflon®, PP, PE, Detrin®, acetal</td>
<td>0-150</td>
<td>0-7,500 mL/min</td>
<td>$990</td>
<td>Requires compressed gas (40 psi minimum).</td>
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<tr>
<td>Keck Geophysical Instruments, Inc.</td>
<td>SP-81 Submersible Sampling Pump</td>
<td>Portable; helical rotor (positive displacement)</td>
<td>1.75/25</td>
<td>SS, Teflon®, PP, EPDM, Viton®</td>
<td>0-160</td>
<td>0-4,500 mL/min</td>
<td>$3,500</td>
<td>DC operated.</td>
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<td>Leonard Mold and Die Works, Inc.</td>
<td>GeoFilter Small Diameter Well Pump (#5000)</td>
<td>Portable; bladder (positive displacement)</td>
<td>1.75/38</td>
<td>SS, Teflon®, PC, Neoprene®</td>
<td>0-400</td>
<td>0-3,500 mL/min</td>
<td>$1,400-1,500</td>
<td>Requires compressed gas (55 psi minimum); pneumatic or AC/DC control module.</td>
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<tr>
<td>Oil Recovery Systems, Inc.</td>
<td>Surface Sampler</td>
<td>Portable; grab (positive displacement)</td>
<td>1.75/12</td>
<td>acrylic, Detrin®</td>
<td>No limit</td>
<td>Approximately 250 mL</td>
<td>$125-160</td>
<td>Other materials and models available; for measuring thickness of &quot;floating&quot; contaminants.</td>
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<tr>
<td>O.E.D. Environmental Systems, Inc.</td>
<td>WELL WIZARD Monitoring System (P-100)</td>
<td>Dedicated; bladder (positive displacement)</td>
<td>1.66/36</td>
<td>PVC</td>
<td>0-230</td>
<td>0-2,000 mL/min</td>
<td>$300-400</td>
<td>Requires compressed gas; piezometric level indicator; other materials available.</td>
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### ATTACHMENT A

**PURGING EQUIPMENT SELECTION**

**PAGE 3**

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Model Name/Number</th>
<th>Principle of Operation</th>
<th>Maximum Outside Diameter/Length (Inches)</th>
<th>Construction Materials (w/lines and tubing)</th>
<th>Lift Range (ft)</th>
<th>Delivery Rates or Volumes</th>
<th>1982 Price (Dollars)</th>
<th>Comments</th>
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<tr>
<td>Randolph Austin Co.</td>
<td>Model 500</td>
<td>Portable, peristaltic (suction)</td>
<td>&lt;0.5/NA (Not submersible) Rubber, Tygon®, or Neoprene®</td>
<td>0-30</td>
<td>See comments</td>
<td>$1,200-1,300</td>
<td>Flow rate dependent on motor and tubing selected; AC operated; other models available.</td>
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<tr>
<td>Robert Bennett Co.</td>
<td>Model 180</td>
<td>Portable; piston (positive displacement)</td>
<td>1.8/22 SS, Teflon®, Delrin® PP, Viton®, acrylic, PE</td>
<td>0-500</td>
<td>0-1,800 mL/min</td>
<td>$2,600-2,700</td>
<td>Requires compressed gas; water level indicator and flow meter; custom models available.</td>
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<tr>
<td>Slope Indicator Co. (SINCO)</td>
<td>Model 514124</td>
<td>Portable; gas drive (positive displacement)</td>
<td>1.9/18 PVC, nylon</td>
<td>0-1,100</td>
<td>250 mL/flushing cycle</td>
<td>$250-350</td>
<td>Requires compressed gas; SS available; piezometer model available; dedicated model available.</td>
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<tr>
<td>Solinst Canada Ltd.</td>
<td>5W Water Sampler</td>
<td>Portable; grab (positive displacement)</td>
<td>1.9/27 PVC, brass, nylon, Neoprene®</td>
<td>0-330</td>
<td>500 mL</td>
<td>$1,300-1,600</td>
<td>Requires compressed gas; custom models available.</td>
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<td>TIMCO Mfg. Co., Inc.</td>
<td>Std. Bailer</td>
<td>Portable; grab (positive displacement)</td>
<td>1.66/Custom PVC, PP</td>
<td>No limit</td>
<td>250 mL/ft of bailer</td>
<td>$20-60</td>
<td>Other sizes, materials, models available; optional bottom-emptying device available; no solvents used.</td>
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<td>TIMCO</td>
<td>Air or Gas Lift Sampler</td>
<td>Portable; gas drive (positive displacement)</td>
<td>1.66/30 PVC, Tygon®, Teflon®</td>
<td>0-150</td>
<td>350 mL/flushing cycle</td>
<td>$100-200</td>
<td>Requires compressed gas; other sizes, materials, models available; no solvents used.</td>
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<td>Tole Devices Co.</td>
<td>Sampling Pump</td>
<td>Portable; bladder (positive displacement)</td>
<td>1.38/48 SS, silicone, Delrin®, Tygon®</td>
<td>0-125</td>
<td>0-4,000 mL/min</td>
<td>$800-1,000</td>
<td>Compressed gas required; DC control module; custom built.</td>
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</table>

**Construction Material Abbreviations:**

| PE | Polyethylene   |
| PP | Polypropylene  |
| PVC| Polyvinyl chloride |
| SS | Stainless steel    |
| PC | Polycarbonate   |
| EPDM | Ethylene-propylene diene (synthetic rubber) |

**Other Abbreviations:**

| NA | Not applicable |
| AC | Alternating current |
| DC | Direct current |

**NOTE:** Other manufacturers market pumping devices which could be used for groundwater sampling, though not expressly designed for this purpose. The list is not meant to be all-inclusive and listing does not constitute endorsement for use. Information in the table is from sales literature and/or personal communication. No skimmer, scavenger-type, or high-capacity pumps are included.

**Source:** Barcelona et al., 1983.
# GROUNDWATER SAMPLE LOG SHEET

## Project Site Name: __________________________ Sample ID No.: __________________________

### Domestic Well Data

- [ ] Domestic Well Data
- [X] Monitoring Well Data
- [ ] Other Well Type:

### QA Sample Type:

- [ ] Low Concentration
- [ ] High Concentration

### Sample Location:

### C.O.C. No.:

### Type of Sample:

### Date:

### Time:

### Method:

### RIS:

### Project Site Name:

### Sample ID No.:

### Sample Location:

### C.O.C. No.:

### Type of Sample:

### Date:

### Time:

### Method:

### Monitor Reading (pg/L):

### Wall Casing Diameter & Material Type:

### Total Well Depth (TD):

### Static Water Level (WL):

### One Casing Volume (gal/L):

### Start Purge (hrs):

### End Purge (hrs):

### Total Purge Time (min):

### Total Vol. Purged (gal/L):

### Analysis:

### Preservative:

### Container Requirements:

### Collected:

### Observations/Notes:

### Circle if applicable:

### MS/MSD

### Duplicate ID No.:

### Signature(s):
## LOW FLOW PURGE DATA SHEET

**PROJECT SITE NAME:**

**PROJECT NUMBER:**

**WELL ID.:**

**DATE:**

<table>
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<tr>
<th>Time (Hrs.)</th>
<th>Water Level (ft. below TOC)</th>
<th>Flow (mL/Min.)</th>
<th>pH</th>
<th>S. Cond. (μS/cm)</th>
<th>Turb. (NTU)</th>
<th>DO (mg/L)</th>
<th>Temp. (Celsius)</th>
<th>ORP (mV)</th>
<th>Salinity (% or ppt)</th>
<th>Comments</th>
</tr>
</thead>
</table>

**SIGNATURE(S):**

**PAGE OF**
TABLE OF CONTENTS

SECTION

1.0 PURPOSE .......................................................................................................................... 2
2.0 SCOPE ............................................................................................................................... 2
3.0 GLOSSARY ......................................................................................................................... 2
4.0 RESPONSIBILITIES ............................................................................................................. 3
5.0 PROCEDURES ..................................................................................................................... 3
  5.1 SAMPLE CONTAINERS ..................................................................................................... 3
  5.2 SAMPLE PRESERVATION ................................................................................................. 3
  5.2.1 Overview ......................................................................................................................... 4
  5.2.2 Preparation and Addition of Reagents ........................................................................... 4
  5.3 FIELD FILTRATION ......................................................................................................... 4
  5.4 SAMPLE PACKAGING AND SHIPPING ............................................................................ 6
    5.4.1 Environmental Samples ................................................................................................. 6
6.0 REFERENCES ...................................................................................................................... 7

ATTACHMENTS

A  GENERAL SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS................. 8
B  ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES,  
    AND HOLDING TIMES ......................................................................................................... 9
1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide information on sample preservation, packaging, and shipping procedures to be used in handling environmental samples submitted for chemical constituent, biological, or geotechnical analysis. Sample chain-of-custody procedures and other aspects of field documentation are addressed in SOP SA-6.3. Sample identification is addressed in SOP CT-04.

2.0 SCOPE

This procedure describes the appropriate containers to be used for samples depending on the analyses to be performed, and the steps necessary to preserve the samples when shipped off site for chemical analysis.

3.0 GLOSSARY

Hazardous Material - A substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated. Under 49 CFR, the term includes hazardous substances, hazardous wastes, marine pollutants, and elevated temperature materials, as well as materials designated as hazardous under the provisions of §172.101 and §172.102 and materials that meet the defining criteria for hazard classes and divisions in Part 173. With slight modifications, IATA has adopted DOT "hazardous materials" as IATA "Dangerous Goods."

Hazardous Waste - Any substance listed in 40 CFR, Subpart D (§261.30 et seq.), or otherwise characterized as ignitable, corrosive, reactive, or toxic (as defined by Toxicity Characteristic Leaching Procedure, TCLP, analysis) as specified under 40 CFR, Subpart C (§261.20 et seq.), that would be subject to manifest requirements specified in 40 CFR 262. Such substances are defined and regulated by EPA.

Marking - A descriptive name, identification number, instructions, cautions, weight, specification or UN marks, or combination thereof required on outer packaging of hazardous materials.

n.o.i - Not otherwise indicated (may be used interchangeably with n.o.s.).

n.o.s. - Not otherwise specified.

Packaging - A receptacle and any other components or materials necessary for compliance with the minimum packaging requirements of 49 CFR 174, including containers (other than freight containers or overpacks), portable tanks, cargo tanks, tank cars, and multi-unit tank-car tanks to perform a containment function in conformance with the minimum packaging requirements of 49 CFR 173.24(a) & (b).

Placard - Color-coded, pictorial sign which depicts the hazard class symbol and name and which is placed on the side of a vehicle transporting certain hazardous materials.

