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FINAL SAMPING AND ANALYSIS PLAN AMENDMENT MUNITIONS RESPONSE PROGRAM REMEDIAL INVESTIGATION OF FORMER MACHINE GUN RANGE COMPLEX NAS JACKSONVILLE FL

11/7/2013

RESOLUTION CONSULTANTS

By inclusion of this cover sheet and the following signature pages, which signify concurrence among the NAS Jacksonville Partnering Team members, the Draft Final Sampling and Analysis Plan Amendment (dated September 2013) becomes the Final Sampling and Analysis Plan Amendment (dated November 2013).

FINAL
SAMPLING AND ANALYSIS PLAN AMENDMENT

Munitions Response Program
Remedial Investigation of Former Machine Gun Range Complex
Naval Air Station Jacksonville
Jacksonville, Florida

Version Number: 1

Prepared For:

Department of the Navy
Naval Facilities Engineering Command Southeast
Building 135 North, P.O. Box 30
Jacksonville, Florida 32212-0030

Prepared By:

Resolution Consultants
A Joint Venture of AECOM & EnSafe
1500 Wells Fargo Building
440 Monticello Avenue
Norfolk, Virginia 23510

Contract Number: N62470-11-D-8013
CTO JM08

November 2013

SAP WORKSHEET #1: TITLE AND APPROVAL PAGE

(UFP-QAPP Manual Section 2.1)

DRAFT-FINAL
SAMPLING AND ANALYSIS PLAN AMENDMENT

Munitions Response Program
Remedial Investigation of Former Machine Gun Range Complex
Naval Air Station Jacksonville
Jacksonville, Florida

Version Number: 1

Prepared For:

Department of the Navy
Naval Facilities Engineering Command Southeast
NAS Jacksonville
Ajax Street, Building 135 North, P.O. Box 30
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1500 Wells Fargo Building
440 Monticello Avenue
Norfolk, Virginia 23510

Contract Number: N62470-11-D-8013
CTO JM08

September 2013

Peter Dao, U.S. EPA Region 4
Remedial Project Manager/Date

Cantwell.Tina Digitally signed by Cantwell.Tina DN: cn=Cantwell.Tina, o=Resolution Consultants, ou, email=tcantwell@ensafe.com, c=US Date: 2013.09.27 10:20:14 -05'00'

Tina Cantwell, Resolution Consultants
Project Chemist/QA Officer/Date

Digitally signed by Todd Haverkost DN: cn=Todd Haverkost, o, ou=Resolution Consultants, email=thaverkost@ensafe.com, c=US Date: 2013.09.27 10:00:32 -05'00'

Todd Haverkost, Resolution Consultants
Task Order Manager/Date

11/13/13

Jennifer Conklin, Florida Department of Environmental Protection
Remedial Project Manager/Date

Jonathan Tucker[1], NAVFAC Atlantic
NAVFAC Atlantic Quality Assurance Officer/Chemist/Date

WILSON.ADRIENNE.TOWNSEL.1228825723 Digitally signed by WILSON.ADRIENNE.TOWNSEL.1228825723 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USN, cn=WILSON.ADRIENNE.TOWNSEL.1228825723 Date: 2013.09.27 11:28:03 -04'00'

Adrienne Wilson, NAVFAC Southeast
Remedial Project Manager/Date

[1] Jonathan Tucker reviewed the *Internal Draft Tier II Sampling and Analysis Plan for the Munitions Response Program Remedial Investigation of the Former Machine Gun Range Complex* on March 28, 2012 and is no longer at NAVFAC Atlantic.

SAP WORKSHEET #1: TITLE AND APPROVAL PAGE

(UFP-QAPP Manual Section 2.1)

DRAFT
SAMPLING AND ANALYSIS PLAN AMENDMENT

Munitions Response Program
Remedial Investigation of Former Machine Gun Range Complex
Naval Air Station Jacksonville
Jacksonville, Florida

Version Number: 0

Prepared For:

Department of the Navy
Naval Facilities Engineering Command Southeast
NAS Jacksonville
Ajax Street, Building 135 North, P.O. Box 30
Jacksonville, Florida 32212-0030

Prepared By:

Resolution Consultants
A Joint Venture of AECOM & EnSafe
1500 Wells Fargo Building
440 Monticello Avenue
Norfolk, Virginia 23510

Contract Number: N62470-11-D-8013
CTO JM08

March 2013

5/16/13

Peter Bao, USEPA Region 4
Remedial Project Manager/Date

Cantwell.Tina
Digitally signed by Cantwell.Tina
DN: cn=Cantwell.Tina, o=EnSafe Inc., ou, email=tcantwell@ensafe.com, c=US
Date: 2013.03.14 11:31:51 -05'00'

Tina Cantwell, Resolution Consultants
Project Chemist/QA Officer/Date

Todd Haverkost
Digitally signed by Todd Haverkost
DN: cn=Todd Haverkost, o, ou=Resolution Consultants, email=thaverkost@ensafe.com, c=US
Date: 2013.03.14 11:23:33 -05'00'

Todd Haverkost, Resolution Consultants
Task Order Manager/Date

David Grabka, Florida Department of Environmental Protection
Remedial Project Manager/Date

Jonathan Tucker[1], NAVFAC Atlantic
NAVFAC Atlantic Quality Assurance Officer/Chemist/Date

WILSON.ADRIENNE.TOWNSEL.1228825723
Digitally signed by WILSON.ADRIENNE.TOWNSEL.1228825723
DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USN, cn=WILSON.ADRIENNE.TOWNSEL.1228825723
Date: 2013.03.15 14:14:20 -04'00'

Adrienne Wilson, NAVFAC Southeast
Remedial Project Manager/Date

[1] Jonathan Tucker reviewed the *Internal Draft Tier II Sampling and Analysis Plan for the Munitions Response Program Remedial Investigation of the Former Machine Gun Range Complex* on March 28, 2012 and is no longer at NAVFAC Atlantic.

EXECUTIVE SUMMARY

The Former Machine Gun Range Complex at Naval Air Station (Jacksonville, in Jacksonville, Florida (**Figure ES-1 in Appendix A**) is the subject of a Munitions Response Program (MRP) Remedial Investigation (RI) being jointly completed by the United States Department of the Navy's (Navy) Comprehensive Long-term Environmental Action Navy (CLEAN) contractors, Resolution Consultants and Tetra Tech. The Former Machine Gun Range Complex comprises six Unexploded Ordnance (UXO) sites that were formerly identified as Potential Source of Contamination (PSC) sites prior to the discovery of Munitions Constituents (MC) in soil and sediment and the sites' subsequent inclusion in the MRP. The six sites, which are shown on **Figure ES-2 in Appendix A,** are as follows:

- Fort Dix Skeet Range (formerly identified as PSC 22, now identified as UXO 1)
- .50 Caliber Range (formerly PSC 23A, now UXO 2)
- Former Skeet Range (formerly PSC 23B, now UXO 3)
- Akron Road Pistol Range (formerly PSC 56, now UXO 4)
- .30 Caliber Range (formerly PSC 57, now UXO 5)
- Trap Ranges (formerly PSC 58, now UXO 6)

The *Final Tier II Sampling and Analysis Plan (SAP) for the Munitions Response Program (MRP) Remedial Investigation (RI) of the Former Machine Gun Range Complex* (Tetra Tech, 2012) addressed all six UXO sites. Tetra Tech has been tasked to implement the SAP and complete the RI at three of the sites, UXO 1, UXO 3, and UXO 5. Resolution Consultants has been tasked under CLEAN Contract Number N62470-11-D-8013, Contract Task Order JM08, to implement the SAP and complete the RI at the remaining three sites, UXO 2, UXO 4, and UXO 6.

Resolution Consultants has largely adopted the Final Tier II SAP (Tetra Tech, 2012); however, minor administrative revisions were needed to some of the worksheets to reflect Resolution Consultants' involvement in the project. This Final Tier II SAP Amendment contains the revised worksheets, provides copies of Resolution Consultants Standard Operating Procedures, and a crosswalk table (Table 2-1) referencing g the Final Tier II SAP (Tetra Tech, 2012) worksheets that were adopted in their entirety without modification. Analytical services for Resolution Consultants' portion of the RI will be provided by the same analytical laboratories identified in the Final Tier II SAP (Tetra Tech, 2012) to promote consistency.

This Amendment, in combination with the Final Tier II SAP (Tetra Tech, 2012), complies with applicable Navy, United States Environmental Protection Agency (U.S. EPA) Region 4, and Florida Department of Environmental Protection requirements, regulations, guidance, and technical standards, as appropriate. This includes the Department of Defense, Department of Energy, and U.S. EPA Interagency Data Quality Task Force environmental requirements regarding federal facilities, as specified in the Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) guidance (U.S. EPA, 2005) and the Navy's guidance for Tier II SAPs (which is the preferred format for use in addressing project sites that are not particularly complex or politically sensitive). A cross-walk indicating the location of information required under the UFP-QAPP guidance is provided in **Table 2-1**.

Table of Contents

Tables

Appendices

Acronyms and Abbreviations

bgs	Below ground surface
Chemtech	Chemtech Consulting Group, Inc.
CLEAN	Comprehensive Long-term Environmental Action Navy
CFR	Code of Federal Regulations
CTO	Contract Task Order
DO	Dissolved oxygen
DoD	Department of Defense
DPT	Direct-push technology
DVA	Data Validation Assistant
EDD	Electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
Empirical	Empirical Laboratories, LLC
eQAPP	Electronic Quality Assurance Project Plan
ESSDR	Explosives Safety Submission Determination Request
FDEP	Florida Department of Environmental Protection
FOL	Field operations leader
FRC	Federal Records Center
GPS	Global positioning system
HSM	Health and safety manager
IDQTF	Intergovernmental Data Quality Task Force
IDW	Investigation-derived waste
IRP	Installation Restoration Program
LCS	Laboratory control sample
LCSD	Laboratory control sample duplicate
MC	Munitions constituents
MPC	Measurement performance criterion
MRP	Munitions Response Program
MS	Matrix spike
MSD	Matrix spike duplicate
mV	milliVolt
NA	Not applicable
NAD 83	North American Datum of 1983
NAS	Naval Air Station
NAVD 88	North American Vertical Datum of 1988
NAVFAC	Naval Facilities Engineering Command
NAVFAC SE	Naval Facilities Engineering Command Southeast
Navy	United States Department of the Navy
NELAP	National Environmental Laboratory Accreditation Program
NIRIS	Naval Installation Restoration Information Solution

Acronyms and Abbreviations (Continued)

ORP	Oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
PM	Project manager
POC	Point of contact
PSC	Potential source of contamination
PVC	Polyvinyl chloride
QA	Quality assurance
QAO	Quality assurance Officer
QA/QC	Quality assurance/quality control
QC	Quality control
RI	Remedial Investigation
RPD	Relative percent difference
RPM	Remedial project manager
%R	Percent recovery
SAP	Sampling and Analysis Plan
SOP	Standard operating procedure
SPCS	State plan coordinate system
SSO	Site safety officer
TBD	To be determined
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plan
U.S.	United States
U.S. EPA	United States Environmental Protection Agency
UXO	Unexploded ordnance
WS	Worksheet

SAP WORKSHEET #2: SAMPLING AND ANALYSIS PLAN IDENTIFYING INFORMATION

(UFP-QAPP Manual Section 2.2.4)

Site Name/Number: Unexploded Ordnance (UXO) Sites 2, 4, and 6

Contractor Name: Resolution Consultants

Contract Number: N62470-11-D-8013

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

Work Assignment Number: Contract Task Order (CTO) JM08

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of the *Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP)* (IDQTF, 2005) and the United States Environmental Protection Agency (U.S. EPA) *Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS* (U.S. EPA, 2002).

2. Identify regulatory program: Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as reauthorized by Superfund Amendments and Reauthorization Act.

3. This SAP is a **project-specific** SAP.

4. List dates of scoping sessions that were held:

Scoping Session	Date
Data Quality Objective Scoping Meetings (Jacksonville Partnering Team)	13 June 2011 and 20 July 2011

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

Title	Date
Quality Assurance Project Plan (QAPP) Sampling and Analysis Plan (SAP) for Munitions Response Program (MRP) Site Inspections at the Former Machine Gun Range Complex, Revision 0, Naval Air Station Jacksonville, Jacksonville Florida, Tetra Tech Inc.	June 2009

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

Organization Partners/Stakeholders	Connection
Florida Department of Environmental Protection (FDEP)	Regulatory Oversight
U.S. Environmental Protection Agency	Regulatory Oversight
Naval Facilities Engineering Command Southeast (NAVFAC SE)	Operator/Lead Agency
Naval Air Station (NAS) Jacksonville	Property Owner

7. Lead organization: Naval NAVFAC SE

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:

This amendment to the *Final Tier II Sampling and Analysis Plan (SAP) for the Munitions Response Program (MRP) Remedial Investigation (RI) of the Former Machine Gun Range Complex* (Tetra Tech, 2012) was prepared in response to a change in Navy contractors responsible for implementing the portions of the SAP related to three of the sites, UXO 2, 4, and 6. Although the goals and technical scope of work remain consistent with the original SAP, administrative revisions are necessary to select worksheets to reflect the fact a different corporate entity, Resolution Consultants, will be performing the work at the aforementioned sites.