Common Preservatives:

- Hydrochloric Acid - HCl
- Sulfuric Acid - H₂SO₄
- Nitric Acid - HNO₃
- Sodium Hydroxide - NaOH
Other Preservatives

- Zinc Acetate
- Sodium Thiosulfate - Na₂S₂O₃

Normality (N) - Concentration of a solution expressed as equivalent per liter, an equivalent being the amount of a substance containing 1 gram-atom of replaceable hydrogen or its equivalent.

Reportable Quantity (RQ) - For the purposes of this SOP, means the quantity specified in column 3 of the Appendix to DOT 49 CFR §172.101 for any material identified in column 1 of the appendix. A spill greater than the amount specified must be reported to the National Response Center.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the location and time of collection.

4.0 RESPONSIBILITIES

Field Operations Leader - Directly responsible for the bottling, preservation, labeling, packaging, shipping, and custody of samples up to and including release to the shipper.

Field Samplers - Responsible for initiating the Chain-of-Custody Record (per SOP SA-6.3), implementing the packaging and shipping requirements, and maintaining custody of samples until they are relinquished to another custodian or to the shipper.

5.0 PROCEDURES

Sample identification, labeling, documentation, and chain-of-custody are addressed by SOP SA-6.3.

5.1 Sample Containers

Different types of chemicals react differently with sample containers made of various materials. For example, trace metals adsorb more strongly to glass than to plastic, whereas many organic chemicals may dissolve various types of plastic containers. Attachments A and B show proper containers (as well as other information) per 40 CFR 136. In general, the sample container shall allow approximately 5-10 percent air space ("ullage") to allow for expansion/vaporization if the sample warms during transport. However, for collection of volatile organic compounds, head space shall be omitted. The analytical laboratory will generally provide certified-clean containers for samples to be analyzed for chemical constituents. Shelby tubes or other sample containers are generally provided by the driller for samples requiring geotechnical analysis. Sufficient lead time shall be allowed for a delivery of sample container orders. Therefore, it is critical to use the correct container to maintain the integrity of the sample prior to analysis.

Once opened, the container must be used at once for storage of a particular sample. Unused but opened containers are to be considered contaminated and must be discarded. Because of the potential for introduction of contamination, they cannot be reclosed and saved for later use. Likewise, any unused containers which appear contaminated upon receipt, or which are found to have loose caps or a missing Teflon liner (if required for the container), shall be discarded.

5.2 Sample Preservation

Many water and soil samples are unstable and therefore require preservation to prevent changes in either the concentration or the physical condition of the constituent(s) requiring analysis. Although complete and irreversible preservation of samples is not possible, preservation does retard the chemical and biological
changes that inevitably take place after the sample is collected. Preservation techniques are usually limited to pH control, chemical addition(s), and refrigeration/ freezing (certain biological samples only).

5.2.1 Overview

The preservation techniques to be used for various analytes are listed in Attachments A and B. Reagents required for sample preservation will either be added to the sample containers by the laboratory prior to their shipment to the field or be added in the field (in a clean environment). Only high purity reagents shall be used for preservation. In general, aqueous samples of low-concentration organics (or soil samples of low- or medium-concentration organics) are cooled to 4°C. Medium-concentration aqueous samples, high-hazard organic samples, and some gas samples are typically not preserved. Low-concentration aqueous samples for metals are acidified with HNO₃, whereas medium-concentration and high-hazard aqueous metal samples are not preserved. Low- or medium-concentration soil samples for metals are cooled to 4°C, whereas high-hazard samples are not cooled.

The following subsections describe the procedures for preparing and adding chemical preservatives. Attachments A and B indicate the specific analytes which require these preservatives.

The FOL is responsible for ensuring that an accurate Chemical Inventory is created and maintained for all hazardous chemicals brought to the work site (see Section 5 of the TtNUS Health and Safety Guidance Manual). Furthermore, the FOL must ensure that a corresponding Material Safety Data Sheet (MSDS) is collected for every substance entered on the site Chemical Inventory, and that all persons using/handling/disposing of these substances review the appropriate MSDS for substances they will work with. The Chemical Inventory and the MSDSs must be maintained at each work site in a location and manner where they are readily-accessible to all personnel.

5.2.2 Preparation and Addition of Reagents

Addition of the following acids or bases may be specified for sample preservation; these reagents shall be analytical reagent (AR) grade or purer and shall be diluted to the required concentration with deionized water before field sampling commences. To avoid uncontrolled reactions, be sure to Add Acid to water (not vice versa). A dilutions guide is provided below.

<table>
<thead>
<tr>
<th>Acid/Base</th>
<th>Dilution</th>
<th>Concentration</th>
<th>Estimated Amount Required for Preservation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrochloric Acid (HCl)</td>
<td>1 part concentrated HCl: 1 part double-distilled, deionized water</td>
<td>6N</td>
<td>5-10 mL</td>
</tr>
<tr>
<td>Sulfuric Acid (H₂SO₄)</td>
<td>1 part concentrated H₂SO₄: 1 part double-distilled, deionized water</td>
<td>18N</td>
<td>2 - 5 mL</td>
</tr>
<tr>
<td>Nitric Acid (HNO₃)</td>
<td>Undiluted concentrated HNO₃</td>
<td>16N</td>
<td>2 - 5 mL</td>
</tr>
<tr>
<td>Sodium Hydroxide (NaOH)</td>
<td>400 grams solid NaOH dissolved in 870 mL double-distilled, deionized water; yields 1 liter of solution</td>
<td>10N</td>
<td>2 mL</td>
</tr>
</tbody>
</table>

The amounts required for preservation shown in the above table assumes proper preparation of the preservative and addition of the preservative to one liter of aqueous sample. This assumes that the sample is initially at pH 7, is poorly buffered, and does not contain particulate matter; as these conditions vary, more preservative may be required. Consequently, the final sample pH must be checked using narrow-range pH paper, as described in the generalized procedure detailed below:
Pour off 5-10 mL of sample into a dedicated, clean container. Use some of this sample to check the initial sample pH using wide range (0-14) pH paper. Never dip the pH paper into the sample; always apply a drop of sample to the pH paper using a clean stirring rod or pipette.

Add about one-half of the estimated preservative required to the original sample bottle. Cap and invert gently several times to mix. Check pH (as described above) using medium range pH paper (pH 0-6 or pH 7.5-14, as applicable).

Cap sample bottle and seal securely.

Additional considerations are discussed below:

To test if ascorbic acid must be used to remove oxidizing agents present in the sample before it can be properly preserved, place a drop of sample on KI-starch paper. A blue color indicates the need for ascorbic acid addition.

If required, add a few crystals of ascorbic acid to the sample and retest with the KI-starch paper. Repeat until a drop of sample produces no color on the KI-starch paper. Then add an additional 0.6 grams of ascorbic acid per each liter of sample volume.

Continue with proper base preservation of the sample as described above.

Samples for sulfide analysis must be treated by the addition of 4 drops (0.2 mL) of 2N zinc acetate solution per 100 ml of sample.

The 2N zinc acetate solution is made by dissolving 220 grams of zinc acetate in 870 mL of double-distilled, deionized water to make 1 liter of solution.

The sample pH is then raised to 9 using the NaOH preservative.

Sodium thiosulfate must be added to remove residual chlorine from a sample. To test the sample for residual chlorine use a field test kit specially made for this purpose.

If residual chlorine is present, add 0.08 grams of sodium thiosulfate per liter of sample to remove the residual chlorine.

Continue with proper acidification of the sample as described above.

For biological samples, 10% buffered formalin or isopropanol may also be required for preservation. Questions regarding preservation requirements should be resolved through communication with the laboratory before sampling begins.

5.3 Field Filtration

At times, field-filtration may be required to provide for the analysis of dissolved chemical constituents. Field-filtration must be performed prior to the preservation of samples as described above. General procedures for field filtration are described below:

- The sample shall be filtered through a non-metallic, 0.45-micron membrane filter, immediately after collection. The filtration system shall consist of dedicated filter canister, dedicated tubing, and a peristaltic pump with pressure or vacuum pumping squeeze action (since the sample is filtered by mechanical peristalsis, the sample travels only through the tubing).
• To perform filtration, thread the tubing through the peristaltic pump head. Attach the filter canister to the discharge end of the silicon tubing (note flow direction arrow); attach the aqueous sample container to the intake end of the silicon tubing. Turn the peristaltic pump on and perform filtration. Run approximately 100 ml of sample through the filter and discard prior to sample collection.

• Continue by preserving the filtrate (contained in the filter canister), as applicable and generally described above.

5.4 Sample Packaging and Shipping

Only employees who have successfully completed the TtNUS “Shipping Hazardous Materials” training course are authorized to package and ship hazardous substances. These trained individuals are responsible for performing shipping duties in accordance with this training.

Samples collected for shipment from a site shall be classified as either environmental or hazardous material samples. Samples from drums containing materials other than Investigative Derived Waste (IDW) and samples obtained from waste piles or bulk storage tanks are generally shipped as hazardous materials. A distinction must be made between the two types of samples in order to:

• Determine appropriate procedures for transportation of samples (if there is any doubt, a sample shall be considered hazardous and shipped accordingly.)

• Protect the health and safety of transport and laboratory personnel receiving the samples (special precautions are used by the shipper and at laboratories when hazardous materials are received.)

Detailed procedures for packaging environmental samples are outlined in the remainder of this section.

5.4.1 Environmental Samples

Environmental samples are packaged as follows:

• Place properly identified sample container, with lid securely fastened, in a plastic bag (e.g. Ziploc baggie), and seal the bag.

• Place sample in a cooler constructed of sturdy material which has been lined with a large, plastic bag (e.g. “garbage” bag). Drain plugs on coolers must be taped shut.

• Pack with enough cushioning materials such as bubble wrap (shoulders of bottles must be iced if required) to minimize the possibility of the container breaking.

• If cooling is required (see Attachments A and B), place ice around sample container shoulders, and on top of packing material (minimum of 8 pounds of ice for a medium-size cooler).

• Seal (i.e., tape or tie top in knot) large liner bag.

• The original (top, signed copy) of the COC form shall be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. If multiple coolers are sent but are included on one COC form, the COC form should be sent with the cooler containing the vials for VOC analysis. The COC form should then state how many coolers are included with that shipment.

• Close and seal outside of cooler as described in SOP SA-6.3. Signed custody seals must be used.
Coolers must be marked as containing "Environmental Samples." The appropriate side of the container must be marked "This End Up" and arrows placed appropriately. No DOT marking or labeling is required; there are no DOT restrictions on mode of transportation.

6.0 REFERENCES


International Air Transport Association (latest issue). Dangerous Goods Regulations, Montreal, Quebec, Canada.


## ATTACHMENT A

### GENERAL SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS

<table>
<thead>
<tr>
<th>Sample Type and Concentration</th>
<th>Container</th>
<th>Sample Size</th>
<th>Preservation</th>
<th>Holding Time</th>
</tr>
</thead>
</table>

#### WATER

<table>
<thead>
<tr>
<th>Organics (GC&amp;GC/MS)</th>
<th>VOC</th>
<th>Container</th>
<th>Sample Size</th>
<th>Preservation</th>
<th>Holding Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Borosilicate glass</td>
<td>2 x 40 mL</td>
<td>Cool to 4°C HCl to ≤ 2</td>
<td>14 days</td>
</tr>
<tr>
<td>Extractables SVOCS and pesticides/PCBs</td>
<td>Low</td>
<td>Amber glass</td>
<td>2x2 L or 4x1 L</td>
<td>Cool to 4°C</td>
<td>7 days to extraction; 40 days after extraction</td>
</tr>
<tr>
<td>Extractables SVOCS and pesticides/PCBs</td>
<td>Medium</td>
<td>Amber glass</td>
<td>2x2 L or 4x1 L</td>
<td>None</td>
<td>7 days to extraction; 40 days after extraction</td>
</tr>
<tr>
<td>Inorganics</td>
<td>Metals</td>
<td>High-density polyethylene</td>
<td>1 L</td>
<td>HNO₃ to pH ≤ 2</td>
<td>6 months (Hg-28 days)</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>Wide-mouth glass</td>
<td>16 oz.</td>
<td>None</td>
<td>6 months</td>
</tr>
<tr>
<td></td>
<td>Cyanide</td>
<td>High-density polyethylene</td>
<td>1 L</td>
<td>NaOH to pH&gt;12</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td>Medium</td>
<td>Wide-mouth glass</td>
<td>16 oz.</td>
<td>None</td>
<td>14 days</td>
</tr>
<tr>
<td>Organic/Inorganic</td>
<td>High Hazard</td>
<td>Wide-mouth glass</td>
<td>8 oz.</td>
<td>None</td>
<td>14 days</td>
</tr>
</tbody>
</table>

#### SOIL

<table>
<thead>
<tr>
<th>Organics (GC&amp;GC/MS)</th>
<th>VOC</th>
<th>EnCore Sampler</th>
<th>(3) 5 g Samplers</th>
<th>Sample Size</th>
<th>Preservation</th>
<th>Holding Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>Wide-mouth glass</td>
<td>8 oz.</td>
<td>Cool to 4°C</td>
<td>14 days to extraction; 40 days after extraction</td>
<td></td>
</tr>
<tr>
<td>Extractables SVOCS and pesticides/PCBs</td>
<td>Low</td>
<td>Wide-mouth glass</td>
<td>8 oz.</td>
<td>Cool to 4°C</td>
<td>14 days to extraction; 40 days after extraction</td>
<td></td>
</tr>
<tr>
<td>Extractables SVOCS and pesticides/PCBs</td>
<td>Medium</td>
<td>Wide-mouth glass</td>
<td>8 oz.</td>
<td>Cool to 4°C</td>
<td>14 days to extraction; 40 days after extraction</td>
<td></td>
</tr>
<tr>
<td>Inorganics</td>
<td>Low/Medium</td>
<td>Wide-mouth glass</td>
<td>8 oz.</td>
<td>Cool to 4°C</td>
<td>6 months (Hg - 28 days) Cyanide (14 days)</td>
<td></td>
</tr>
<tr>
<td>Organic/Inorganic</td>
<td>High Hazard</td>
<td>Wide-mouth glass</td>
<td>8 oz.</td>
<td>None</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>Dioxin/Furan</td>
<td>All</td>
<td>Wide-mouth glass</td>
<td>4 oz.</td>
<td>None</td>
<td>35 days until extraction; 40 days after extraction</td>
<td></td>
</tr>
<tr>
<td>TCLP</td>
<td>All</td>
<td>Wide-mouth glass</td>
<td>8 oz.</td>
<td>None</td>
<td>7 days until preparation; analysis as per fraction</td>
<td></td>
</tr>
</tbody>
</table>

#### AIR

<table>
<thead>
<tr>
<th>Volatile Organics</th>
<th>Container</th>
<th>Sample Size</th>
<th>Preservation</th>
<th>Holding Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low/Medium</td>
<td>Charcoal tube – 7 cm long, 6 mm OD, 4 mm ID</td>
<td>100 L air</td>
<td>Cool to 4°C</td>
<td>5 days recommended</td>
</tr>
</tbody>
</table>

1. All glass containers should have Teflon cap liners or septa.
2. See Attachment E. Preservation and maximum holding time allowances per 40 CFR 136.
### ATTACHMENT B

**ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES**

<table>
<thead>
<tr>
<th>Parameter Number/Name</th>
<th>Container</th>
<th>Preservation</th>
<th>Maximum Holding Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INORGANIC TESTS:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acidity</td>
<td>P, G</td>
<td>Cool, 4°C</td>
<td>14 days</td>
</tr>
<tr>
<td>Alkalinity</td>
<td>P, G</td>
<td>Cool, 4°C</td>
<td>14 days</td>
</tr>
<tr>
<td>Ammonia - Nitrogen</td>
<td>P, G</td>
<td>Cool, 4°C; H₂SO₄ to pH 2</td>
<td>28 days</td>
</tr>
<tr>
<td>Biochemical Oxygen Demand (BOD)</td>
<td>P, G</td>
<td>Cool, 4°C</td>
<td>48 hours</td>
</tr>
<tr>
<td>Bromide</td>
<td>P, G</td>
<td>None required</td>
<td>28 days</td>
</tr>
<tr>
<td>Chemical Oxygen Demand (COD)</td>
<td>P, G</td>
<td>Cool, 4°C; H₂SO₄ to pH 2</td>
<td>28 days</td>
</tr>
<tr>
<td>Chloride</td>
<td>P, G</td>
<td>None required</td>
<td>28 days</td>
</tr>
<tr>
<td>Chlorine, Total Residual</td>
<td>P, G</td>
<td>None required</td>
<td>Analyze immediately</td>
</tr>
<tr>
<td>Color</td>
<td>P, G</td>
<td>Cool, 4°C</td>
<td>48 hours</td>
</tr>
<tr>
<td>Cyanide, Total and Amenable to Chlorination</td>
<td>P, G</td>
<td>Cool, 4°C; NaOH to pH 12; 0.6 g ascorbic acid</td>
<td>14 days</td>
</tr>
<tr>
<td>Fluoride</td>
<td>P</td>
<td>None required</td>
<td>28 days</td>
</tr>
<tr>
<td>Hardness</td>
<td>P, G</td>
<td>HNO₃ to pH 2; H₂SO₄ to pH 2</td>
<td>6 months</td>
</tr>
<tr>
<td>Total Kjeldahl and Organic Nitrogen</td>
<td>P, G</td>
<td>Cool, 4°C; H₂SO₄ to pH 2</td>
<td>28 days</td>
</tr>
<tr>
<td>Nitrate - Nitrogen</td>
<td>P, G</td>
<td>None required</td>
<td>48 hours</td>
</tr>
<tr>
<td>Nitrate-Nitrite - Nitrogen</td>
<td>P, G</td>
<td>Cool, 4°C; H₂SO₄ to pH 2</td>
<td>28 days</td>
</tr>
<tr>
<td>Nitrite - Nitrogen</td>
<td>P, G</td>
<td>Cool, 4°C</td>
<td>48 hours</td>
</tr>
<tr>
<td>Oil &amp; Grease</td>
<td>G</td>
<td>Cool, 4°C; H₂SO₄ to pH 2</td>
<td>28 days</td>
</tr>
<tr>
<td>Total Organic Carbon (TOC)</td>
<td>P, G</td>
<td>Cool, 4°C; HCl or H₂SO₄ to pH 2</td>
<td>28 days</td>
</tr>
<tr>
<td>Orthophosphate</td>
<td>P, G</td>
<td>Filter immediately; Cool, 4°C</td>
<td>48 hours</td>
</tr>
<tr>
<td>Oxygen, Dissolved-Probe</td>
<td>G Bottle &amp; top</td>
<td>None required</td>
<td>Analyze immediately</td>
</tr>
<tr>
<td>Oxygen, Dissolved-Winkler</td>
<td>G Bottle &amp; top</td>
<td>Fix on site and store in dark</td>
<td>8 hours</td>
</tr>
<tr>
<td>Phenols</td>
<td>G</td>
<td>Cool, 4°C; H₂SO₄ to pH 2</td>
<td>28 days</td>
</tr>
<tr>
<td>Phosphorus, Total</td>
<td>P, G</td>
<td>Cool, 4°C; H₂SO₄ to pH 2</td>
<td>28 days</td>
</tr>
<tr>
<td>Residue, Total</td>
<td>P, G</td>
<td>Cool, 4°C</td>
<td>7 days</td>
</tr>
<tr>
<td>Residue, Filterable (TDS)</td>
<td>P, G</td>
<td>Cool, 4°C</td>
<td>7 days</td>
</tr>
<tr>
<td>Residue, Nonfilterable (TSS)</td>
<td>P, G</td>
<td>Cool, 4°C</td>
<td>7 days</td>
</tr>
<tr>
<td>Residue, Settleable</td>
<td>P, G</td>
<td>Cool, 4°C</td>
<td>48 hours</td>
</tr>
<tr>
<td>Residue, Volatile (Ash Content)</td>
<td>P, G</td>
<td>Cool, 4°C</td>
<td>7 days</td>
</tr>
<tr>
<td>Silica</td>
<td>P</td>
<td>Cool, 4°C</td>
<td>28 days</td>
</tr>
<tr>
<td>Specific Conductance</td>
<td>P, G</td>
<td>Cool, 4°C</td>
<td>28 days</td>
</tr>
<tr>
<td>Sulfate</td>
<td>P, G</td>
<td>Cool, 4°C</td>
<td>28 days</td>
</tr>
</tbody>
</table>
### ATTACHMENT B
### ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES
### PAGE TWO