The administrative revisions consist of replacing the words "Tetra Tech" with "Resolution Consultants," replacing the names of Tetra Tech personnel with Resolution Consultants personnel where appropriate, and changing references to company specific standard operating procedures (SOP). The unaffected worksheets in the original SAP have been adopted by Resolution Consultants and are incorporated into this amendment by reference. Table 2-1 lists all of the required SAP worksheets and indicates which ones have been amended and which ones are unchanged from the original version. A CD-ROM containing an electronic version of the Final Tier II SAP (Tetra Tech, 2012) is in **Appendix B**.

Table 2-1
UFP SAP Amendment Crosswalk

UFP SAP Worksheet #	Required Information	Changes Provided (Yes/No)	Crosswalk to Related Information
A. Project Management and Objectives			
Documentation			
1	Title and Approval Page	Yes	Included in this UFP SAP Amendment
ES	Executive Summary	Yes	Included in this UFP SAP Amendment
TOC	Table of Contents	Yes	Included in this UFP SAP Amendment
2	SAP Identifying Information	Yes	Included in this UFP SAP Amendment
3	Distribution List	Yes	Included in this UFP SAP Amendment
4	Project Personnel Sign-Off Sheet	Yes	Included in this UFP SAP Amendment
Project Organization			
5	Project Organizational Chart	Yes	Included in this UFP SAP Amendment
6	Communication Pathways	Yes	Included in this UFP SAP Amendment
7	Personnel Responsibilities Table	Yes	Included in this UFP SAP Amendment
8	Special Personnel Training Requirements Table	Yes	Included in this UFP SAP Amendment
Project Planning/Problem Definition			
9	Project Scoping Session Participants Sheet	No	Adopted WS#9, Section 3.0, pages 18-23 in the Final Tier II SAP (Tetra Tech, 2012).
10	Conceptual Site Model	No	Adopted WS#10, Section 4.0, pages 24-46 in the Final Tier II SAP (Tetra Tech, 2012).
11	Project Quality Objectives/Systematic Planning Process Statements	No	Adopted WS#11, Section 5.0, pages 47-56 in the Final Tier II SAP (Tetra Tech, 2012).
12	Field Quality Control Samples	No	Adopted WS#12, Section 6.0, page 57 in the Final Tier II SAP (Tetra Tech, 2012).
13	Secondary Data Criteria and Limitations Table	No	Adopted Appendix G, WS#13 in the Final Tier II SAP (Tetra Tech, 2012).
14	Summary of Project Tasks	Yes	Included in this UFP SAP Amendment
15	Reference Limits and Evaluation Tables	No	Adopted WS#15, Section 9.0, pages 94-101 in the Final Tier II SAP (Tetra Tech, 2012).
16	Project Schedule/Timeline Table	Yes	Included in this UFP SAP Amendment
B. Measurement/Data Acquisition			
Sampling Tasks			
17	Sampling Design and Rationale	No	Adopted WS#17, Section 7.0, pages 58-63 in the Final Tier II SAP (Tetra Tech, 2012).
18	Location-Specific Sampling Methods/SOP Requirements Table	Yes	Included in this UFP SAP Amendment and modified to only include samples related to sites UXO 2, 4, and 6.
19	Field Sampling Requirements Table	No	Adopted WS#19, Section 8.6, page 92 in the Final Tier II SAP (Tetra Tech, 2012).
20	Field quality control (QC) Sample Summary Table	Yes	Included in this UFP SAP Amendment and modified to only include samples related to sites UXO 2, 4, and 6.
21	Project Sampling SOP References Table	Yes	Included in this UFP SAP Amendment

Table 2-1
UFP SAP Amendment Crosswalk

UFP SAP Worksheet #	Required Information	Changes Provided (Yes/No)	Crosswalk to Related Information
22	Field Equipment Calibration, Maintenance, Testing, and Inspection Table	Yes	Included in this UFP SAP Amendment
Analytical Tasks			
23	Analytical SOP References Table	No	Adopted WS#23, Section 10.0, page 102 in the Final Tier II SAP (Tetra Tech, 2012).
24	Analytical Instrument Calibration Table	No	Adopted Appendix G, WS#24 in the Final Tier II SAP (Tetra Tech, 2012).
25	Analytical Instrument and Equipment Maintenance, Testing, and Inspection Table	No	Adopted Appendix G, WS#25 in the Final Tier II SAP (Tetra Tech, 2012).
Sample Collection			
26	Sample Handling System	Yes	Included in this UFP SAP Amendment
27	Sample Custody Requirements	Yes	Included in this UFP SAP Amendment
Quality Control Samples			
28	Laboratory QC Samples Table	No	Adopted WS#28, Section 11.0, pages 103-107 in the Final Tier II SAP (Tetra Tech, 2012).
Data Management Tasks			
29	Project Documents and Records Table	Yes	Included in this UFP SAP Amendment
30	Analytical Services Table	No	Adopted WS#30, Section 8.6, page 92 in the Final Tier II SAP (Tetra Tech, 2012).
C. Assessment Oversight			
31	Planned Project Assessments Table	No	Adopted Appendix G, WS#31 in the Final Tier II SAP (Tetra Tech, 2012).
32	Assessment Findings and Corrective Action Responses Table	No	Adopted Appendix G, WS#32 in the Final Tier II SAP (Tetra Tech, 2012).
33	Quality assurance (QA) Management Reports Table	Yes	Included in this UFP SAP Amendment
D. Data Review			
34	Verification (Step I) Process Table	Yes	Included in this UFP SAP Amendment
35	Validation (Steps IIa and IIb) Process Table	Yes	Included in this UFP SAP Amendment
36	Validation (Steps IIa and IIb) Summary Table	Yes	Included in this UFP SAP Amendment
37	Usability Assessment	Yes	Included in this UFP SAP Amendment

Notes:
UFP = Uniform Federal Policy for Quality Assurance Project Plans
SAP = Sampling and Analysis Plan
SOP = Standard operating procedure
WS = Worksheet
QC = Quality Control

SAP WORKSHEET #3: DISTRIBUTION LIST

(UFP-QAPP Manual Section 2.3.1)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-Mail Address or Mailing Address
Adrienne Wilson	NAVFAC RPM/Manages Project Activities for the Navy	Department of the Navy Naval Facilities Southeast Code OPDE3/AW Attn: Ajax Street, Building 135N P.O. Box 30A Jacksonville, Florida 32212-0030	904-542-6160	adrienne.wilson@navy.mil
Tim Curtin	Installation Restoration Program Manager/ NAS Jacksonville Point of Contact	Naval Air Station Jacksonville Building 1, Code 064TC NASJAX/Yorktown/Langley Jacksonville, Florida 32212	904-542-4228	tim.l.curtin@navy.mil
Jonathan Tucker[1]	NAVFAC QAO/Government Chemist	NAVFAC Atlantic EV32 6506 Hampton Blvd Building A Norfolk, Virginia 23508	757-322-8288	jonathan.tucker@navy.mil
Jennifer Conklin	FDEP RPM/Provides Regulator Input	FDEP 2600 Blair Stone Road, MS 4535 Tallahassee, Florida 32399-2400	850-245-8935	jennifer.conklin@dep.state.fl.us
Peter Dao	U.S. EPA RPM/Provides Regulator Input	U.S. EPA Region 4 Atlanta Federal Center 61 Forsyth Street, SW Atlanta, Georgia 30303-8960	404-562-8508	dao.peter@epa.gov
Bonnie Capito	Librarian and Records Manager	Naval Facilities Engineering Command Code 1832 5 l 0 Gilbert Street. Norfolk, Virginia 23511-2699	757-322-4785	bonnie.capito@navy.mil
Frank McInturff	Activity Coordinator/Oversees Project Activities	Resolution Consultants 7775 Baymeadows Way, Suite 104 Jacksonville, Florida 32256	904-367-4324 Ext. 6101	fmcinturff@ensafe.com

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-Mail Address or Mailing Address
Todd Haverkost	PM/Manages Project Activities	Resolution Consultants 5724 Summer Trees Drive Memphis, Tennessee 38134	901-372-7962 Ext. 4223	thaverkost@ensafe.com
David Myers	Field Operations Leader/Site Safety Officer/Manages Field Operation and Site Safety Issues	Resolution Consultants 7775 Baymeadows Way, Suite 104 Jacksonville, Florida 32256	904-367-4324 Ext. 6104	dmyers@ensafe.com
Tina Cantwell (electronic copy only)	Project Chemist/QAO/Coordinates laboratory and data validation; oversees project quality assurance.	Resolution Consultants 5724 Summer Trees Drive Memphis, Tennessee 38134	901-937-4315	tcantwell@ensafe.com
Kurt Hummler (electronic copy only)	Laboratory PM/Representative for Laboratory and Analytical Issues	Chemtech Consulting Group, Inc. 283 Sheffield Street Mountainside, New Jersey 07092	908-728-3143	khummler@chemtech.net
Sonya Gordon (electronic copy only)	Laboratory PM/Representative for Laboratory and Analytical Issues	Empirical Laboratories, LLC 621 Mainstream Drive, Suite 270 Nashville, Tennessee 37228	615-345-1113 Ext. 249	sgordon@empirlabs.com

Notes:

[1] Jonathan Tucker reviewed the *Internal Draft Tier II Sampling and Analysis Plan for the Munitions Response Program Remedial Investigation of the Former Machine Gun Range Complex* on March 28, 2012 is no longer at NAVFAC Atlantic.

RPM = Remedial Project Manager
NAVFAC = Department of the Navy, Naval Facilities Engineering Command
QAO = Quality Assurance Officer
FDEP = Florida Department of Environmental Protection
U.S. EPA = U.S. Environmental Protection Agency
NAS = Naval Air Station
PM = Project Manager

SAP WORKSHEET #4: PROJECT PERSONNEL SIGN-OFF SHEET

(UFP-QAPP Manual Section 2.3.2)

Certification that project personnel have read the text will be obtained by one of the following methods, as applicable:

1. In the case of regulatory agency personnel with oversight authority, approval letters and/or Approval Page (Worksheet #1) signatures will constitute verification that applicable sections of the SAP have been reviewed. Copies of regulatory agency approval letters will be retained in the project files and are listed in Worksheet #29 as project records.

2. E-mails will be sent to the Navy, Resolution Consultants, and subcontractor project personnel who will be requested to verify by e-mail that they have read the applicable SAP/sections and the date on which they were reviewed. Copies of the verification e-mail will be included in the project files and are identified in Worksheet #29.

   A copy of the signed Worksheet #4 will be retained in the project files and is identified as a project document in Worksheet #29.

Name	Organization/Title/Role	Telephone Number	Signature/E-Mail Receipt	SAP Section Reviewed	Date SAP Read
Navy and Regulator Partnering Team Personnel					
Adrienne Wilson	Navy/RPM/Manages Project Activities for the Navy	904-542-6160	See Worksheet #1 for signature	All	
Tim Curtin	Navy/IRP Manager/NAS Jacksonville POC	904-542-4228		All	
Jennifer Conklin	FDEP/RPM/Provides Regulator Input	850-245-8935	See Worksheet #1 for signature	All	
Peter Dao	U.S. EPA Region 4/RPM/Provides Regulator Input	404-562-8508	See Worksheet #1 for signature	All	