<table>
<thead>
<tr>
<th>Parameter Number/Name</th>
<th>Container(1)</th>
<th>Preservation(2)(3)</th>
<th>Maximum Holding Time(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INORGANIC TESTS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfide</td>
<td>P, G</td>
<td>Cool, 4°C; add zinc acetate plus sodium hydroxide to pH 9</td>
<td>7 days</td>
</tr>
<tr>
<td>Sulfite</td>
<td>P, G</td>
<td>None required</td>
<td>Analyze immediately</td>
</tr>
<tr>
<td>Turbidity</td>
<td>P, G</td>
<td>Cool, 4°C</td>
<td>48 hours</td>
</tr>
<tr>
<td><strong>METALS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chromium VI (Hexachrome)</td>
<td>P, G</td>
<td>Cool, 4°C</td>
<td>24 hours</td>
</tr>
<tr>
<td>Mercury (Hg)</td>
<td>P, G</td>
<td>HNO₃ to pH 2</td>
<td>28 days</td>
</tr>
<tr>
<td>Metals, except Chromium VI and Mercury</td>
<td>P, G</td>
<td>HNO₃ to pH 2</td>
<td>6 months</td>
</tr>
<tr>
<td><strong>ORGANIC TESTS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purgeable Halocarbons</td>
<td>G, Teflon-lined septum</td>
<td>Cool, 4°C; 0.008% Na₂S₂O₅</td>
<td>14 days</td>
</tr>
<tr>
<td>Purgeable Aromatic Hydrocarbons</td>
<td>G, Teflon-lined septum</td>
<td>Cool, 4°C; 0.008% Na₂S₂O₅, HCl to pH 2</td>
<td>14 days</td>
</tr>
<tr>
<td>Acrolein and Acrylonitrile</td>
<td>G, Teflon-lined septum</td>
<td>Cool, 4°C; 0.008% Na₂S₂O₅, adjust pH to 4-5</td>
<td>14 days</td>
</tr>
<tr>
<td>Phenols(11)</td>
<td>G, Teflon-lined cap</td>
<td>Cool, 4°C; 0.008% Na₂S₂O₅</td>
<td>7 days until extraction; 40 days after extraction</td>
</tr>
<tr>
<td>Benzidines(11),(12)</td>
<td>G, Teflon-lined cap</td>
<td>Cool, 4°C; 0.008% Na₂S₂O₅</td>
<td>7 days until extraction(13)</td>
</tr>
<tr>
<td>Phthalate esters(13)</td>
<td>G, Teflon-lined cap</td>
<td>Cool, 4°C</td>
<td>7 days until extraction; 40 days after extraction</td>
</tr>
<tr>
<td>Nitrosamines(13),(14)</td>
<td>G, Teflon-lined cap</td>
<td>Cool, 4°C; store in dark; 0.008% Na₂S₂O₅</td>
<td>7 days until extraction; 40 days after extraction</td>
</tr>
<tr>
<td>PCBs(11)</td>
<td>G, Teflon-lined cap</td>
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<tr>
<td>Nitroaromatics &amp; Isophorone(17)</td>
<td>G, Teflon-lined cap</td>
<td>Cool, 4°C; 0.008% Na₂S₂O₅, store in dark</td>
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<td>Polynuclear Aromatic Hydrocarbons (PAHs)(11),(14)</td>
<td>G, Teflon-lined cap</td>
<td>Cool, 4°C; 0.008% Na₂S₂O₅, store in dark</td>
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<tr>
<td>Haloethers(11)</td>
<td>G, Teflon-lined cap</td>
<td>Cool, 4°C; 0.008% Na₂S₂O₅</td>
<td>7 days until extraction; 40 days after extraction</td>
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<tr>
<td>Dioxin/Furan (TCDD/TCDF)(17)</td>
<td>G, Teflon-lined cap</td>
<td>Cool, 4°C; 0.008% Na₂S₂O₅</td>
<td>7 days until extraction; 40 days after extraction</td>
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</table>
ATTACHMENT B
ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES
PAGE THREE

(1) Polyethylene (P): generally 500 ml or Glass (G): generally 1 L.
(2) Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
(3) When any sample is to be shipped by common carrier or sent through the United States Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172).
(4) Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer periods, and has received a variance from the Regional Administrator.
(5) Should only be used in the presence of residual chlorine.
(6) Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustments are made to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.
(7) Samples should be filtered immediately on site before adding preservative for dissolved metals.
(8) Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.
(9) Sample receiving no pH adjustment must be analyzed within 7 days of sampling.
(10) The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.
(11) When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for 7 days before extraction and for 40 days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re: the requirement for thiosulfate reduction of residual chlorine) and footnotes 12, 13 (re: the analysis of benzidine).
(12) If 1,2-diphenylthydrazine is likely to be present, adjust the pH of the sample to 4.0±0.2 to prevent rearrangement to benzidine.
(13) Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.
(14) For the analysis of diphenylaminomine, add 0.008% Na2S2O3 and adjust pH to 7-10 with NaOH within 24 hours of sampling.
(15) The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% Na2S2O3.
### TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>SECTION</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 PURPOSE</td>
<td>2</td>
</tr>
<tr>
<td>2.0 SCOPE</td>
<td>2</td>
</tr>
<tr>
<td>3.0 GLOSSARY</td>
<td>2</td>
</tr>
<tr>
<td>4.0 RESPONSIBILITIES</td>
<td>2</td>
</tr>
<tr>
<td>5.0 PROCEDURES</td>
<td>2</td>
</tr>
<tr>
<td>5.1 SITE LOGBOOK</td>
<td>2</td>
</tr>
<tr>
<td>5.1.1 General</td>
<td>2</td>
</tr>
<tr>
<td>5.1.2 Photographs</td>
<td>3</td>
</tr>
<tr>
<td>5.2 FIELD NOTEBOOKS</td>
<td>3</td>
</tr>
<tr>
<td>5.3 FIELD FORMS</td>
<td>4</td>
</tr>
<tr>
<td>5.3.1 Sample Collection, Labeling, Shipment, Request for Analysis, and Field Test Results</td>
<td>4</td>
</tr>
<tr>
<td>5.3.2 Hydrogeological and Geotechnical Forms</td>
<td>5</td>
</tr>
<tr>
<td>5.4 FIELD REPORTS</td>
<td>6</td>
</tr>
<tr>
<td>5.4.1 Daily Activities Report</td>
<td>6</td>
</tr>
<tr>
<td>5.4.2 Weekly Status Reports</td>
<td>7</td>
</tr>
<tr>
<td>6.0 LISTING OF TETRA TECH NUS FIELD FORMS FOUND ON THE TTNUS INTRANET SITE.</td>
<td>7</td>
</tr>
</tbody>
</table>

**HTTP://INTRANET.TTNUS.COM CLICK ON FIELD LOG SHEETS**

**ATTACHMENTS**

<table>
<thead>
<tr>
<th>ATTACHMENT</th>
<th>DESCRIPTION</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>TYPICAL SITE LOGBOOK ENTRY</td>
<td>9</td>
</tr>
<tr>
<td>B</td>
<td>SAMPLE LABEL</td>
<td>10</td>
</tr>
<tr>
<td>C</td>
<td>CHAIN-OF-CUSTODY RECORD FORM</td>
<td>11</td>
</tr>
<tr>
<td>D</td>
<td>CHAIN-OF-CUSTODY SEAL</td>
<td>12</td>
</tr>
</tbody>
</table>
1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to identify and designate the field data record forms, logs and reports generally initiated and maintained for documenting Tetra Tech NUS field activities.

2.0 SCOPE

Documents presented within this procedure (or equivalents) shall be used for all Tetra Tech NUS field activities, as applicable. Other or additional documents may be required by specific client contracts or project planning documents.

3.0 GLOSSARY

None

4.0 RESPONSIBILITIES

Project Manager (PM) - The Project Manager is responsible for obtaining hardbound, controlled-distribution logbooks (from the appropriate source), as needed. In addition, the Project Manager is responsible for placing all field documentation used in site activities (i.e., records, field reports, sample data sheets, field notebooks, and the site logbook) in the project's central file upon the completion of field work.

Field Operations Leader (FOL) - The Field Operations Leader is responsible for ensuring that the site logbook, notebooks, and all appropriate and current forms and field reports illustrated in this guideline (and any additional forms required by the contract) are correctly used, accurately filled out, and completed in the required time-frame.

5.0 PROCEDURES

5.1 Site Logbook

5.1.1 General

The site logbook is a hard-bound, paginated, controlled-distribution record book in which all major onsite activities are documented. At a minimum, the following activities/events shall be recorded or referenced (daily) in the site logbook:

- All field personnel present
- Arrival/departure of site visitors
- Time and date of H&S training
- Arrival/departure of equipment
- Time and date of equipment calibration
- Start and/or completion of borehole, trench, monitoring well installation, etc.
- Daily onsite activities performed each day
- Sample pickup information
- Health and Safety issues (level of protection observed, etc.)
- Weather conditions

A site logbook shall be maintained for each project. The site logbook shall be initiated at the start of the first onsite activity (e.g., site visit or initial reconnaissance survey). Entries are to be made for every day
that onsite activities take place which involve Tetra Tech NUS or subcontractor personnel. Upon completion of the fieldwork, the site logbook must become part of the project's central file.

The following information must be recorded on the cover of each site logbook:

- Project name
- Tetra Tech NUS project number
- Sequential book number
- Start date
- End date

Information recorded daily in the site logbook need not be duplicated in other field notebooks (see Section 5.2), but must summarize the contents of these other notebooks and refer to specific page locations in these notebooks for detailed information (where applicable). An example of a typical site logbook entry is shown in Attachment A.

If measurements are made at any location, the measurements and equipment used must either be recorded in the site logbook or reference must be made to the field notebook in which the measurements are recorded (see Attachment A).

All logbook, notebook, and log sheet entries shall be made in indelible ink (black pen is preferred). No erasures are permitted. If an incorrect entry is made, the entry shall be crossed out with a single strike mark, and initialed and dated. At the completion of entries by any individual, the logbook pages used must be signed and dated. The site logbook must also be signed by the Field Operations Leader at the end of each day.

5.1.2 Photographs

When movies, slides, or photographs are taken of a site or any monitoring location, they must be numbered sequentially to correspond to logbook/notebook entries. The name of the photographer, date, time, site location, site description, and weather conditions must be entered in the logbook/notebook as the photographs are taken. A series entry may be used for rapid-sequence photographs. The photographer is not required to record the aperture settings and shutter speeds for photographs taken within the normal automatic exposure range. However, special lenses, films, filters, and other image-enhancement techniques must be noted in the logbook/notebook. If possible, such techniques shall be avoided, since they can adversely affect the accuracy of photographs. Chain-of-custody procedures depend upon the subject matter, type of camera (digital or film), and the processing it requires. Film used for aerial photography, confidential information, or criminal investigation require chain-of-custody procedures. Once processed, the slides of photographic prints shall be consecutively numbered and labeled according to the logbook/notebook descriptions. The site photographs and associated negatives and/or digitally saved images to compact disks must be docketed into the project's central file.

5.2 Field Notebooks

Key field team personnel may maintain a separate dedicated field notebook to document the pertinent field activities conducted directly under their supervision. For example, on large projects with multiple investigative sites and varying operating conditions, the Health and Safety Officer may elect to maintain a separate field notebook. Where several drill rigs are in operation simultaneously, each site geologist assigned to oversee a rig must maintain a field notebook.
5.3 **Field Forms**

All Tetra Tech NUS field forms (see list in Section 6.0 of this SOP) can be found on the company's intranet site (http://intranet.ttnus.com) under Field Log Sheets. Forms may be altered or revised for project-specific needs contingent upon client approval. Care must be taken to ensure that all essential information can be documented. Guidelines for completing these forms can be found in the related sampling SOP.

5.3.1 **Sample Collection, Labeling, Shipment, Request for Analysis, and Field Test Results**

5.3.1.1 **Sample Log Sheet**

Sample Log Sheets are used to record specified types of data while sampling. The data recorded on these sheets are useful in describing the sample as well as pointing out any problems, difficulties, or irregularities encountered during sampling. A log sheet must be completed for each sample obtained, including field quality control (QC) samples.

5.3.1.2 **Sample Label**

A typical sample label is illustrated in Attachment B. Adhesive labels must be completed and applied to every sample container. Sample labels can usually be obtained from the appropriate Program source electronically generated in-house, or are supplied from the laboratory subcontractor.

5.3.1.3 **Chain-of-Custody Record Form**

The Chain-of-Custody (COC) Record is a multi-part form that is initiated as samples are acquired and accompanies a sample (or group of samples) as they are transferred from person to person. This form must be used for any samples collected for chemical or geotechnical analysis whether the analyses are performed on site or off site. One carbonless copy of the completed COC form is retained by the field crew, one copy is sent to the Project Manager (or designee), while the original is sent to the laboratory. The original (top, signed copy) of the COC form shall be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. If multiple coolers are sent but are included on one COC form, the COC form should be sent with the cooler containing vials for VOC analysis or the cooler with the air bill attached. The air bill should then state how many coolers are included with that shipment. An example of a Chain-of-Custody Record form is provided as Attachment C. Once the samples are received at the laboratory, the sample cooler and contents are checked and any problems are noted on the enclosed COC form (any discrepancies between the sample labels and COC form and any other problems that are noted are resolved through communication between the laboratory point-of-contact and the Tetra Tech NUS Project Manager). The COC form is signed and copied. The laboratory will retain the copy while the original becomes part of the samples' corresponding analytical data package.

5.3.1.4 **Chain-of-Custody Seal**

Attachment D is an example of a custody seal. The Custody seal is an adhesive-backed label. It is part of a chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field and sealed in coolers for transport to the laboratory. The COC seals are signed and dated by the sampler(s) and affixed across the lid and body of each cooler (front and back) containing environmental samples (see SOP SA-6.1). COC seals may be available from the laboratory; these seals may also be purchased from a supplier.
5.3.1.5 Geochemical Parameters Log Sheets

Field Analytical Log Sheets are used to record geochemical and/or natural attenuation field test results.

5.3.2 Hydrogeological and Geotechnical Forms

5.3.2.1 Groundwater Level Measurement Sheet

A Groundwater Level Measurement Sheet must be filled out for each round of water level measurements made at a site.

5.3.2.2 Data Sheet for Pumping Test

During the performance of a pumping test (or an in-situ hydraulic conductivity test), a large amount of data must be recorded, often within a short time period. The Pumping Test Data Sheet facilitates this task by standardizing the data collection format for the pumping well and observation wells, and allowing the time interval for collection to be laid out in advance.

5.3.2.3 Packer Test Report Form

A Packer Test Report Form must be completed for each well upon which a packer test is conducted.

5.3.2.4 Boring Log

During the progress of each boring, a log of the materials encountered, operation and driving of casing, and location of samples must be kept. The Summary Log of Boring, or Boring Log is used for this purpose and must be completed for each soil boring performed. In addition, if volatile organics are monitored on cores, samples, cuttings from the borehole, or breathing zone, (using a PID or FID), these readings must be entered on the boring log at the appropriate depth. The “Remarks” column can be used to subsequently enter the laboratory sample number, the concentration of key analytical results, or other pertinent information. This feature allows direct comparison of contaminant concentrations with soil characteristics.

5.3.2.5 Monitoring Well Construction Details Form

A Monitoring Well Construction Details Form must be completed for every monitoring well, piezometer, or temporary well point installed. This form contains specific information on length and type of well riser pipe and screen, backfill, filter pack, annular seal and grout characteristics, and surface seal characteristics. This information is important in evaluating the performance of the monitoring well, particularly in areas where water levels show temporal variation, or where there are multiple (immiscible) phases of contaminants. Depending on the type of monitoring well (in overburden or bedrock, stick-up or flush mount), different forms are used.

5.3.2.6 Test Pit Log

When a test pit or trench is constructed for investigative or sampling purposes, a Test Pit Log must be filled out by the responsible field geologist or sampling technician.
5.3.2.7 **Miscellaneous Monitoring Well Forms**

Monitoring Well Materials Certificate of Conformance should be used as the project directs to document all materials utilized during each monitoring well installation.

The Monitoring Well Development Record should be used as the project directs to document all well development activities.

5.3.2.8 **Miscellaneous Field Forms - QA and Checklists**

Container Sample and Inspection Sheet should be used as the project directs each time a container (drum, tank, etc.) is sampled and/or inspected.

QA Sample Log Sheet should be used at the project directs each time a QA sample is collected, such as Rinsate Blank, Source Blank, etc.

Field Task Modification Request (FTMR) will be prepared for all deviations from the project planning documents. The FOL is responsible for initiating the FTMRs. Copies of all FTMRs will be maintained with the onsite planning documents and originals will be placed in the final evidence file.

The Field Project Daily Activities Check List and Field Project Pre-Mobilization Checklist should be used during both the planning and field effort to assure that all necessary tasks are planned for and completed. These two forms are not a requirement but a useful tool for most field work.

5.3.3 **Equipment Calibration and Maintenance Form**

The calibration or standardization of monitoring, measuring or test equipment is necessary to assure the proper operation and response of the equipment, to document the accuracy, precision or sensitivity of the measurement, and determine if correction should be applied to the readings. Some items of equipment require frequent calibration, others infrequent. Some are calibrated by the manufacturer, others by the user.

Each instrument requiring calibration has its own Equipment Calibration Log which documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. An Equipment Calibration Log must be maintained for each electronic measuring device used in the field; entries must be made for each day the equipment is used or in accordance with the manufacturer's recommendations.

5.4 **Field Reports**

The primary means of recording onsite activities is the site logbook. Other field notebooks may also be maintained. These logbooks and notebooks (and supporting forms) contain detailed information required for data interpretation or documentation, but are not easily useful for tracking and reporting of progress. Furthermore, the field logbook/notebooks remain onsite for extended periods of time and are thus not accessible for timely review by project management.

5.4.1 **Daily Activities Report**

To provide timely oversight of onsite contractors, Daily Activities Reports are completed and submitted as described below.
5.4.1.1 Description

The Daily Activities Report (DAR) documents the activities and progress for each day's field work. This report must be filled out on a daily basis whenever there are drilling, test pitting, well construction, or other related activities occurring which involve subcontractor personnel. These sheets summarize the work performed and form the basis of payment to subcontractors. The DAR form can be found on the TtNUS intranet site.

5.4.1.2 Responsibilities

It is the responsibility of the rig geologist to complete the DAR and obtain the driller's signature acknowledging that the times and quantities of material entered are correct.

5.4.1.3 Submittal and Approval

At the end of the shift, the rig geologist must submit the Daily Activities Report to the Field Operations Leader (FOL) for review and filing. The Daily Activities Report is not a formal report and thus requires no further approval. The DAR reports are retained by the FOL for use in preparing the site logbook and in preparing weekly status reports for submission to the Project Manager.

5.4.2 Weekly Status Reports

To facilitate timely review by project management, photocopies of logbook/notebook entries may be made for internal use.

It should be noted that in addition to summaries described herein, other summary reports may also be contractually required.

All Tetra Tech NUS field forms can be found on the company's intranet site at http://intranet.ttnus.com under Field Log Sheets.

6.0 Listing of Tetra Tech NUS Field Forms Found on the TTNUS Intranet Site. HTTP://INTRANET.TTNUS.COM Click on Field Log Sheets

Groundwater Sample Log Sheet
Surface Water Sample Log Sheet
Soil/Sediment Sample Log Sheet
Container Sample and Inspection Sheet
Geochemical Parameters (Natural Attenuation)
Groundwater Level Measurement Sheet
Pumping Test Data Sheet
Packer Test Report Form
Boring Log
Monitoring Well Construction Bedrock Flush Mount
Monitoring Well Construction Bedrock Open Hole
Monitoring Well Construction Bedrock Stick Up
Monitoring Well Construction Confining Layer
Monitoring Well Construction Overburden Flush Mount
Monitoring Well Construction Overburden Stick Up
Test Pit Log
Monitoring Well Materials Certificate of Conformance
Monitoring Well Development Record
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<tr>
<td>FIELD DOCUMENTATION</td>
<td>SA-6.3</td>
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<td>Effective Date</td>
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- Daily Activities Record
- Field Task Modification Request
- Hydraulic Conductivity Test Data Sheet
- Low Flow Purge Data Sheet
- QA Sample Log Sheet
- Equipment Calibration Log
- Field Project Daily Activities Checklist
- Field Project Pre-Mobilization Checklist
ATTACHMENT A
TYPICAL SITE LOGBOOK ENTRY

START TIME: ______________________ DATE: ______________________

SITE LEADER: ______________________
PERSONNEL: ______________________
TtNUS ______________________ DRILLER ______________________ SITE VISITORS ______________________

WEATHER: Clear, 68°F, 2-5 mph wind from SE

ACTIVITIES:

1. Steam jenny and fire hoses were set up.

2. Drilling activities at well _____ resumes. Rig geologist was ______________________. See Geologist's Notebook, No. 1, page 29-30, for details of drilling activity. Sample No. 123-21-S4 collected; see sample logbook, page 42. Drilling activities completed at 11:50 and a 4-inch stainless steel well installed. See Geologist's Notebook, No. 1, page 31, and well construction details for well ______.

3. Drilling rig No. 2 steam-cleaned at decontamination pit. Then set up at location of well ______.

4. Well _____ drilled. Rig geologist was ______________________. See Geologist's Notebook, No. 2, page _____ for details of drilling activities. Sample numbers 123-22-S1, 123-22-S2, and 123-22-S3 collected; see sample logbook, pages 43, 44, and 45.

5. Well _____ was developed. Seven 55-gallon drums were filled in the flushing stage. The well was then pumped using the pitcher pump for 1 hour. At the end of the hour, water pumped from well was "sand free."

6. EPA remedial project manager arrives on site at 14:25 hours.

7. Large dump truck arrives at 14:45 and is steam-cleaned. Backhoe and dump truck set up over test pit ______.

8. Test pit _____ dug with cuttings placed in dump truck. Rig geologist was ______________________. See Geologist's Notebook, No. 1, page 32, for details of test pit activities. Test pit subsequently filled. No samples taken for chemical analysis. Due to shallow groundwater table, filling in of test pit ____ resulted in a very soft and wet area. A mound was developed and the area roped off.