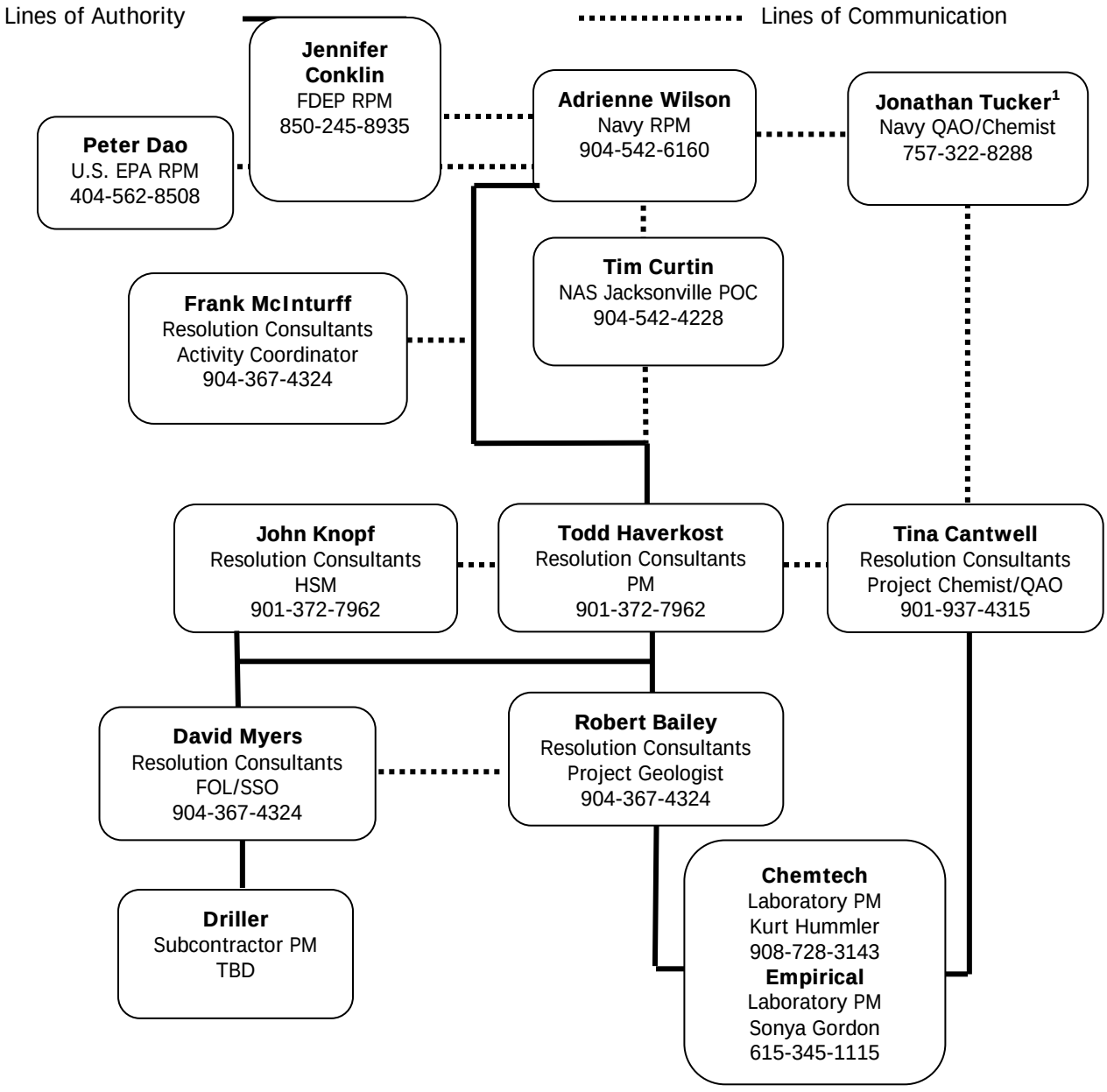
Name	Organization/Title/Role	Telephone Number	Signature/E-Mail Receipt	SAP Section Reviewed	Date SAP Read
Resolution Consultants Project Team Personnel					
Todd Haverkost	Resolution Consultants/PM/Manages Project Activities	901-372-7962 Ext. 4223	See Worksheet #1 for signature	All	
David Myers	Resolution Consultants/FOL/SSO/Manages Field Operation and Site Safety Issues	904-367-4324 Ext. 6104		All	
Robert Bailey	Resolution Consultants/ Project Geologist	904-367-4324 Ext. 6103		All	
Tina Cantwell	Resolution Consultants/Project Chemist/ QAO/Data Validation Manager/Coordinates laboratory and validation; oversees project quality assurance.	901-937-4315	See Worksheet #1 for signature	All	
Subcontractor Personnel					
Kurt Hummler	Chemtech Consulting Group, Inc./ Laboratory PM/Representative for Laboratory and Analytical Issues	908-728-3143		Worksheets #6, #12, #14, #15, #19, #23-28, #30, and #34-36	
Sonya Gordon	Empirical Laboratories, LLC/ Laboratory PM/Representative for Laboratory and Analytical Issues	615-345-1113 Ext. 249		Worksheets #6, #12, #14, #15, #19, #23-28, #30, and #34-36	

Notes:

RPM = Remedial Project Manager
IRP = Installation Restoration Program
POC = Point of Contact
FDEP = Florida Department of Environmental Protection
U.S. EPA = United States Environmental Protection Agency
PM = Project Manager
FOL = Field Operations Leader
SSO = Site Safety Officer
QAO = Quality Assurance Officer
SAP = Sampling and Analysis Plan

SAP WORKSHEET #5: PROJECT ORGANIZATIONAL CHART

(UFP-QAPP Manual Section 2.4.1)



[1] Jonathan Tucker who reviewed the *Internal Draft Tier II Sampling and Analysis Plan for the Munitions Response Program Remedial Investigation of the Former Machine Gun Range Complex* on March 28, 2012 is no longer at NAVFAC Atlantic.

Chemtech	=	Chemtech Consulting Group, Inc.	POC	=	Point of Contact
Empirical	=	Empirical Laboratories, LLC	QAO	=	Quality Assurance Officer
FDEP	=	Florida Department of Environmental Protection	RPM	=	Remedial Project Manager
FOL	=	Field Operations Leader	SSO	=	Site Safety Officer
HSM	=	Health and Safety Manager	TBD	=	To Be Determined
NAS	=	Naval Air Station	PM	=	Project Manager
U.S. EPA	=	United States Environmental Protection Agency	Navy	=	United States Department of the Navy

SAP WORKSHEET #6: COMMUNICATION PATHWAYS

(UFP-QAPP Manual Section 2.4.2)

The communication pathways for the SAP are shown below. Communications described in this worksheet will be documented in the appropriate format for the specific interaction. Appropriate forms of documentation include, but are not limited to: e-mail, telephone logs, field logbook notations, field forms, audit reports, and formal memoranda, or as described below. Communications will be part of the project records and will be maintained in the locations described in Worksheet #29.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Regulatory Agency Interface	U.S. EPA RPM FDEP RPM Navy RPM	Peter Dao Jennifer Conklin Adrienne Wilson	404-562-8508 850-245-8935 904-542-6160	The Navy RPM will contact each regulatory agency via phone and/or e-mail within 24 hours of recognizing the issue whenever issues arise.
Field Progress Reports	Resolution Consultants FOL Resolution Consultants PM	David Myers Todd Haverkost	904-367-4324 x6104 901-372-7962 x4223	The Resolution Consultants FOL will contact the Resolution Consultants PM on a daily basis via phone, and every 1-2 days summarizing progress via e-mail.
Gaining Site Access	Resolution Consultants FOL NAS Jacksonville POC	David Myers Tim Curtin	904-367-4324 x6104 904-542-4228	The Resolution Consultants FOL will contact the NAS Jacksonville POC verbally or via e-mail at least 3 days prior to commencement of field work to arrange for access to the site for all field personnel.
Obtaining Utility Clearances for Intrusive Activities	Resolution Consultants FOL NAS Jacksonville POC	David Myers Tim Curtin	904-367-4324 x6104 904-542-4228	The Resolution Consultants FOL will coordinate verbally or via e-mail with NAS Jacksonville POC at least 7 days in advance of site access to initiate the utility clearance process for all well boring locations. The Resolution Consultants FOL will contact both the Sunshine State One Call system and NAS Jacksonville infrastructure personnel verbally or via e-mail at least 3 days prior to commencement of field work to complete a utility clearance ticket for the areas under investigation.
Stop Work Due to Safety Issues	Resolution Consultants SSO Resolution Consultants PM Resolution Consultants HSM Navy RPM NAS Jacksonville POC	David Myers Todd Haverkost John Knopf Adrienne Wilson Tim Curtin	904-367-4324 x6104 901-372-7962 x4223 901-372-7962 x4255 904-542-6160 904-542-4228	Any field team member who observes an unsafe situation has the authority to stop work. If Resolution Consultants is the responsible party for a stop work command, the Resolution Consultants SSO will inform onsite personnel, subcontractor(s), the NAS Jacksonville POC, and the identified Partnering Team members within 1 hour (verbally or by e-mail). If a subcontractor is the responsible party, the subcontractor PM must verbally inform the Resolution Consultants SSO within 15 minutes, and the Resolution Consultants SSO will then follow the procedure listed above.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
SAP Changes Prior to Field/Laboratory Work	Resolution Consultants FOL Resolution Consultants PM Navy RPM NAS Jacksonville POC U.S. EPA RPM FDEP RPM	David Myers Todd Haverkost Adrienne Wilson Tim Curtin Peter Dao Jennifer Conklin	904-367-4324 x6104 901-372-7962 x4223 904-542-6160 904-542-4228 404-562-8508 850-245-8935	The Resolution Consultants PM will document the proposed changes via a Field Task Modification Request within 5 days and send the Navy RPM a concurrence letter within 7 days of identifying the need for change if necessary. SAP amendments will be submitted by the Resolution Consultants PM to the Navy RPM and NAS Jacksonville POC for review and approval. The Resolution Consultants PM will send scope changes to the Partnering Team via e-mail within 1 business day. Any change of the approved SAP will be made only upon authorization of the Navy RPM and regulatory agencies.
SAP Changes in the Field	Resolution Consultants FOL Resolution Consultants PM Navy RPM NAS Jacksonville POC	David Myers Todd Haverkost Adrienne Wilson Tim Curtin	904-367-4324 x6104 901-372-7962 x4223 904-542-6160 904-542-4228	The Resolution Consultants FOL will verbally inform the Resolution Consultants PM on the day that the issue is discovered. The Resolution Consultants PM will inform the Navy RPM and the NAS Jacksonville POC (verbally or via e-mail) within 1 business day of discovery. The Navy RPM will issue a scope change (verbally or via e-mail), if warranted. The scope change is to be implemented before further work is executed. The Resolution Consultants PM will document the change via a Field Task Modification Request within 2 days of identifying the need for change and will obtain required approvals within 5 days of initiating the form.
Field Corrective Actions	Resolution Consultants PM Resolution Consultants QAO Navy RPM	Todd Haverkost Tina Cantwell Adrienne Wilson	901-372-7962 x4223 901-372-7962 x4315 904-542-6160	The Resolution Consultants QAO will notify the Resolution Consultants PM verbally or by e-mail within one business day that the corrective action has been completed. The Resolution Consultants PM will then notify the Navy RPM (verbally or by e-mail) within 1 business day.
Sample Receipt Variances	Chemtech Laboratory PM Empirical Laboratory PM Resolution Consultants FOL Resolution Consultants PM	Kurt Hummler Sonya Gordon David Myers Todd Haverkost	908-728-3143 615-345-1115 904-367-4324 x6104 901-372-7962 x4223	The Laboratory PM will notify (verbally or via e-mail) the Resolution Consultants FOL immediately upon receipt of any chain of custody/sample receipt variances for clarification or direction from the Resolution Consultants FOL. The Resolution Consultants FOL will notify (verbally or via e-mail) the Resolution Consultants PM within 1 business day, if corrective action is required. The Resolution Consultants PM will notify (verbally or via e-mail) the Laboratory PM and the Resolution Consultants FOL within 1 business day of any required corrective action.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Reporting Laboratory Quality Variances	Chemtech Laboratory PM Empirical Laboratory PM Resolution Consultants Project Chemist Resolution Consultants PM Resolution Consultants FOL Chemtech Laboratory QAO Empirical Laboratory QAO	Kurt Hummler Sonya Gordon Tina Cantwell Todd Haverkost David Myers Krupa Dubey Marcia McGinnity	908-728-3143 615-345-1115 901-937-4315 901-372-7962 x4223 904-367-4324 x6104 908-728-3152 615-345-1115	Any planned SOP variances from the quality elements specified in the *Department of Defense Quality Systems Manual for Environmental Laboratories*, Version 4.2 (November 2010) are identified in WS#23, Section 10.0, page 102 in the Final Tier II SAP (Tetra Tech, 2012). The Laboratory PM will notify (verbally or via e-mail) the Resolution Consultants project chemist of any variance from the quality limits identified in this SAP on the day that the variance becomes known. The Resolution Consultants project chemist will notify (verbally or via e-mail) the Resolution Consultants PM within 1 business day of the need for corrective action, if the variance is a significant issue. The Resolution Consultants PM will notify (verbally or via e-mail) the Laboratory PM and the Resolution Consultants FOL and project chemist within 1 business day of any required corrective action. The Laboratory QAO will document all quality variances in the Case Narrative of the Analytical Laboratory Report.
Reporting Concerns Involving Laboratory	Resolution Consultants Project Chemist Resolution Consultants PM Resolution Consultants FOL Chemtech Laboratory PM Empirical Laboratory PM	Tina Cantwell Todd Haverkost David Myers Kurt Hummler Sonya Gordon	901-937-4315 901-372-7962 x4223 904-367-4324 x6104 908-728-3143 615-345-1115	If reported analytical results are inconsistent with the planned details identified in this SAP, the Resolution Consultants project chemist will notify (verbally or via e-mail) the Resolution Consultants PM within 1 business day of identifying a concern to determine if corrective action is needed. The Resolution Consultants PM will notify (verbally or via e-mail) the Laboratory PM and the Resolution Consultants FOL and project chemist within 1 business day of any required corrective action.
Analytical Corrective Actions and Reporting Data Validation Issues	Chemtech Laboratory PM Empirical Laboratory PM Resolution Consultants Project Chemist Resolution Consultants PM Navy RPM Resolution Consultants chemist	Kurt Hummler Sonya Gordon Tina Cantwell Todd Haverkost Adrienne Wilson Tina Cantwell	908-728-3143 615-345-1115 610-382-1171 901-372-7962 x4223 904-542-6160 901-937-4315	The Laboratory PM will notify (verbally or via e-mail) the Resolution Consultants project chemist within 1 business day of when an issue related to laboratory data is discovered. The Resolution Consultants project chemist will notify (verbally or via e-mail) the Resolution Consultants PM within 1 business day. Resolution Consultants project chemist will notify the Resolution Consultants PM verbally or via e-mail within 48 hours of validation completion that a non-routine and significant laboratory quality deficiency has been detected that could affect this project and/or other projects. The Resolution Consultants PM will verbally advise the Navy RPM within 24 hours of notification from the Resolution Consultants project chemist. The Navy RPM will take corrective action appropriate for the identified deficiency. Examples of significant laboratory deficiencies include data reported that has a corresponding failed mass spectrometer tune or initial calibration verification. Corrective actions may include a consult with the Navy QAO/Chemist.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Notification of Non-Usable Data	Chemtech Laboratory PM Empirical Laboratory PM Resolution Consultants Project Chemist	Kurt Hummler Sonya Gordon Tina Cantwell	908-728-3143 615-345-1115 901-937-4315	If the laboratory determines that any data they have generated is non-usable, the Laboratory PM will notify (verbally or via e-mail) the Resolution Consultants project chemist within 1 business day of when the issue is discovered.
	Resolution Consultants PM U.S. EPA RPM FDEP RPM	Todd Haverkost Peter Dao Jennifer Conklin	901-372-7962 x4223 404-562-8508 850-245-8935	The Resolution Consultants project chemist will notify (verbally or via e-mail) Resolution Consultants PM within 1 business day of the need for corrective action, if the non-usable data is a significant issue (i.e., critical sample data). Corrective action may include resampling and/or reanalyzing the effected samples. If a Resolution Consultants project chemist or data validator identifies non-usable data during the data validation process, the PM will be notified verbally or via e-mail within 48 hours of validation completion that a non-routine and significant laboratory quality deficiency has resulted in non-usable data. The Resolution Consultants PM will take corrective action appropriate for the identified deficiency to ensure the project objectives are met. The Resolution Consultants PM will notify (verbally or via e-mail) the NAVFAC RPM on any problems with the laboratory or analysis that could significantly affect the usability of the data or project failures that impact the ability to complete the scope of work. If there are significant data quality or non-useable data issues the NAVFAC QAO/Chemist will be contacted to ensure the issues do not have the potential to impact other Navy projects. Such notification will be made within 1 business day of when the issue is discovered. The NAVFAC RPM will notify the U.S. EPA and FDEP within 3 days when any significant corrective action is taken.

Notes:

U.S. EPA	=	United States Environmental Protection Agency	RPM	=	Remedial project manager
FDEP	=	Florida Department of Environmental Protection	FOL	=	Field operation leader
PM	=	Project manager	POC	=	Point of contact
SSO	=	Site safety officer	NAS	=	Naval Air Station
HSM	=	Health and safety manager	SAP	=	Sampling and analysis plan
QAO	=	Quality assurance officer	SOP	=	Standard Operating Procedure
WS	=	Worksheet			

SAP WORKSHEET #7: PERSONNEL RESPONSIBILITIES TABLE

(UFP-QAPP Manual Section 2.4.3)

Name	Title/Role	Organizational Affiliation	Responsibilities
Adrienne Wilson	Navy RPM/Manages project activities for the Navy	NAVFAC SE	Oversees project implementation including scoping, data review, and evaluation.
Tim Curtin	IRP Manager/Manages daily site activities related to this project	NAS Jacksonville	Oversees site activities and participates in scoping, data review, evaluation, and reviews the SAP.
Jennifer Conklin	RPM/Provides regulator input	FDEP	Participates in scoping, data review, evaluation, and approves the SAP.
Peter Dao	RPM/Provides regulator input	U.S. EPA Region 4	Participates in scoping, data review, evaluation, and approves the SAP.
Frank McInturff	Activity Coordinator/ Oversees project activities	Resolution Consultants	Oversees project implementation, including scoping, data review, and evaluation.
Todd Haverkost	PM/ Manages project on a daily basis	Resolution Consultants	Oversees project and manages financial, schedule, and technical day-to-day activities of the project.
David Myers	FOL/SSO Manages field operations and oversees site activities to ensure safety requirements are met	Resolution Consultants	As FOL, supervises, coordinates, and performs field sampling activities. As the SSO, is responsible for onsite project-specific health and safety training and monitoring site conditions. Details of these responsibilities are presented in the Health and Safety Plan.
Tina Cantwell	Resolution Consultants/ Project Chemist/QAO/Data Validation Manager/Coordinates laboratory and validation; oversees project quality assurance.	Resolution Consultants	As project chemist, prepares laboratory scopes of work, and coordinates laboratory related functions with laboratory. Performs or oversees data quality reviews and quality assurance of data validation deliverables. As QAO, ensures quality aspects of the project are implemented, documented, and maintained. As data validation manager, performs or oversees data validation and data input in both the project database and the Navy's Naval Installation Restoration Information Solution database.
John Knopf	HSM/ Oversees health and safety activities	Resolution Consultants	Responsible for providing health and safety training for all personnel and approving the site-specific Health and Safety Plan. Prepares health and safety reports for management.
Kurt Hummler Sonya Gordon	Laboratory PM/ Representative for Laboratory and Analytical Issues	Chemtech Empirical	Coordinates analyses with laboratory chemists, ensures that scope of work is followed, provides quality assurance of data packages, and communicates with Resolution Consultants project staff.

Notes:

RPM = Remedial project manager
IRP = Installation Restoration Program
SAP = Sampling and analysis plan
U.S. EPA = United States Environmental Protection Agency
FOL = Field operation leader
QAO = Quality assurance officer
NAVFAC SE = Naval Facilities Engineering Command Southeast
NAS = Naval Air Station
FDEP = Florida Department of Environmental Protection
PM = Project manager
SSO = Site safety officer
HSM = Health and safety manager

SAP WORKSHEET #8: SPECIAL PERSONNEL TRAINING REQUIREMENTS TABLE

(UFP-QAPP Manual Section 2.4.4)

All field personnel will have appropriate training to conduct the field activities to which they are assigned. Project-specific safety requirements are addressed in greater detail in a standalone Accident Prevention Plan that includes a Site Safety and Health Plan.

SAP WORKSHEET #9: PROJECT SCOPING SESSION PARTICIPANTS SHEET

(UFP-QAPP Manual Section 2.5.1)

Resolution Consultants is adopting Worksheet #9, Section 3.0, pages 18-23 in the Final Tier II SAP (Tetra Tech, 2012) in its entirety.

SAP WORKSHEET #10: CONCEPTUAL SITE MODEL

(UFP-QAPP Manual Section 2.5.2)

Resolution Consultants is adopting Worksheet #10, Section 4.0, pages 24-26 in the Final Tier II SAP (Tetra Tech, 2012) in its entirety.

SAP WORKSHEET #11: PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS

(UFP-QAPP Manual Section 2.6.1)

Resolution Consultants is adopting Worksheet #11, Section 5.0, pages 47-56 in the Final Tier II SAP (Tetra Tech, 2012) in its entirety.

SAP WORKSHEET #12: FIELD QUALITY CONTROL SAMPLES

(UFP-QAPP Manual Section 2.6.2)

Resolution Consultants is adopting Worksheet #12, Section 6.0, page 57 in the Final Tier II SAP (Tetra Tech, 2012) in its entirety.

SAP WORKSHEET #13: SECONDARY DATA CRITERIA AND LIMITATIONS TABLE

(UFP-QAPP Manual Section 2.7)

Resolution Consultants is adopting Appendix G, Worksheet #13 in the Final Tier II SAP (Tetra Tech, 2012) in its entirety.

SAP WORKSHEET #14: SUMMARY OF PROJECT TASKS

(UFP-QAPP Manual Section 2.8.1)

Resolution Consultants-specific field SOPs will be used in addition to FDEP sampling SOPs. Project-specific SOPs and Field Forms for field tasks referenced in this worksheet are identified by title in Worksheet #21 and copies of each SOP are in **Appendix C**. The RI field tasks are as follows:

- Mobilization/Demobilization
- Utility Clearance
- Sample Collection and Sample Handling Tasks
- Monitoring Equipment Calibration
- Surface and Subsurface Soil Sampling
- Surface Water and Sediment Sampling
- Well Borings and Lithologic Soil Sampling
- Temporary Well Installation and Development
- Groundwater Level Measurements
- Temporary Well Groundwater Sampling
- Global Positioning System Locating
- Land Surveying
- Investigation-Derived Waste (IDW) Management
- Field Decontamination Procedures
- Field Documentation Procedures
- Quality Control Tasks

14.1 Mobilization/Demobilization

Mobilization will consist of the delivery of all equipment, materials, and supplies to the site, complete assembly (in satisfactory working order) of all such equipment at the site, and secure storage at the site of all such materials and supplies, along with the acquisition of personnel and vehicle base access badges. The Resolution Consultants field operations leader (FOL) or designee will coordinate with the NAS Jacksonville point of contact (POC) to identify appropriate locations for the temporary storage of equipment and supplies. Site-specific health and safety training for all Resolution Consultants field personnel and subcontractors will be conducted as part of site mobilization.

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

14.2 Utility Clearance

Utility clearance will be performed using Resolution Consultants SOP 3-1. One week prior to the commencement of any intrusive activities, Resolution Consultants will coordinate utility clearance with the NAS Jacksonville POC and with Sunshine State One Call. The NAS Jacksonville personnel and Utility Companies subscribed to Sunshine State One Call will identify and mark-out utilities that may be present near the soil boring locations. The Resolution Consultants FOL will coordinate with the Public Works Department and Golf Course Superintendent at NAS Jacksonville to document the utility clearance process and obtain approval for conducting intrusive activities.

Utilities that are identified in the field, but not shown or incorrectly located on the work approval documentation, will be marked directly on the document and returned to the NAS Jacksonville POC for inclusion in the Geographic Information System database.

14.3 Sample Collection and Sample Handling Tasks

The sampling and analysis program is outlined in Worksheet #17, Section 7.0, pages 58-63 in the Final Tier II SAP (Tetra Tech, 2012) and Worksheet #18. Sample collection and handling will be in accordance with Resolution Consultants-specific field SOPs and FDEP sampling SOPs listed in Worksheet #21. Sample labeling will be in accordance with Resolution Consultants SOP 3-03A, and the sample numbering scheme will be as identified in Worksheet #18. Methods for sample handling will be in accordance with Resolution Consultants SOP 3-03A. Sample containers will be provided in "certified-clean" condition from the analytical laboratory. The selection of sample containers, sample preservation, packaging, and shipping will be in accordance with Resolution Consultants SOP 3-04A and Worksheet #19, Section 8.6, page 92 in the Final Tier II SAP (Tetra Tech, 2012). Field and laboratory QC samples will be collected as outlined in Worksheet #20.

14.4 Monitoring Equipment Calibration

Field equipment will be calibrated in accordance with FDEP SOP FT 1000 and associated field testing FDEP SOPs and with manufacturer's guidance by the Resolution Consultants FOL or designee. Documentation of the field equipment calibration is required. Field equipment should be calibrated at the beginning and end of each day, unless otherwise stated by the equipment manufacturer.

14.5 Surface and Subsurface Soil Sampling

Surface soil samples will be collected by trowel, and subsurface soil samples will be collected by hand auger or corer in accordance with FDEP SOP FS 3000. All soil samples will be collected as discrete grab samples. The soil borings will be described by the field personnel in accordance with Resolution Consultants SOP 3-16. Any visual signs of potential contamination (such as the presence of bullet or skeet fragments or soil staining) will be noted on the soil boring log.

The areas to be sampled will be cleared of any surface debris (i.e., leaves, twigs). A properly decontaminated stainless steel trowel will be used to remove the surface soil sample material from 0 to 6 inches below ground surface (bgs) and transfer it to the appropriate sample container.

Soil samples from below 6 inches bgs will be collected using a hand auger in accordance with FDEP SOP FS 3000. The area to be sampled will be cleared of any surface debris (i.e., leaves, twigs). The hand auger system consists of a stainless steel bucket bit (i.e., cylinder 6.5 inches long and 2.75 inches in diameter), a 3- or 4-foot extension rod, and a cross handle. A properly decontaminated bucket bit is attached to a clean extension rod, and then onto the cross handle. The hand auger is turned into the ground and the sample material is removed and placed onto clean aluminum foil until reaching the final desired depth. Larger debris items such as twigs, roots, or stones are removed from the sample prior to transfer to the appropriate sample container.