9. Express carrier picked up samples (see Sample Logbook, pages 42 through 45) at 17:50 hours. Site activities terminated at 18:22 hours. All personnel off site, gate locked.

__________________________________
Field Operations Leader
<table>
<thead>
<tr>
<th>Sample No:</th>
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<tbody>
<tr>
<td>Date:</td>
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<tr>
<td>Preserve:</td>
<td></td>
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<tr>
<td>Analysis:</td>
<td></td>
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<tr>
<td>Sampled by:</td>
<td>Laboratory:</td>
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<tr>
<td>Date</td>
<td>Time</td>
</tr>
<tr>
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1. RELINQUISHED BY
   - Date
   - Time
   - 1. RECEIVED BY
   - Date
   - Time

2. RELINQUISHED BY
   - Date
   - Time
   - 2. RECEIVED BY
   - Date
   - Time

3. RELINQUISHED BY
   - Date
   - Time
   - 3. RECEIVED BY
   - Date
   - Time

DISTRIBUTION:
- WHITE (ACCOMPANIES SAMPLE)
- YELLOW (FIELD COPY)
- PINK (FILE COPY)
TABLE OF CONTENTS

SECTION PAGE
1.0 PURPOSE........................................................................................................................................ 2
2.0 SCOPE............................................................................................................................................ 2
3.0 GLOSSARY .................................................................................................................................... 2
4.0 RESPONSIBILITIES ........................................................................................................................ 3
5.0 PROCEDURES ................................................................................................................................ 3
   5.1 DECONTAMINATION DESIGN/CONSTRUCTIONS CONSIDERATIONS .................................. 3
   5.1.1 Temporary Decontamination Pads ......................................................................................... 3
   5.1.2 Decontamination Activities at Drill Rigs/DPT Units ............................................................... 4
   5.1.3 Decontamination Activities at Remote Sample Locations ...................................................... 5
   5.2 EQUIPMENT DECONTAMINATION PROCEDURES ................................................................ 5
   5.2.1 Monitoring Well Sampling Equipment .................................................................................. 5
   5.2.2 Down-Hole Drilling Equipment .............................................................................................. 6
   5.2.3 Soil/Sediment Sampling Equipment ..................................................................................... 6
   5.3 CONTACT WASTE/MATERIALS ............................................................................................ 7
   5.3.1 Decontamination Solutions .................................................................................................. 7
   5.4 DECONTAMINATION EVALUATION ....................................................................................... 7
1.0 PURPOSE

Decontamination is the process of removing and/or neutralizing site contaminants that have contacted and/or accumulated on equipment. The objective/purpose of this SOP is intended to protect site personnel, general public, and the sample integrity through the prevention of cross contamination onto unaffected persons or areas. It is further intended through this procedure to provide guidelines regarding the appropriate procedures to be followed when decontaminating drilling equipment, monitoring well materials, chemical sampling equipment and field analytical equipment.

2.0 SCOPE

This procedure applies to all equipment including drilling equipment, heavy equipment, monitoring well materials, as well as chemical sampling and field analytical equipment decontamination that may be used to provide access/acquire environmental samples. Where technologically and economically feasible, single use sealed disposable equipment will be employed to minimize the potential for cross contamination. This procedure also provides general reference information on the control of contaminated materials.

3.0 GLOSSARY

Acid - For decontamination of equipment when sampling for trace levels of inorganics, a 10% solution of nitric acid in deionized water should be used. Due to the leaching ability of nitric acid, it should not be used on stainless steel.

Alconox/Liquinox - A brand of phosphate-free laboratory-grade detergent.

Decontamination Solution - Is a solution selected/identified within the Health and Safety Plan or Project-Specific Quality Assurance Plan. The solution is selected and employed as directed by the project chemist/health and safety professional.

Deionized Water (DI) - Deionized water is tap water that has been treated by passing through a standard deionizing resin column. This water may also pass through additional filtering media to attain various levels of analyte-free status. The DI water should meet CAP and NCCLS specifications for reagent grade, Type I water.

Potable Water - Tap water used from any municipal water treatment system. Use of an untreated potable water supply is not an acceptable substitute for tap water.

Pressure Washing - Employs high pressure pumps and nozzle configuration to create a high pressure spray of potable water. High pressure spray is employed to remove solids.

Solvent - The solvent of choice is pesticide-grade Isopropanol. Use of other solvents (methanol, acetone, pesticide-grade hexane, or petroleum ether) may be required for particular projects or for a particular purpose (e.g. for the removal of concentrated waste) and must be justified in the project planning documents. As an example, it may be necessary to use hexane when analyzing for trace levels of pesticides, PCBs, or fuels. In addition, because many of these solvents are not miscible in water, the equipment should be air dried prior to use. Solvents should not be used on PVC equipment or well construction materials.

Steam Pressure Washing - This method employs a high pressure spray of heated potable water. This method through the application of heat provides for the removal of various organic/inorganic compounds.
4.0 RESPONSIBILITIES

Project Manager - Responsible for ensuring that all field activities are conducted in accordance with approved project plan(s) requirements.

Field Operations Leader (FOL) - Responsible for the onsite verification that all field activities are performed in compliance with approved Standards Operating Procedures or as otherwise dictated by the approved project plan(s).

Site Health and Safety Officer (SHSO) - The SHSO exercises shared responsibility with the FOL concerning decontamination effectiveness. All equipment arriving on-site (as part of the equipment inspection), leaving the site, moving between locations are required to go through a decontamination evaluation. This is accomplished through visual examination and/or instrument screening to determine the effectiveness of the decontamination process. Failure to meet these objectives are sufficient to restrict equipment from entering the site/exiting the site/ or moving to a new location on the site until the objectives are successfully completed.

5.0 PROCEDURES

The process of decontamination is accomplished through the removal of contaminants, neutralization of contaminants, or the isolation of contaminants. In order to accomplish this activity a level of preparation is required. This includes site preparation, equipment selection, and evaluation of the process. Site contaminant types, concentrations, media types, are primary drivers in the selection of the types of decontamination as well as where it will be conducted. For purposes of this SOP discussion will be provided concerning general environmental investigation procedures.

The decontamination processes are typically employed at:

- Temporary Decontamination Pads/Facilities
- Sample Locations
- Centralized Decontamination Pad/Facilities
- Combination of some or all of the above

The following discussion represents recommended site preparation in support of the decontamination process.

5.1 Decontamination Design/Constructions Considerations

5.1.1 Temporary Decontamination Pads

Temporary decontamination pads are constructed at satellite locations in support of temporary work sites. These structures are generally constructed to support the decontamination of heavy equipment such as drill rigs and earth moving equipment but can be employed for smaller articles.

The purpose of the decontamination pad is to contain wash waters and potentially contaminated soils generated during decontamination procedures. Therefore, construction of these pads should take into account the following considerations.
Site Location – The site selected should be within a reasonable distance from the work site but should avoid:

- Pedestrian/Vehicle thoroughfares
- Areas where control/custody cannot be maintained
- Areas where a potential releases may be compounded through access to storm water transport systems, streams or other potentially sensitive areas.
- Areas potentially contaminated.

Pad – The pad should be constructed to provide the following characteristics

- Size – The size of the pad should be sufficient to accept the equipment to be decontaminated as well as permitting free movement around the equipment by the personnel conducting the decontamination.

- Slope – An adequate slope will be constructed to permit the collection of the water and potentially contaminated soils within a trough or sump constructed at one end. The collection point for wash waters should be of adequate distance that the decontamination workers do not have to walk through the wash waters while completing their tasks.

- Sidewalls – The sidewalls should be a minimum of 6-inches in height to provide adequate containment for wash waters and soils. If splash represents a potential problem, splash guards should be constructed to control overspray. Sidewalls maybe constructed of wood, inflatables, sand bags, etc. to permit containment.

- Liner – Depending on the types of equipment and the decontamination method the liner should be of sufficient thickness to provide a puncture resistant barrier between the decontamination operation and the unprotected environment. Care should be taken to examine the surface area prior to placing the liner to remove sharp articles (sticks, stones, debris) that could puncture the liner. Liners are intended to form an impermeable barrier. The thickness may vary from a minimum recommended thickness of 10 mil to 30 mil. Achieving the desired thickness maybe achieved through layering lighter constructed materials. It should be noted that various materials (rubber, polyethylene sheeting) become slippery when wet. To minimize this potential hazard associated with a sloped liner a light coating of sand maybe applied to provide traction as necessary.

- Wash/drying Racks – Auger flights, drill/drive rods require racks positioned off of the ground to permit these articles to be washed, drained, and dried while secured from falling during this process. A minimum ground clearance of 2-feet is recommended.

- Maintenance – The work area should be periodically cleared of standing water, soils, and debris. This action will aid in eliminating slip, trip, and fall hazards. In addition, these articles will reduce potential backsplash and cross contamination. Hoses should be gathered when not in use to eliminate potential tripping hazards.

5.1.2 Decontamination Activities at Drill Rigs/DPT Units

During subsurface sampling activities including drilling and direct push activities decontamination of drive rods, Macro Core Samplers, split spoons, etc. are typically conducted at an area adjacent to the operation. Decontamination is generally accomplished using a soap/water wash and rinse utilizing buckets and brushes. This area requires sufficient preparation to accomplish the decontamination objectives.
Buckets shall be placed within mortar tubs or similar secondary containment tubs to prevent splash and spills from reaching unprotected media. Drying racks will be employed as directed for temporary pads to permit parts to dry and be evaluated prior to use/re-use.

5.1.3 Decontamination Activities at Remote Sample Locations

When sampling at remote locations sampling devices such as trowels, pumps/tubing should be evacuated of potentially contaminated media to the extent possible. This equipment should be wrapped in plastic for transport to the temporary/centralized decontamination location for final cleaning and disposition.

5.2 Equipment Decontamination Procedures

The following represents procedures to be employed for the decontamination of equipment that may have contacted and/or accumulated contamination through site investigation activities.

5.2.1 Monitoring Well Sampling Equipment

5.2.1.1 Groundwater sampling pumps – This includes pumps inserted into the monitoring well such as Bladder pumps, Whale pumps, Redi-Flo, reusable bailers, etc.

1) Evacuate to the extent possible, any purge water within the pump.
2) Scrub using soap and water and/or steam clean the outside of the pump and tubing, where applicable.
3) Insert the pump and tubing into a clean container of soapy water. Pump a sufficient amount of soapy water through the pump to flush any residual purge water. Once flushed, circulate soapy water through the pump to ensure the internal components are thoroughly flushed.
4) Remove the pump and tubing from the container, rinse external components using tap water. Insert the pump and tubing into a clean container of tap water. Pump a sufficient amount of tap water through the pump to evacuate all of the soapy water (until clear).
5) Rinse equipment with pesticide grade isopropanol.
6) Repeat item #4 using deionized water through the hose to flush out the tap water and solvent residue as applicable.
7) Drain residual deionized water to the extent possible, allow components to air dry.
8) Wrap pump in aluminum foil or a clear clean plastic bag for storage.