The sample ID, date, and time will be marked on the container with an indelible marker. Required information will be entered on the Soil Sample Log Sheet and the Chain-of-Custody Form. Excess soil core material will be returned to the hole, and the hand auger assembly will be decontaminated between discrete sample locations in accordance with FDEP SOP FC 1000.

14.6 Surface Water and Sediment Sampling

The surface water sampling procedures discussed in FDEP SOP FS 2100 and the sediment sampling procedures discussed in FDEP SOP 4000 will be followed for the collection of surface water and underlying sediment samples in ponds that may have been impacted by historical operations.

FDEP SOP FS 2100 establishes the procedure for standard grab surface water sampling in ponds. Surface grab samples will be collected from the top 12 inches of the water column above the sediment most likely to be impacted by inflow of surface runoff or drainage.

FDEP SOP FS 4000 establishes the procedure for sediment sampling in streams, ponds, and other waterways. Vegetative matter or debris, if present, will be avoided when selecting precise sample locations. Sample material will be collected from the top 6 inches of sediment using a clean petite Ponar dredge sampler. Material will be transferred directly to an appropriate sample container that has been marked with the sample ID, date, and time. Required information will be entered on the Sediment Sample Log Sheet and the Chain-of-Custody Form.

14.7 Well Borings and Lithologic Soil Sampling

Soil samples will be obtained for lithologic logging purposes from the well borings using a combination of hand auger and direct-push technology (DPT) dual-tube methods. The proposed well boring locations are presented on **Figures 7-2, 7-4, 7-5, and 7-6** in the Final Tier II SAP (Tetra Tech, 2012). Copies of these figures are in **Appendix A.** The top 5 feet of soil at each boring location will be removed using a hand auger to avoid any potential utility interference. The remainder of the soil core (i.e., below 5 feet bgs) will be collected continuously at each location by advancing a macrocore sampler (in 4- to 5-foot long segments) using a DPT rig mounted on an all-terrain vehicle to the target depth (i.e., approximately 8 feet below the top of the first water-bearing zone encountered). The macrocore sampler will be withdrawn, and the soils will be described in accordance with Resolution Consultants SOP 3-16. When lithologic logging is completed, each boring will be converted into a temporary well to facilitate the collection of groundwater samples for chemical analyses.

14.8 Temporary Well Installation and Development

Temporary wells will be installed across the first (i.e., shallowest) water-bearing zone encountered. The wells are located to provide data that can be used to determine whether contaminants are migrating from the ground surface to underlying groundwater. Proposed locations are shown on **Figures 7-2, 7-4, 7-5, and 7-6** in **Appendix A**. The temporary wells will be installed using DPT dual-tube drilling methods, and constructed with nominal 1-inch inside diameter polyvinyl chloride (PVC) pre-packed screens. The wells will be abandoned within 3 days of sample collection by removing the PVC riser and screen before backfilling the borehole with cement/bentonite grout from the bottom up using a tremie pipe. Each of the temporary wells will

be developed in accordance with Resolution Consultants SOP 3-13 and FDEP SOP FS 2200. If there is any conflict between these two SOPs, the FDEP method will be followed.

14.9 Groundwater Level Measurements

Prior to the start of sampling, the depth to the static water level will be measured in all wells using an electronic water level meter in accordance with FDEP SOP FS 220. The depth will be measured in units of feet (to the nearest 0.01 foot) with respect to the top of the PVC well riser. The stick-up length of the PVC well riser will be measured from the ground surface to the reference measuring point to determine the depth-to-water below the ground surface. Water levels will be recorded on a Resolution Consultants water level measurement form. The water level meter will be decontaminated prior to use and between each monitoring well.

14.10 Groundwater Sampling

All temporary wells will be purged prior to sampling using low-flow sampling techniques in accordance with FDEP SOP FS 2200, section FS 2212. Groundwater samples will be collected in accordance with FDEP SOP FS 2200, section FS 2220.

Worksheet #17, Section 7.0, pages 58-63 in the Final Tier II SAP (Tetra Tech, 2012) and Worksheet #18 specify the sample locations and target analytes for this investigation, and Worksheet #23, Section 10.0, page 102 in the Final Tier II SAP (Tetra Tech, 2012) specifies the analytical methods to be used. After collection, the samples will be placed in a cooler, chilled with ice, and shipped under chain-of-custody protocol to Chemtech for analysis.

14.11 Global Positioning System Locating

A hand-held global positioning system (GPS) unit capable of sub-meter accuracy (i.e., Trimble GeoXT or equivalent) will be used to locate all sampling points in accordance with Resolution Consultants SOP 3-07. The GPS coordinate system will be set up so that horizontal coordinates are collected and documented in the field using the Florida State Plane Coordinate System (SPCS) North Sheet, North American Datum of 1983 (NAD 83) in United States (U.S.) survey feet for easting and northing. Vertical coordinates must be documented by land surveying (see below) referenced to mean sea level, North American Vertical Datum, 1988 (NAVD 88) adjustment to map the ground surface and groundwater elevations to the accuracy required to properly determine groundwater flow direction.

The GPS survey will utilize third order monument data, if available. Select monuments or markers (such as surveyed permanent monitoring wells) will be visited at the start and end of each day. Prior to the start of fieldwork, Resolution Consultants will load site boundaries, known cultural or terrain features that may affect surveys, and background maps into the GPS unit. In addition, coordinates of the planned sampling locations will be loaded into the unit so that the field team can reacquire and mark each location in the field. Field personnel will have the flexibility to adjust sampling locations up to 10 feet in any direction, as necessary, to avoid physical obstructions or safety hazards (e.g., pavement, utility lines, sprinkler heads, etc.) or otherwise ensure proper placement of samples. If the Resolution Consultants FOL determines that moving a sampling location more than 10 feet is appropriate, he will contact the Resolution Consultants PM, who will engage the NAVFAC RPM and other Partnering Team members, as necessary, at the discretion of the RPM.

Following sample collection, each location will be resurveyed using GPS to obtain the coordinates of the actual soil, sediment, and groundwater sampling locations. GPS data collected during the survey will be stored in the GPS unit and downloaded to a computer daily or as soon as possible after acquisition. Data will also be manually entered into a field log as it is collected. Once downloaded from the GPS unit, the data will then be uploaded for processing by Resolution Consultants Geographic Information System personnel. Certain spatial data acquired during the RI fieldwork will be uploaded as well, to ensure that significant site features are appropriately documented in the NAS Jacksonville spatial database files.

To ensure sub-meter accuracy, the GPS SOP requires a minimum of six satellites to capture a position. If GPS accuracy is not sub-meter, data will not be collected until more satellites become available and the accuracy criteria specified in Resolution Consultants SOP 3-07 are met. In locations where the overhead canopy interferes with satellite lines-of-sight and GPS accuracy cannot be reasonably established, an alternative positioning technique will be employed (e.g., compass and tape measure, fiducials, or total station) to ensure that anomaly locations can be reacquired at a later date, if necessary.

14.12 Land Surveying

After the temporary wells are installed, well locations will be surveyed by Resolution Consultants personnel or by a professional surveyor licensed in the State of Florida. The Resolution Consultants FOL or designee will provide the surveyor with the coordinate designation nomenclature, and all coordinate systems will be pre-approved prior to commencement of the survey. All measurements will be reported and recorded in U.S. survey feet. The surveyor will establish the

horizontal location and vertical elevation for each temporary well. One horizontal measurement and two vertical measurements will be required per well. The two vertical measurements are: (1) the top of the PVC riser pipe (herein referred to as "top of casing"), and (2) the top of ground adjacent to the pipe. All of the vertical measurements should be taken from marked positions on each temporary well or, if missing a mark, on the north side of the riser pipe.

The surveyor will find and use existing survey control. It is anticipated that adequate control is located within 1 mile of the site. Horizontal locations will be referenced to the Florida SPCS North Sheet, NAD 83. As appropriate, the control will be referenced to the appropriate SPCS Zone and/or other State Adjustments. Elevations shall be referenced to mean sea level, NAVD 88. All survey data will be determined to the nearest 0.03 meter horizontally (equivalent to 0.1 foot) and the nearest 0.003 meter vertically (equivalent to 0.01 foot).

The surveyor will record all fieldwork in a clear, legible, and complete manner. The field record will contain a complete description of the nature and location of the new and existing points. The record will also include a sketch of the point locations and the benchmark witness points for both Project Control and Local Control.

Resolution Consultants will use the survey data, along with groundwater level measurements to determine the direction of groundwater flow. A potentiometric surface map will be included in the RI Report.

14.13 Investigation-Derived Waste Management

Solid or semi-solid IDW in the form of soil will be generated during field activities such as the installation of temporary wells and/or collection of subsurface soil samples using DPT. To the extent possible, soil removed during sampling activities but not included in the sample volume shipped to the laboratory for analysis will be replaced into the boring from which it was removed.

Liquid IDW generated during sampling, including decontamination fluids, will be handled in accordance with Resolution Consultants SOP 3-05. Wastewater will be generated during DPT grab groundwater sampling, temporary well development, well purging and sampling, and decontamination procedures. All aqueous IDW will be containerized in drums provided by the NAS Jacksonville Public Works Department Part B facility. The facility will pick up the filled drums and stage them at the designated waste accumulation area to await waste characterization

analyses. Based on waste characterization results, the drummed water will be transported and appropriately disposed at a Navy-approved offsite disposal facility by the IDW subcontractor.

Used personal protective equipment will be bagged and disposed of as regular trash in an appropriate facility waste container.

14.14 Field Decontamination Procedures

Decontamination of sampling equipment will not be necessary for dedicated and disposable hand trowels. Decontamination of reusable sampling equipment (e.g., non-disposable hand trowels, hand augers, and DPT sampling equipment) will be conducted prior to sampling and between samples at each location. Decontamination of major equipment and sampling equipment will be in general accordance with FDEP SOP FC 1000.

14.15 Field Documentation Procedures

Field documentation will be performed in accordance with Resolution Consultants SOP 3-03A and FDEP SOP FD 1000.

Matrix-specific sample log sheets will be maintained for each sample collected. In addition, sample collection information will be recorded in bound field notebooks or specific field forms. Samples will be packaged and shipped according to Resolution Consultants SOP 3-04A and FDEP SOP FS 1000.

A summary of field activities will be properly recorded in indelible ink in a bound logbook with consecutively numbered pages that cannot be removed. Logbooks will be assigned to field personnel and stored in a secured area when not in use.

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

14.16 Quality Control Tasks

QC samples will be collected at frequencies listed in Worksheet #20.

14.17 Additional Project-Related Tasks

Additional project-related tasks include:

- Analytical Tasks
- Data Management
- Data Review
- Project Reports

14.18 Analytical Tasks

Chemical analyses for metals will be performed by Chemtech Consulting Group, Inc. (Chemtech), which is a current DoD Environmental Laboratory Accreditation Program (ELAP)-accredited laboratory for these analyses. In addition, Chemtech holds National Environmental Laboratory Accreditation Program (NELAP) accreditation with the State of Florida Department of Health. Chemical analysis for nitroglycerin will be performed by Empirical Laboratories LLC, (Empirical) which is a current DoD ELAP-accredited and NELAP-accredited laboratory for nitroglycerin. Copies of the pertinent laboratory accreditations are in Appendix F of the Final Tier II SAP (Tetra Tech, 2012). Each laboratory's accreditation will be verified prior to each sampling event. Analyses will be performed in accordance with the analytical methods identified in Worksheets #19 and #30, Section 8.6, page 92 in the Final Tier II SAP (Tetra Tech, 2012). Chemtech and Empirical will meet the screening criteria specified in Worksheet #15, Section 9.0, pages 94-101 in the Final Tier II SAP (Tetra Tech, 2012) and will perform the chemical analyses following the laboratory-specific SOPs identified in Worksheet #23, Section 10.0, page 102 in the Final Tier II SAP (Tetra Tech, 2012). Copies of the Laboratory SOPs are available to the Partnering Team upon request.

Soil results will be reported by each laboratory on an adjusted dry-weight basis. Results of percent moisture will be reported in each analytical data package and associated electronic data deliverable (EDD) files. This information will also be captured in the project database, which will eventually be uploaded to the Naval Installation Restoration Information Solution (NIRIS) database.

The analytical data packages provided by Chemtech and Empirical will be fully validatable and will contain summary quality control forms and all raw data.

14.19 Data Management

The principal data generated for this project will be from field data and laboratory analytical data. The field forms, chain of custody, air bills, and logbooks will be placed in the project files after the completion of the field program. The field logbooks for this project will be used only for this site, and will also be categorized and maintained in the project files after the completion of the field program. All project records will be maintained in a secure location. Laboratory data, provided in electronic format, will verified for accuracy prior to use and during the data validation process. After data are validated, the electronic data results will be uploaded into the Resolution Consultants database for use in data evaluation and subsequent report preparation. The project database will be on a password protected secure network and access to changing data files will be restricted to qualified personnel. The Resolution Consultants PM (or designee) is responsible for the overall tracking and control of data generated for the project.

- **Data Tracking**. The PM (or designee) is responsible for the overall tracking and control of data generated for the project. Data are tracked from generation to archiving in the project specific files. The project chemist (or designee) is responsible for tracking the samples collected and shipped to the contracted laboratory. Upon receipt of the data packages from the analytical laboratory, the project chemist will oversee the data validation effort, which includes verifying that the data packages are complete and that results for all samples have been delivered by the analytical laboratory.

  Resolution Consultants shall submit all Administrative Record Files, Site Files, and Post Decision Files in accordance with the specifications defined in the NAVFAC *Environmental Restoration Recordkeeping Manual* (NAVFAC, 2009). Additionally, Resolution Consultants will update and manage the project related documents, data, and maps in NIRIS. Project related spatial data including maps, models, and associated collected or created data will also be uploaded into NIRIS. All documentation submittals for NIRIS will be coordinated with the RPM.

- **Data Storage, Archiving, and Retrieval**. After the data are validated, the data packages are entered into the Resolution Consultants' Navy CLEAN file system and archived in secure files. The field records including field logbooks, sample logs, chain-of-custody records, and field calibration logs will be submitted by the Resolution Consultants FOL to be entered into the Navy CLEAN file system before archiving in secure project files. Project files are audited for accuracy and completeness. Project files

will be kept in a secured, limited access area. At the completion of the Navy contract, files will be shipped to the Federal Records Center (FRC) for storage where the files will remain until 50 years after the last decision document for NAS Jacksonville.

- **Data Security**. Access to Resolution Consultants project files is restricted to designated personnel only. The Resolution Consultants Data Manager maintains the electronic data files, and access to the data files is restricted to qualified personnel only. File and data backup procedures are routinely performed.

- **Electronic Data**. All final electronic data and administrative records will be compiled uploaded into NIRIS for final repository.

14.20 Data Review and Validation

After receipt of analytical laboratory results, Resolution Consultants will verify data completeness as specified on Worksheet #34. To ensure that the analytical results meet the project quality objectives, the laboratory data will undergo verification and validation as cited in Worksheets #34 through #36 and described below. The usability assessment processes are described in Worksheet #37.

Prior to data validation, electronic laboratory data will be verified for accuracy against the hardcopy laboratory report and the electronic quality assurance project plan (eQAPP) will be established using the project-specific criteria defined in Worksheets #12, #19, and #28. The laboratory will be requested to resubmit electronic data found to be inaccurate.

During the data validation process, the Resolutions Consultant's Data Validation Assistant (DVA) tool will be used to review method accuracy and precision data from field and laboratory QC samples contained in the laboratory EDD and qualify that data according to the project-specific eQAPP. The DVA tool uses the power of EarthSoft's EQuIS relational database to assemble a series of Excel worksheets into a DVA workbook for the validator that present:

- data validation QC elements that they need to review, compared to control limits stored in the project-specific eQAPP

- associated sample results for duplicated samples and blanks

- a place to make the necessary qualifications and result updates directly into an electronic format documentation of qualifications using coded reasons

- a list all samples affected by the qualification

Laboratory calibration will be assessed against the criteria presented in Worksheet #24 using the hardcopy laboratory report and the results of these findings will be added to the Excel DVA workbook. The DVA workbook ultimately serves as an EDD to update the project database with the validator's changes. Using standard EQuIS tools that check and load data, qualifiers and edits are directly uploaded to the database, thereby eliminating the manual data entry process and allowing for 100% of data to be reviewed prior to uploading to the project database.

14.21 Project Reports

A Draft RI Report will be prepared and submitted to the Partnering Team for review. The report will include a summary of the work performed in accordance with the approved SAP; field modifications as documented by the Resolution Consultants FOL; summary and analysis of analytical results; updated conceptual site models, human health risk assessments, ecological risk assessments, as appropriate, based on the risk screening evaluations, decision rules; and conclusions and recommendations for each site. Resolution Consultants will respond to comments received on the Draft RI Report, and submit a final version of the report that incorporates the agreed-upon responses to comments. The final version of the RI Report will be submitted in hardcopy and electronic format to the Partnering Team and the Administrative Record. Additionally, the final RI report will be uploaded to NIRIS.

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES

(UFP-QAPP Manual Section 2.8.1)

Resolution Consultants is adopting Worksheet #15, Section 9.0, pages 94-101 in the Final Tier II SAP (Tetra Tech, 2012) in its entirety.

SAP WORKSHEET #16: PROJECT SCHEDULE/TIMELINE TABLE

(UFP-QAPP Manual Section 2.8.2)

Activities	Organization	Dates (MM/DD/YY)		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
Prepare/Submit Draft SAP Amendment	**Resolution Consultants**	**12/7/12**	**2/21/13**	**Draft SAP Amendment**	**2/22/13**
Navy Review of SAP Amendment	Navy	**2/22/13**	**3/23/13**	NA	NA
Prepare/Submit Draft Final SAP Amendment	**Resolution Consultants**	**3/24/13**	**4/6/13**	**Draft Final SAP Amendment**	**4/7/13**
Regulatory Review of SAP Amendment	U.S. EPA, FDEP	**4/7/13**	**7/5/13**	NA	NA
Prepare/Submit Final SAP Amendment	**Resolution Consultants**	**7/6/13**	**10/3/13**	**Final SAP Amendment**	**10/4/14**
Prepare/Submit Draft ESSDR	**Tetra Tech**	**05/15/12**	**05/25/12**	**Draft ESSDR**	**05/25/12**
Navy Review of ESSDR Complete	Navy	05/29/12	06/08/12	NA	NA
Prepare/Submit Final ESSDR	**Tetra Tech**	**06/11/12**	**06/15/12**	**Final ESSDR**	**06/15/12**
Receive approval of ESSDR	NOSSA	06/18/12	07/02/12	NA	NA
Field Work	**Resolution Consultants**	**10/4/14**	**11/18/13**	**NA**	**NA**
Laboratory Results	Chemtech, Empirical	10/18/13	11/14/13	Laboratory EDDs	NA
Data Validation Reports	Resolution Consultants	11/15/13	12/14/13	Data Validation Technical Memoranda	NA
Prepare/Submit Draft RI Report	**Resolution Consultants**	**12/15/13**	**2/13/14**	**Draft RI Report**	**2/14/14**
Navy Review of RI Complete	Navy	2/14/14	3/15/14	NA	NA

Activities	Organization	Dates (MM/DD/YY)		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
Prepare/Submit Draft Final RI Report	**Resolution Consultants**	**3/16/14**	**3/29/14**	**Draft Final RI Report**	**3/30/14**
Regulatory Review of RI Complete	U.S. EPA, FDEP	3/30/14	6/27/14	NA	NA
Prepare/Submit Final RI Report	**Resolution Consultants**	**6/28/14**	**9/11/14**	**Final RI Report**	**9/12/14**

Notes:

SAP = Sampling and Analysis Plan
ESSDR = Explosives Safety Submission Determination Request
NA = Not applicable
EDD = Electronic data deliverable
RI = Remedial Investigation
U.S. EPA = U.S. Environmental Protection Agency
FDEP = Florida Department of Environmental Protection

SAP WORKSHEET #17: SAMPLING DESIGN AND RATIONALE

(UFP-QAPP Manual Section 3.1.1)

Resolution Consultants is adopting Worksheet #17, Section 7.0, pages 58-63 in the Final Tier II SAP (Tetra Tech, 2012) in its entirety.

SAP WORKSHEET #18: LOCATION-SPECIFIC SAMPLING METHODS/SOP REQUIREMENTS TABLE

(UFP-QAPP Manual Section 3.1.1)

Sample Location	Sample ID	Sample Location Rationale[1]	Sample Depth[2] (feet bgs)	Sampling SOP[3]	Laboratory Analyses						Field Analyses						
					Antimony	Arsenic	Copper	Lead	Zinc	Nitroglycerin	Water Level	Temperature	pH	Spec. Cond.	ORP	DO	Turbidity
PSC 23A — .50 Caliber Range (UXO Site 2)																	
Surface and Subsurface Soil																	
X2SB001	X2SB0010405	Horizontal delineation south of JAX-23A-SBSS008	4.0-5.0	FS 3000	•			•									
X2SB002	X2SB0020405	Horizontal delineation west of JAX-23A-SBSS008	4.0-5.0	FS 3000	•			•									
X2SB003	X2SB0030405	Horizontal delineation north of JAX-23A-SBSS008	4.0-5.0	FS 3000	•			•									
X2SB004	X2SB0040405	Horizontal delineation east of JAX-23A-SBSS008	4.0-5.0	FS 3000	•			•									
X2SB005	X2SB0050304	Horizontal delineation west of JAX-23A-SBSS012 **(plus field duplicate)**	3.0-4.0	FS 3000	•		•	•									
X2SB005	X2SB0050405	Horizontal delineation west of JAX-23A-SBSS012	4.0-5.0	FS 3000	•		•	•									
X2SB006	X2SB0060304	Horizontal delineation south-west of JAX-23A-SBSS012	3.0-4.0	FS 3000	•		•	•									
X2SB006	X2SB0060405	Horizontal delineation south-west of JAX-23A-SBSS012	4.0-5.0	FS 3000	•		•	•									
X2SB007	X2SB0070304	Horizontal delineation south of JAX-23A-SBSS012	3.0-4.0	FS 3000	•		•	•									
X2SB007	X2SB0070405	Horizontal delineation south of JAX-23A-SBSS012	4.0-5.0	FS 3000	•		•	•									
X2SB008	X2SB0080304	Horizontal delineation north of JAX-23A-SBSS012	3.0-4.0	FS 3000	•		•	•									

Sample Location	Sample ID	Sample Location Rationale[1]	Sample Depth[2] (feet bgs)	Sampling SOP[3]	Laboratory Analyses						Field Analyses						
					Antimony	Arsenic	Copper	Lead	Zinc	Nitroglycerin	Water Level	Temperature	pH	Spec. Cond.	ORP	DO	Turbidity
X2SB008	X2SB0080405	Horizontal delineation north of JAX-23A-SBSS012	4.0-5.0	FS 3000	•		•	•									
X2SB009	X2SB0090304	Horizontal delineation east of JAX-23A-SBSS012	3.0-4.0	FS 3000	•		•	•									
X2SB009	X2SB0090405	Horizontal delineation east of JAX-23A-SBSS012	4.0-5.0	FS 3000	•		•	•									
Groundwater																	
TW04	X2TW04	DPT temporary well TW-04 underlying X2SB006 **(plus field duplicate)**	6-12	FS 2200, FT 1000 to FT 1600	•			•			•	•	•	•	•	•	•
PSC 56 — Akron Road Pistol Range (UXO Site 4)																	
Surface and Subsurface Soil																	
X4SB001	X4SS0010006	Horizontal delineation north of JAX-56-SBSS028 **(plus field duplicate)**	0.0-0.5	FS 3000	•	•	•	•	•								
X4SB001	X4SS0010624	Horizontal delineation north of JAX-56-SBSS028 **(plus field duplicate)**	0.5-2.0	FS 3000		•		•									
X4SB002	X4SS0020006	Horizontal delineation north of JAX-56-SBSS032	0.0-0.5	FS 3000	•	•	•	•	•								
X4SB002	X4SS0020624	Horizontal delineation north of JAX-56-SBSS032	0.5-2.0	FS 3000		•		•									
X4SB003	X4SS0030006	Horizontal delineation north of JAX-56-SBSS033	0.0-0.5	FS 3000	•	•	•	•	•								
X4SB003	X4SS0030624	Horizontal delineation north of JAX-56-SBSS033	0.5-2.0	FS 3000		•		•									
X4SB004	X4SS0040006	Horizontal delineation north-east of JAX-56-SBSS027, east of floor of eastern berm (in native soil)	0.0-0.5	FS 3000	•	•	•	•	•								