5.2.1.2 Electronic Water Level Indicators/Sounders/Tapes

During water level measurements, rinsing with the extracted tape and probe with deionized water and wiping the surface of the extracted tape is acceptable. However, periodic full decontamination should be conducted as indicated below.

- The solvent should be employed when samples contain oil, grease, PAHs, PCBs, and other hard to remove materials. If these are not of primary concern, the solvent step may be omitted. In addition, do not rinse PE, PVC, and associated tubing with solvents.
1) Wash with soap and water
2) Rinse with tap water
3) Rinse with deionized water

Note: In situations where oil, grease, free product, other hard to remove materials are encountered probes and exposed tapes should be washed in hot soapy water.

5.2.1.3 Miscellaneous Equipment

Miscellaneous equipment including analytical equipment (water quality testing equipment) should be cleaned per manufacturer’s instructions. This generally includes wiping down the sensor housing and rinsing with tap and deionized water.

Coolers/Shipping Containers employed to ship samples are received from the lab in a variety of conditions from marginal to extremely poor. Coolers should be evaluated prior to use for:

- Structural integrity – Coolers missing handles or having breaks within the outer housing should be removed and not used. Notify the laboratory that the risk of shipping samples will not be attempted and request a replacement unit.

- Cleanliness – As per protocol only volatile organic samples are accompanied by a trip blank. If a cooler’s cleanliness is in question (visibly dirty/stained) or associated with noticeable odors it should be decontaminated prior to use.

1) Wash with soap and water
2) Rinse with tap water
3) Dry

If these measures fail to clean the cooler to an acceptable level, remove the unit from use as a shipping container and notify the laboratory to provide a replacement unit.

5.2.2 Down-Hole Drilling Equipment

This includes any portion of the drill rig that is over the borehole including auger flights, drill stems, rods, and associated tooling that would extend over the borehole. This procedure is to be employed prior to initiating the drilling/sampling activity, then between locations.

1) Remove all soils to the extent possible using shovels, scrapers, etc. to remove loose soils.
2) Through a combination of scrubbing using soap and water and/or steam cleaning remove visible dirt/soils.
3) Rinse with tap water.
4) Rinse equipment with pesticide grade isopropanol
5) To the extent possible allow components to air dry.
6) Wrap or cover equipment in clear plastic until it is time to be used.

5.2.3 Soil/Sediment Sampling Equipment

This consists of soil sampling equipment including but not limited to hand augers, stainless steel trowels/spoons, bowls, dredges, scoops, split spoons, Macro Core samplers, etc.
1) Remove all soils to the extent possible.

2) Through a combination of scrubbing using soap and water and/or steam cleaning remove visible dirt/soils.

3) Rinse with tap water.

4) Rinse equipment with pesticide grade isopropanol

5) Rinse with deionized water

6) To the extent possible allow components to air dry.

7) If the device is to be used immediately, screen with a PID/FID to insure all solvents (if they were used) and trace contaminants have been adequately removed.

8) Once these devices have been dried wrap in aluminum foil for storage until it is time to be used.

5.3 Contact Waste/Materials

During the course of field investigations disposable/single use equipment becomes contaminated. These items include tubing, trowels, PPE (gloves, overboots, splash suits, etc.) broken sample containers.

With the exception of the broken glass, single use articles should be cleaned (washed and rinsed) of visible materials and disposed of as normal refuse. The exception to this rule is that extremely soiled materials that cannot be cleaned should be containerized for disposal in accordance with applicable federal state and local regulations.

5.3.1 Decontamination Solutions

All waste decontamination solutions and rinses must be assumed to contain the hazardous chemicals associated with the site unless there are analytical or other data to the contrary. The waste solution volumes could vary from a few gallons to several hundred gallons in cases where large equipment required cleaning.

Containerized waste rinse solutions are best stored in 55-gallon drums (or equivalent containers) that can be sealed until ultimate disposal at an approved facility. These containers must be appropriately labeled.

5.4 Decontamination Evaluation

Determining the effectiveness of the decontamination process will be accomplished in the following manner

- Visual Evaluation – A visual evaluation will be conducted to insure the removal of particulate matter. This will be done to insure that the washing/rinsing process is working as intended.

- Instrument Screening – A PID and/or an FID should be used to evaluate the presence of the contaminants or solvents used in the cleaning process. The air intake of the instrument should be passed over the article to be evaluated. A positive detection requires a repeat the decontamination process. It should be noted that the instrument scan is only viable if the contaminants are detectable within the instruments capabilities.
- Rinsate Blanks – It is recommended that Rinsate samples be collected to
  - Evaluate the decontamination procedure representing different equipment applications (pumps versus drilling equipment) and different decontamination applications.
  - Single use disposable equipment – The number of samples should represent different types of equipment as well as different Lot Numbers of single use articles.

The collection and the frequency of collection of rinsate samples are as follows:
- Per decontamination method
- Per disposable article/Batch number of disposable articles

It is recommended that an initial rinsate sample be collected early in the project to ensure that the decontamination process is functioning properly and in an effort to avoid using a contaminated batch of single use articles. It is recommended that a follow up sample be collected during the execution of the project to insure those conditions do not change. Lastly, rinsate samples collection may be driven by types of and/or contaminant levels. Hard to remove contaminants, oils/greases, some PAHs/PCBs, etc. may also support the collection of additional rinsates due to the obvious challenges to the decontamination process. This is a field consideration to be determined by the FOL.
APPENDIX B

LABORATORY
STANDARD OPERATING PROCEDURES

- NOT AVAILABLE -

The laboratory will be procured every 2 years prior to each sampling event. Prior to sampling, TBDs will be filled in with laboratory specific information and Laboratory SOPs will be submitted to stake holders for review.
APPENDIX C

FIGURES
LOCATION OF IR SITES
NAS JRB WILLOW GROVE
WILLOW GROVE, PENNSYLVANIA
APPENDIX D

EPA REGION 3 RECOMMENDED PROCEDURE FOR LOW - FLOW PURGING AND SAMPLING OF GROUNDWATER MONITORING WELLS
RECOMMENDED PROCEDURE FOR LOW-FLOW PURGING AND SAMPLING OF GROUNDWATER MONITORING WELLS

1.0 OBJECTIVE AND APPLICATION

This directive provides a procedure for collection of ground-water samples in small-diameter wells with short-screened intervals using low-flow purging and sampling. While these procedures pertain to the Superfund program in Region III, they were based on recommendations presented in the EPA Ground Water Issue paper entitled “Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures”. The low-flow purging and sampling method is not appropriate for use in all hydrogeologic regimes, and particular groundwater monitoring well designs may make the method unsuitable (e.g. open hole and long screen monitoring wells in bedrock and stratified sand and clay where the water bearing zones have not been characterized). Therefore, please confer with a Region III hydrogeologist or geologist before using these procedures at a site.

2.0 BACKGROUND

Past scientific research (Barcelona et al., 1983; Nielson and Yeates, 1985) and EPA guidance have discussed sampling devices in terms of their compatibility with contaminants being sampled, and well construction, depth, and diameter. Although some sampling devices have been used in order to provide more representative groundwater samples in certain situations, most of these incorporate high-volume withdrawal techniques (i.e., in excess of the “natural” recharge rate of groundwater flow through the well screen) for both purging and sampling.

Research conducted by Puls et al. (1992), Puls and Powell (1992), and Powell and Puls (1993) has shown that high-volume purging and sampling cause significant turbidity and suspended particulate artifacts that can result in biased-high metals results. Additionally, purging can cause pressure changes and bailing can cause aeration that can strip VOCs from the sample (Pennino, 1988). The use of low-flow pumping devices (preferably dedicated) for purging and sampling minimizes both the disturbance of water in well casing and the potential for mobilization of colloidal material (Barcelona et al., 1994). Low-flow purging with maintenance of water level in the well and stabilization of indicator parameters (especially turbidity) allows collection of groundwater samples that are more representative of conditions without filtering (U.S. EPA, 1993; Backhus et al., 1993). In many cases, use of a low-flow pump to purge and sample monitoring wells decreases sampling time, reduces the need to handle large volumes of purge water and lowers the cost associated with its disposal, and allows collection of samples for inorganic analyses without filtering. This procedure is designed to be used in conjunction with groundwater sampling and analyses for the most common types of groundwater contaminants (volatile and semi-volatile organic compounds, pesticides, PCBs and inorganic compounds).

3.0 EQUIPMENT
Adjustable rate, positive displacement pumps (e.g. low flow-rate submersible centrifugal or bladder pumps constructed of stainless steel or Teflon). Low flow-rate electrical submersible pumps are recommended because (1) they are not subject to cyclical flow/arrest and consequent potential for mobilizing fine-grained material, and (2) they may be less prone to operator error, thereby reducing potential error resulting from application by different personnel. The pump should be easily adjustable and capable of operating reliably at lower flow rates. Peristaltic pumps may be used only for inorganic sample collection. Bailers are inappropriate for use in this procedure.

Tubing: Tubing used in purging and sampling each well must be dedicated to the individual well. Once properly located, moving the pump in the well should be avoided. Consequently, the same tubing should be used for purging and sampling. Teflon or Teflon-lined polyethylene tubing must be used to collect samples for organic analysis. For samples collected for inorganic analysis, Teflon or Teflon lined polyethylene, PVC, Tygon or polyethylene tubing may be used. The tubing wall thickness should be maximized (3/8 to ½ inch) and the tubing length should be minimized (i.e. do not have excess tubing outside of the well).

Polyethylene sheeting and sampling gloves.

Water level measuring device, 0.01 feet accuracy, (electronic preferred for tracking water level drawdown during all pumping operations).

Flow measurement supplies (e.g. graduated cylinder and stop watch).

Interface probe, if needed.

Power source (e.g. generator, located downwind; nitrogen tank, etc). The generator should not be oversized for the pump.

In-line flow-through cell containing purge criteria parameter monitoring instruments for pH, turbidity, specific conductance, temperature, Eh and dissolved oxygen (DO). The in-line device should be bypassed or disconnected during sample collection.

Photoionization detector (PID), or equivalent.

Nylon stay-ties.

Decontamination supplies.

Logbook(s).

Sample Bottles. It is recommended that preservatives are added to sample bottles prior to field activities to reduce potential error or introduction of contaminants.
Sample preservation supplies (as required by the analytical method; see previous bullet).

Sample tags or labels, chain of custody.

Well construction data, location map, field data from last sampling event.

Approved Field Sampling Plan/QA Project Plan.

4.0 PRELIMINARY SITE ACTIVITIES

1) Check the condition of the monitoring well for damage and evidence of tampering, and record pertinent observations.