Sample Location	Sample ID	Sample Location Rationale[1]	Sample Depth[2] (feet bgs)	Sampling SOP[3]	Laboratory Analyses						Field Analyses						
					Antimony	Arsenic	Copper	Lead	Zinc	Nitroglycerin	Water Level	Temperature	pH	Spec. Cond.	ORP	DO	Turbidity
X4SB004	X4SS0040624	Horizontal delineation north-east of JAX-56-SBSS027, east of floor of eastern berm (in native soil)	0.5-2.0	FS 3000		•		•									
X4SB005	X4SS0050006	Horizontal delineation east of JAX-56-SBSS031, east of floor of eastern berm (in native soil)	0.0-0.5	FS 3000	•	•	•	•	•								
X4SB005	X4SS0050624	Horizontal delineation east of JAX-56-SBSS031, east of floor of eastern berm (in native soil)	0.5-2.0	FS 3000		•		•									
X4SB006	X4SS0060006	Horizontal delineation east of JAX-56-SBSS034, east of floor of eastern berm (in native soil)	0.0-0.5	FS 3000	•	•	•	•	•								
X4SB006	X4SS0060624	Horizontal delineation east of JAX-56-SBSS034, east of floor of eastern berm (in native soil)	0.5-2.0	FS 3000		•		•									
X4SB007	X4SS0070006	Horizontal delineation east of JAX-56-SBSS039, east of floor of eastern berm (in native soil)	0.0-0.5	FS 3000	•	•	•	•	•								
X4SB007	X4SS0070624	Horizontal delineation east of JAX-56-SBSS039, east of floor of eastern berm (in native soil)	0.5-2.0	FS 3000		•		•									
X4SB008	X4SS0080006	Horizontal delineation east of JAX-56-SBSS038	0.0-0.5	FS 3000	•	•	•	•	•								
X4SB008	X4SS0080624	Horizontal delineation east of JAX-56-SBSS038	0.5-2.0	FS 3000		•		•									
X4SB009	X4SS0090006	Horizontal delineation south of JAX-56-SBSS037	0.0-0.5	FS 3000	•	•	•	•	•								

Sample Location	Sample ID	Sample Location Rationale[1]	Sample Depth[2] (feet bgs)	Sampling SOP[3]	Laboratory Analyses						Field Analyses						
					Antimony	Arsenic	Copper	Lead	Zinc	Nitroglycerin	Water Level	Temperature	pH	Spec. Cond.	ORP	DO	Turbidity
X4SB009	X4SS0090624	Horizontal delineation south of JAX-56-SBSS037	0.5-2.0	FS 3000		•		•									
X4SB010	X4SS0100006	Horizontal delineation south of JAX-56-SBSS035	0.0-0.5	FS 3000	•	•	•	•	•								
X4SB010	X4SS0100624	Horizontal delineation south of JAX-56-SBSS035	0.5-2.0	FS 3000		•		•									
X4SB011	X4SS0110006	Horizontal delineation south of JAX-56-SBSS026 **(plus field duplicate)**	0.0-0.5	FS 3000	•	•	•	•	•								
X4SB011	X4SS0110624	Horizontal delineation south of JAX-56-SBSS026	0.5-2.0	FS 3000		•		•									
X4SB012	X4SS0120006	Horizontal delineation north-west of JAX-56-SBSS026, west of floor of western berm (in native soil)	0.0-0.5	FS 3000	•	•	•	•	•								
X4SB012	X4SS0120624	Horizontal delineation north-west of JAX-56-SBSS026, west of floor of western berm (in native soil)	0.5-2.0	FS 3000		•		•									
X4SB013	X4SS0130006	Horizontal delineation west of JAX-56-SBSS014, west of floor of western berm (in native soil)	0.0-0.5	FS 3000	•	•	•	•	•								
X4SB013	X4SS0130624	Horizontal delineation west of JAX-56-SBSS014, west of floor of western berm (in native soil)	0.5-2.0	FS 3000		•		•									
X4SB014	X4SS0140006	Horizontal delineation west of JAX-56-SBSS008, west of floor of western berm (in native soil)	0.0-0.5	FS 3000	•	•	•	•	•								

Sample Location	Sample ID	Sample Location Rationale[1]	Sample Depth[2] (feet bgs)	Sampling SOP[3]	Laboratory Analyses						Field Analyses						
					Antimony	Arsenic	Copper	Lead	Zinc	Nitroglycerin	Water Level	Temperature	pH	Spec. Cond.	ORP	DO	Turbidity
X4SB014	X4SS0140624	Horizontal delineation west of JAX-56-SBSS008, west of floor of western berm (in native soil)	0.5-2.0	FS 3000		•		•									
X4SB015	X4SS0150006	Horizontal delineation west of JAX-56-SBSS002, west of floor of western berm (in native soil)	0.0-0.5	FS 3000	•	•	•	•	•								
X4SB015	X4SS0150624	Horizontal delineation west of JAX-56-SBSS002, west of floor of western berm (in native soil)	0.5-2.0	FS 3000		•		•									
X4SB016	X4SB0160406	Vertical delineation below JAX-56-SBSS040	4.0-6.0	FS 3000	•			•									
X4SB017	X4SB0170406	Vertical delineation below JAX-56-SBSS042	4.0-6.0	FS 3000	•	•	•	•									
X4SB018	X4SB0180406	Vertical delineation below JAX-56-SBSS044	4.0-6.0	FS 3000				•									
X4SB019	X4SB0190406	Vertical delineation below JAX-56-SBSS045	4.0-6.0	FS 3000				•									
X4SB020	X4SB0200406	Vertical delineation below JAX-56-SBSS046	4.0-6.0	FS 3000				•									
X4SB021	X4SB0210006C	Sample from within the 25-yard firing line area **(plus field duplicate**)	0.0-0.5	FS 3000						•							
X4SB022	X4SB0220006C	Sample from within the 25-yard firing line area	0.0-0.5	FS 3000						•							
X4SB023	X4SB0230006C	Sample from within the 25-yard firing line area	0.0-0.5	FS 3000						•							
X4SB024	X4SB0240006C	Sample from within the 25-yard firing line area	0.0-0.5	FS 3000						•							
X4SB025	X4SB0250006C	Sample from within the 25-yard firing line area	0.0-0.5	FS 3000						•							
X4SB026	X4SB0260006C	Sample from within the 25-yard firing line area	0.0-0.5	FS 3000						•							

Sample Location	Sample ID	Sample Location Rationale[1]	Sample Depth[2] (feet bgs)	Sampling SOP[3]	Laboratory Analyses						Field Analyses						
					Antimony	Arsenic	Copper	Lead	Zinc	Nitroglycerin	Water Level	Temperature	pH	Spec. Cond.	ORP	DO	Turbidity
X4SB027	X4SB0270006C	Sample from within the 25-yard firing line area	0.0-0.5	FS 3000						•							
X4SB028	X4SB0280006C	Sample from within the 25-yard firing line area	0.0-0.5	FS 3000						•							
X4SB029	X4SB0290006C	Sample from within the 25-yard firing line area	0.0-0.5	FS 3000						•							
X4SB030	X4SB0300006C	Sample from within the 25-yard firing line area	0.0-0.5	FS 3000						•							
X4SB031	X4SB0310006C	Sample locations from within the 50-yard firing line area	0.0-0.5	FS 3000						•							
X4SB032	X4SB0320006C	Sample locations from within the 50-yard firing line area	0.0-0.5	FS 3000						•							
X4SB033	X4SB0330006C	Sample locations from within the 50-yard firing line area	0.0-0.5	FS 3000						•							
X4SB034	X4SB0340006C	Sample locations from within the 50-yard firing line area	0.0-0.5	FS 3000						•							
X4SB035	X4SB0350006C	Sample locations from within the 50-yard firing line area	0.0-0.5	FS 3000						•							
X4SB036	X4SB0360006C	Sample locations from within the 50-yard firing line area	0.0-0.5	FS 3000						•							
X4SB037	X4SB0370006C	Sample locations from within the 50-yard firing line area	0.0-0.5	FS 3000						•							
X4SB038	X4SB0380006C	Sample locations from within the 50-yard firing line area	0.0-0.5	FS 3000						•							
X4SB039	X4SB0390006C	Sample locations from within the 50-yard firing line area	0.0-0.5	FS 3000						•							
X4SB040	X4SB0400006C	Sample locations from within the 50-yard firing line area	0.0-0.5	FS 3000						•							

Sample Location	Sample ID	Sample Location Rationale[1]	Sample Depth[2] (feet bgs)	Sampling SOP[3]	Laboratory Analyses						Field Analyses						
					Antimony	Arsenic	Copper	Lead	Zinc	Nitroglycerin	Water Level	Temperature	pH	Spec. Cond.	ORP	DO	Turbidity
Groundwater																	
TW05	X4TW05	DPT temporary well TW-05 north of JAX-56-SBSS044, at the center of the range floor at the base of the backstop berm	6-12	FS 2200, FT 1000 to 1600	•			•			•	•	•	•	•	•	•
PSC 58 — Trap Ranges (UXO Site 6)																	
Surface and Subsurface Soil																	
X6SB001	X6SB0010406	Vertical delineation below JAX-58-SBSS028 **(plus field duplicate)**	4.0-6.0	FS 3000	•	•		•									
X6SB002	X6SS0020006	Horizontal delineation south-west of JAX-58-SBSS028 **(plus field duplicate)**	0.0-0.5	FS 3000	•	•		•									
X6SB003	X6SS0030006	Horizontal delineation south-east of JAX-58-SBSS025	0.0-0.5	FS 3000	•	•		•									
X6SB004	X6SS0040006	Horizontal delineation south-west of JAX-58-SBSS025	0.0-0.5	FS 3000	•	•		•									
X6SB005	X6SS0050006	Horizontal delineation west of JAX-58-SBSS019	0.0-0.5	FS 3000	•	•		•									
X6SB006	X6SS0060006	Horizontal delineation west of JAX-58-SBSS007	0.0-0.5	FS 3000	•	•		•									
X6SB007	X6SS0070006	Horizontal delineation north of JAX-58-SBSS008	0.0-0.5	FS 3000	•	•		•									
X6SB008	X6SS0080006	Horizontal delineation north of JAX-58-SBSS010	0.0-0.5	FS 3000	•	•		•									
X6SB009	X6SS0090006	Horizontal delineation north of JAX-58-SBSS012	0.0-0.5	FS 3000	•	•		•									
X6SB010	X6SS0100006	Horizontal delineation east of JAX-58-SBSS024	0.0-0.5	FS 3000	•	•		•									

Sample Location	Sample ID	Sample Location Rationale[1]	Sample Depth[2] (feet bgs)	Sampling SOP[3]	Laboratory Analyses						Field Analyses						
					Antimony	Arsenic	Copper	Lead	Zinc	Nitroglycerin	Water Level	Temperature	pH	Spec. Cond.	ORP	DO	Turbidity
X6SB011	X6SB0110006	Horizontal delineation east of JAX-58-SBSS029	0.0-0.5	FS 3000	•	•		•									
Sediment																	
X6SD001	X6SD0010006	Sample 1 in Center Pond **(plus field duplicate)**	0.0-0.5	FS 4000	•	•		•									
X6SD002	X6SD0020006	Sample 2 in Center Pond	0.0-0.5	FS 4000	•	•		•									
X6SD003	X6SD0030006	Sample 3 in Center Pond	0.0-0.5	FS 4000	•	•		•									
Surface Water																	
X6SW001	X6SW0010006	Sample 1 in Center Pond **(plus field duplicate)**	0.0-0.5	FS 2100, FT 1000 to 1600	•	•		•			•	•	•	•	•	•	•
X6SW002	X6SW0020006	Sample 2 in Center Pond	0.0-0.5	FS 2100, FT 1000 to 1600	•	•		•			•	•	•	•	•	•	•
X6SW003	X6SW0030006	Sample 3 in Center Pond	0.0-0.5	FS 2100, FT 1000 to 1600	•	•		•			•	•	•	•	•	•	•
Groundwater																	
TW06	X6TW06	DPT temporary well TW-06 underlying X6SB001	6-12	FS 2200, FT 1000 to 1600	•	•		•			•	•	•	•	•	•	•

Notes:

[1] Sample rationale is based on the recommendations provided in the SI Report (Tetra Tech, 2010).

[2] Depths are estimated for proposed wells. Actual depths may vary based on site conditions. Well screens will be placed across the first water-bearing zone.

[3] Florida Department of Environmental Protection Field SOPs can be obtained at the following website: www.dep.state.fl.us/water/sas/sop/sops.htm

bgs = Below grade surface
SOP = Standard operating procedure
DPT = Direct push technology
UXO = Unexploded ordnance
PSC = Potential source of contamination
ORP = Oxidation-reduction potential
DO = Dissolved oxygen

SAP WORKSHEET #19: FIELD SAMPLING REQUIREMENTS TABLE

(UFP-QAPP Manual Section 3.1.1)

Resolution Consultants is adopting Worksheet #19, Section 8.6, page 92 in the Final Tier II SAP (Tetra Tech, 2012) in its entirety.

SAP WORKSHEET #20: FIELD QUALITY CONTROL SAMPLE SUMMARY TABLE

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs[1]	No. of Equipment Blanks[2]	Total No. of Samples to Laboratory
Surface Soil	Nitroglycerin	20	2	1/1	0	22
	Total Metals	40	4	3/3	0	44
Subsurface Soil	Total Metals	20	2	1/1	2	24
Sediment	Total Metals	3	1	1/1	1	5
Surface Water	Total Metals	3	1	1/1	0	4
	Dissolved Metals (Field-Filtered)	0 minimum; 3 maximum	1	1/1	1[3]	0 minimum; 5 maximum
Groundwater	Total Metals	3	1	1/1	0	4
	Dissolved Metals (Field-Filtered)	0 minimum; 3 maximum	1	1/1	1[3]	0 minimum; 5 maximum

Notes:

[1] Although matrix spike (MS) and matrix spike duplicate (MSD) samples are not typically considered field QC samples, they are included here because location determination is often established in the field. MS/MSD samples are not included in the total number of samples sent to the laboratory. For total (and dissolved if required) metals, a laboratory duplicate will be collected in place of an MSD.