2) In order to maintain a clean work area, lay out a sheet of polyethylene to place sampling and monitoring equipment.

3) Remove well cap and measure VOCs at the rim of the well with a PID or FID instrument and record the reading in the field logbook.

4) If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing) make one.

5) Measure and record the depth to water (to 0.01 feet) in all wells to be sampled before any purging begins. Care should be taken to minimize disturbance to the water column and to any particulate attached to the sides or at the bottom of the well. Consequently, in order to avoid disturbing any accumulated sediment and to prevent mixing of stagnant water with water in the screened interval, the total depth of a well should be measured well in advance (one to two weeks) of purging and sampling or after sampling is completed. Obtain depth to bottom of well information from the well construction log and calculate standing water volume as: depth of water column times cross-sectional area of the well.

6) For wells where an Light Non-aqueous Phase Liquid (LNAPL) has been detected, a stilling tube should be inserted into the well prior to purging. Refer to Section 7.2.4 of EPA (1992) for the procedure to follow. If the wells are constructed so that DNAPLs could accumulate, their detection and/or sampling should occur, at a minimum, a week before groundwater purging and sampling. Measurement and sampling of potential DNAPL should be conducted as a separate event to minimize disturbance of any sediments which have accumulated in the bottom of the well. A double check valve, bottom loading bailer is recommended for sampling. Light non-aqueous phase liquid (LNAPL) measurement may be conducted (with an interface probe), with care to avoid disturbance of the water column within the well.

5.0 PURGING AND SAMPLING PROCEDURES

The following describes the procedure for the low-flow purging and sampling method. Equipment calibration, logbook documentation, sample bottle filling and preservation, and
shipping will be conducted in accordance with the site-specific Quality Assurance Project Plan (QAPjP). Personal protective equipment will be donned in accordance with the requirements of the site-specific Health and Safety Plan. Wells should be sampled in the order of least contaminated to most contaminated.

1) Attach and secure the polyethylene tubing to the low-flow pump. As the pump is slowly lowered into the well, secure the safety drop cable, tubing, and electrical lines to each other using nylon stay-ties.

2) Pump, safety cable, tubing and electrical lines should be lowered slowly into the well to a depth corresponding to the center of the saturated screen section of the well, or at a location determined to either be a preferential flow path or zone where contamination is present. The pump intake should be kept above the bottom of the well to prevent mobilization of any sediment or DNAPL present in the bottom of the well. It is recommended that the pump be placed in the well 12 to (preferably) 48 hours prior to purging/sampling to minimize the effects of turbidity and mixing in the well from introducing the pump.

3) Measure the water level again with the pump in the well before starting the pump. Start pumping water from the well at a rate of 100 to 400 milliliters per minute (mL/min). Avoid surging. Observe air bubbles displaced from discharge tube to assess progress of steady pumping until water arrives at the surface. The pumping rate should cause little or no water level drawdown in the well (less than 0.2 ft) and the water level should stabilize. Water level measurements should be made continuously. Precautions should be taken to avoid pump suction loss or air entrainment. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to avoid pumping the well dry and ensure stabilization of indicator parameters. If the recharge rate of the well is very low, purging should be interrupted so as not to cause the drawdown within the well to advance below the pump intake but the operator should attempt to maintain a steady flow rate with the pump to the extent practicable. In these low-yielding wells, where 100 mL/min exceeds the entrance rate of groundwater into the well, it is important to avoid dewatering the well screen interval. In these cases, the pump should remain in place and the water level should be allowed to recover repeatedly until there is sufficient volume in the well to permit collection of samples. An alternative means of sample collection may be necessary under these conditions.

4) While purging the well, monitoring of in-line water quality indicator parameters should include turbidity, specific conductance, pH, dissolved oxygen (DO) and redox potential (Eh) which must be collected every three to five minutes until all of the parameters have stabilized. Stabilization is achieved when three successive readings are within ±0.1 for pH, ±3% for conductivity, ±10mv for redox potential (Eh), and ±10% for turbidity and DO. A minimum subset of these parameters that can be used to determine stabilization during purging in this procedure are pH, specific conductivity and turbidity or DO. Turbidity and DO are typically the last parameters to stabilize. If the parameters have stabilized, but the turbidity is not in the range of 5-10 NTU, then follow step 6.

5) Once stabilization has been documented, VOC and gas sensitive (e.g. Fe^{+2}, CH₄, H₂S/HS)
parameter samples should be immediately collected first and directly into pre-preserved sample containers. All sample containers should be filled by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

Samples requiring pH adjustment should have their pH checked to assure that the proper pH has been obtained. For VOC samples, this will require that a test sample be collected to determine the amount of preservative required to be added to the sample containers prior to sampling.

6) If the turbidity measurements do not approach the range of that of natural groundwater (10 NTU), both filtered and unfiltered samples should be collected for metals analysis. Filtered metal samples are to be collected with an in-line filter. A high capacity, in-line 0.45 micron particulate filter must be pre-rinsed according to the manufacturer’s recommendations, or with approximately 1 liter of groundwater following purging and prior to sampling. After the sample is filtered it must be preserved immediately.

7) As each sample is collected, the sample should be labeled as defined in the QAPjP. All samples should be placed into a cooler with proper temperature control as outlined in the QAPjP.

After collection of the samples, the tubing from the pump should be properly discarded or dedicated to the well for re-sampling (by hanging the tubing inside the well).

8) Measure and record well total depth.

9) Secure the well (close and lock it up).

6.0 REFERENCES


APPENDIX E

MONITORING WELL CONSTRUCTION LOGS
WATER WELL COMPLETION REPORT

Well Driller: EICHELBERGERS INC.  
Driller Well ID: DS10050-MW0150
Driller License: 0198  
Local Permit #:
Type of Activity: New Well  
Original Well By: Current Driller
Date Drilled: 4/20/2011  
Drilling Method: AIR ROTARY

Owner: USACE  
Address of Well: 1301 EASTON RD  
Zipcode: 19090
County: MONTGOMERY  
Municipality: HORSHAM  
Municipality Type: T
Coordinate Method: Commercial Street Atlas Program  
Quadrangle: Latitude: 40.15864  
Longitude: -75.12262

Well Depth (ft): 24  
Well Finish: SCREEN
Depth to Bedrock (ft):  
Did Not Encounter Bedrock: X
Well Yield (gpm):  
Yield Measure Method:
Static Water Level:  
(Water level after yield test:  
(ft below land surface)
Length of Yield Test:  
(Saltwater Zone (ft):)
Use of Well: OBSERVATION  
Use of Water: UNUSED

DRILLER'S LOG

<table>
<thead>
<tr>
<th>UNIT TOP</th>
<th>UNIT BOTTOM</th>
<th>DESCRIPTION OF UNITS PENETRATED</th>
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<tr>
<td>Unit Top 1: 0</td>
<td>Unit Bottom 1: 13</td>
<td>Unit 1: OVERBURDEN</td>
</tr>
<tr>
<td>Unit Top 2: 13</td>
<td>Unit Bottom 2: 24</td>
<td>Unit 2: WEATHERED RED SILTSTONE</td>
</tr>
</tbody>
</table>

BOREHOLE

Section 1:  
Top: 0  Bottom: 24  Diameter: 6

CASING

Casing 1:  
Top: 0  Bottom: 11  Diameter: 2  Material: PVC OR OTHER PLASTIC

### Seal(Grout) 1:
- Top: 0
- Bottom: 9
- Type: BENTONITE CHIPS/PELLETS

### SCREEN/SLOT
- **Screen 1:**
  - Top: 11
  - Bottom: 24
  - Diameter: 2
  - Type: SCREEN
  - Material: PLASTIC
  - Slot Size: 20
  - Packing: Screened Sand

---

I hereby certify that the above information is true and complete to the best of my knowledge and belief.

[Signature]

Driller's Signature (required)  Date: 6/24/11
## WATER WELL COMPLETION REPORT

**Well Driller:** EICHELBERGERS INC.  
**Driller License:** 0198  
**Type of Activity:** New Well  
**Date Drilled:** 4/20/2011  
**Drilling Method:** AIR ROTARY

**Owner:** USACE  
**Address of Well:** 1301 EASTON RD  
**County:** MONTGOMERY  
**Municipality:** HORSHAM  
**Coordinate Method:** Commercial Street Atlas Program

**Well Depth (ft):** 40  
**Depth to Bedrock (ft):** 24  
**Well Yield (gpm):** Did Not Encounter Bedrock:  
**Static Water Level:** Water level after yield test:  
**Length of Yield Test:** Saltwater Zone (ft):  
**Use of Well:** OBSERVATION  
**Use of Water:** UNUSED

### DRILLER'S LOG

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<th>UNIT BOTTOM</th>
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<td>Unit 3: RED SILTSTONE AND SANDSTONE</td>
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### BOREHOLE

**Section 1:**  
**Top:** 0  
**Bottom:** 40  
**Diameter:** 6

### CASING

Casing 1:

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6/14/2011
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**Seal(Grout) 1:**

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### SCREEN/SLOT

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<tr>
<td>Packing: Screened Sand</td>
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</tr>
</tbody>
</table>

I hereby certify that the above information is true and complete to the best of my knowledge and belief.

[Signature]

Drillers Signature (required) Date
OVERBURDEN / BEDROCK MONITORING WELL SHEET

PROJECT: Willow Grove  LOCATION: Privet Road
PROJECT NO.: 3552  BORING: PRW-6
ELEVATION: 295.8  DATE: 9-29-91
FIELD GEOLOGIST: R. Good

ELEVATION OF TOP OF SURFACE CASING: 298.6'
ELEVATION TOP OF RISER: 298.0'

TYPE OF SURFACE SEAL: Cement / Bentonite Grout

TYPE OF PROTECTIVE CASING: Steel CSG
I.D. OF PROTECTIVE CASING

BOREHOLE DIAMETER: 10" Ø Hole

TYPE OF RISER PIPE: 4" PVC, SCH. 40
RISER PIPE I.D.: 4" ID

TYPE OF BACKFILL/SEAL: Cement / Bentonite Grout

DEPTH/ELEVATION TOP OF SAND:
50'

DEPTH/ELEVATION TOP OF SCREEN:
60'

TYPE OF SCREEN: 4" ID PVC, SCH. 40
SLOT SIZE x LENGTH: 10 Slot x 20'

DEPTH/ELEVATION BOTTOM OF SCREEN:
80'

TYPE OF SAND PACK: No. 1 SAND

DEPTH/ELEVATION BOTTOM OF SAND:
26.0'

DEPTH/ELEVATION BOTTOM OF SAND:
27.0'

DEPTH/ELEVATION BOTTOM OF HOLE:
28.0'

BACKFILL MATERIAL BELOW SAND: 0

B.3.5