[2] Equipment rinsate blanks will be collected if non-dedicated submersible pumps or other equipment are used.

[3] The equipment blank for dissolved metals, if collected, will be obtained by passing rinse water through a 0.45-micron filter.

No. = Number
MS = Matrix spike
MSD = Matrix spike duplicate

SAP WORKSHEET #21: PROJECT SAMPLING SOP REFERENCES TABLE

(UFP-QAPP Manual Section 3.1.2)

Reference Number	Title, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Yes/No)	Comments
FC 1000	Cleaning/Decontamination Procedures, December 2008	FDEP	Decontamination equipment (scrub brushes, phosphate free detergent, de-ionized water)	No	See footnote
FD 1000	Documentation Procedures, December 2008	FDEP	Documentation of all sampling activities (log book, sampling logs, chains-of-custody)	No	See footnote
FS 1000	General Sampling Procedures, December 2008	FDEP	Not Applicable	No	See footnote
FS 2100	Surface Water Sampling, December 2008	FDEP	Direct grab technique using sample jars	No	See footnote
FS 2200	Groundwater Sampling, December 2008 (Includes Well Purging and Groundwater Sampling Techniques)	FDEP	Submersible pump, Teflon tubing	No	See footnote
FS 3000	Soil Sampling, December 2008	FDEP	Soil sampling equipment (e.g., trowel, hand auger)	No	See footnote
FS 4000	Sediment Sampling, December 2008	FDEP	Stainless steel or disposable trowel	No	See footnote
FT 1000	Field Testing General, December 2008	FDEP	Multi-parameter water quality meter, such as a YSI 556 Series	No	See footnote
FT 1100	Field pH, December 2008	FDEP	Multi-parameter water quality meter, such as a YSI 556 Series	No	See footnote
FT 1200	Field Specific Conductance, December 2008	FDEP	Multi-parameter water quality meter, such as a YSI 556 Series	No	See footnote
FT 1400	Field Temperature, December 2008	FDEP	Multi-parameter water quality meter, such as a YSI 556 Series	No	See footnote
FT 1500	Field Dissolved Oxygen, December 2008	FDEP	Multi-parameter water quality meter, such as a YSI 556 Series	No	See footnote

Reference Number	Title, Revision Date and/or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Yes/No)	Comments
FT 1600	Field Turbidity, December 2008	FDEP	Turbidity meter, such as LaMotte Model 2020e or similar	No	See footnote
3-01	Utility Clearance	Resolution Consultants	Not Applicable	No	In **Appendix C**
3-03A	Sample Labeling, and Chain-of-Custody, Revision 0, August 2012	Resolution Consultants	Not Applicable	No	In **Appendix C**
3-04A	Sample Handling, Storage, and Shipping, Revision 0, May 2012	Resolution Consultants	Not Applicable	No	In **Appendix C**
3-05	Investigation Derived Waste Management, Revision 0, May 2012	Resolution Consultants	Not Applicable	No	In **Appendix C**
3-07	Land Surveying, Revision 0, August 2012	Resolution Consultants	Global Positioning System Trimble Geo XT (or similar)	No	In **Appendix C**
3-12	Monitoring Well Installation, Revision 0, May 2012	Resolution Consultants	Health and safety equipment, well drilling and installation equipment, hydrogeologic equipment	No	In **Appendix C**
3-13	Monitoring Well Development, Revision 0, June 2012	Resolution Consultants	Surge block, Submersible pump	No	In **Appendix C**
3-16	Soil and Rock Classification, Revision 0, August 2012	Resolution Consultants	Not Applicable	No	In **Appendix C**

Notes:
FDEP Field SOPs can be obtained at the following website: www.dep.state.fl.us/water/sas/sop/sops.htm
FDEP = Florida Department of Environmental Protection

SAP WORKSHEET #22: FIELD EQUIPMENT CALIBRATION, MAINTENANCE, TESTING, AND INSPECTION TABLE

(UFP-QAPP Manual Section 3.1.2.4)

Field Equipment	Activity	Frequency	Acceptance Criterion	Corrective Action	Responsible Person	SOP Reference[1]	Spare Parts (Kept in Carrying Case)
Multi-Parameter Water Quality Meter such as YSI 556 Series (or similar)	Visual Inspection Calibration/ Verification	Daily Beginning of each day	pH ± 0.2 standard units Specific Conductance ± 10% Dissolved oxygen ± 0.2 mg/L Temperature ±4 °Celsius Oxygen reduction potential ± 10 mV	Operator correction or replacement	Resolution Consultants FOL or designee	3-13, Manufacturer's Guidance Manual, FDEP FT 1100, FT 1200, FT 1400, FT 1500	Batteries Field-replaceable DO, pH, and pH/ORP probes DO membranes Calibration solutions
Turbidity Meter LaMotte Model 2020e (or similar)	Visual Inspection Calibration/ Verification	Daily Beginning of each day	Nephelometric Turbidity Unit 10%	Operator correction or replacement	Resolution Consultants FOL or designee	3-13, Manufacturer's Guidance Manual, FDEP FT 1600	Batteries Sample Cells Calibration solutions
Water Level Indicator such as Solinst Model 101 (or similar)	Visual Inspection Field checks as per manufacturer	Once upon receiving from vendor Then Daily	0.01 foot accuracy	Operator correction or replacement	Resolution Consultants FOL or designee	3-14, Manufacturer's Guidance Manual	Batteries
Global Positioning System Trimble Geo XT (or similar)	Positioning	Beginning and end of each day used	Accuracy: sub-meter horizontal dilution of precision < 3, number of satellites must be at least six	Wait for better signal, replace unit, or choose alternate location technique	Resolution Consultants FOL or designee	3-07, Manufacturer's Guidance Manual	Battery Pack Spare stylus and tether

Notes:
SOP = Standard operating procedure
% = Percent
mg/L = Milligrams per liter
mV = Millivolts
FOL = Field operations leader
DO = Dissolved oxygen
ORP = Oxygen reduction potential
FDEP = Florida Department of Environmental Protection

SAP WORKSHEET #23: ANALYTICAL SOP REFERENCES TABLE

(UFP-QAPP Manual Section 3.2.1)

Resolution Consultants is adopting Worksheet #23, Section 10.0, page 102 in the Final Tier II SAP (Tetra Tech, 2012) in its entirety.

SAP WORKSHEET #24: ANALYTICAL INSTRUMENT CALIBRATION TABLE

(UFP-QAPP Manual Section 3.2.2)

Resolution Consultants is adopting Appendix G, WS#24 in the Final Tier II SAP (Tetra Tech, 2012) in its entirety.

SAP WORKSHEET #25: ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION TABLE

(UFP-QAPP Manual Section 3.2.3)

Resolution Consultants is adopting Appendix G, WS#25 in the Final Tier II SAP (Tetra Tech, 2012) in its entirety.

SAP WORKSHEET #26: SAMPLE HANDLING SYSTEM

(UFP-QAPP Manual Appendix A)

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT	
Sample Collection (Personnel/Organization):	Resolution Consultants FOL or designee
Sample Packaging (Personnel/Organization):	Resolution Consultants FOL or designee
Coordination of Shipment (Personnel/Organization):	Resolution Consultants FOL or designee
Type of Shipment/Carrier:	FedEx
SAMPLE RECEIPT AND ANALYSIS	
Sample Receipt (Personnel/Organization):	Sample Custodians/Chemtech Consulting Group, Inc. and Empirical Laboratories, LLC
Sample Custody and Storage (Personnel/Organization):	Sample Custodians/Chemtech Consulting Group, Inc. and Empirical Laboratories, LLC
Sample Preparation (Personnel/Organization):	Extraction Laboratory, Metals Preparation Laboratory/Chemtech Consulting Group, Inc. and Empirical Laboratories, LLC
Sample Determinative Analysis (Personnel/Organization):	Organic and Metals Analysts/Chemtech Consulting Group, Inc. and Empirical Laboratories, LLC
SAMPLE ARCHIVING	
Field Sample Storage (Number of days from sample collection):	60 days from receipt
Sample Extract/Digestate Storage (No. of days from extraction/digestion):	3 months from sample digestion/extraction
Biological Sample Storage (Number of days from sample collection):	not applicable
SAMPLE DISPOSAL	
Personnel/Organization:	Sample Custodians/Chemtech Consulting Group, Inc. and Empirical Laboratories, LLC

Note:
FOL = Field operations leader

SAP WORKSHEET #27: SAMPLE CUSTODY REQUIREMENTS

(UFP-QAPP Manual Section 3.3.3)

The following sections outline the procedures that will be used to document project activities and sample collection, handling, tracking, and custody procedures during the investigation. All forms must be filled in as completely as possible.

27.1 Sample Nomenclature

Refer to Worksheet #18 for how the samples will be labeled.

Sample nomenclature put forth for this field event has been selected based on historical usage. The sample nomenclature for each tracking number includes the site being investigated, sample media identifier, and sample location number. The standard sample matrix and type codes used for this field event are as follows: Duplicate samples will be submitted to the laboratory as blind duplicates. The quality assurance/ quality control (QA/QC) codes used for this field event are as follows: RB for equipment rinsate blanks. Field QC blanks will be labeled sequentially followed by the date (i.e., TB-20101213, FB-20101214, etc.). Samples to be used for MS/MSDs will be labeled MS/MSD on the container label and noted on the chain-of-custody, as required in the laboratory QA Plan; however, "MS/MSD" will not be part of the unique sample identifier in order to maintain consistency with the project database. Additional information regarding protocol for sample labeling is contained in Resolution Consultants SOP 3-03A (**Appendix B**).

27.2 Sample Collection Documentation

Documentation of field observations will be recorded in a field logbook and/or field log sheets including sample collection logs, boring logs, volatile organic screening logs, and monitoring well construction logs. Field logbooks utilized on this project will consist of a bound, water-resistant logbook. All pages of the logbook will be numbered sequentially and observations will be recorded with indelible ink.

Field sample log sheets will be used to document sample collection details and other observations and activities will be recorded in the field logbook. Instrument calibration logs will be used to record the daily instrument calibration.

For sampling and field activities, the following types of information will be recorded in the field logbook as appropriate:

- Site name and location
- Date and time of logbook entries
- Personnel and their affiliations
- Weather conditions
- Activities involved with the sampling
- Subcontractor activity summary
- Site observations including site entry and exit times
- Site sketches made onsite
- Visitor names, affiliations, arrival and departure times
- Health and safety issues, including personal protective equipment

27.3 Sample Handling and Tracking System

Following sample collection into the appropriate bottleware, all samples will be immediately placed on ice in a cooler. The glass sample containers will be enclosed in bubble-wrap to protect the bottleware during shipment. The cooler will be secured using strapping tape along with a signed custody seal. Sample coolers will be delivered to a local courier location for priority overnight delivery to the selected laboratory for analysis. Samples will be preserved as appropriate based on the analytical method. The laboratories will provide pre-preserved sample containers for sample collection. Samples will be maintained at 0 to 6 degrees Celsius until delivery to the laboratory. Proper custody procedures will be followed throughout all phases of sample collection and handling.

After collection, each sample will be maintained in the sampler's custody until formally transferred to another party (e.g., FedEx). For all samples collected, chain-of-custody forms 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 chain-of-custody form. Resolution Consultants SOP 3-03A provides further details on the chain-of-custody procedure, which is in **Appendix C**.

These subsections outline the procedures that will be used by field and laboratory personnel to document project activities and sample collection procedures. All forms must be filled in as completely as possible.

Resolution Consultants personnel will collect the samples. The samplers will take care not to contaminate samples through improper handling. Samples will be sealed in appropriate containers, packaged by Resolution Consultants personnel and placed into sealed coolers under chain-of-custody in accordance with the applicable SOP. All coolers will contain a temperature blank. Samples will be transferred under chain-of-custody to a courier as described below. Once received by the laboratory, receipt will be documented on the chain-of-custody form and the samples will be checked in. The samples will remain under chain-of-custody throughout the analysis period to ensure their integrity is preserved. Details are provided below.

Samples to be delivered to the laboratory(s) will be made by a public courier (i.e., FedEx). After samples have been collected, they will be sent to the laboratory(s) within 24 hours. Under no circumstances will sample holding times be exceeded.

27.4 Field Sample Custody Procedures

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 Resolution Consultants SOP 3-04A (**Appendix B**).

A sample is under custody if:

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

Custody documentation is designed to provide documentation of preparation, handling, storage, and shipping of all samples collected. A multi-part form is used with each page of the form signed and dated by the recipient of a sample or portion of sample. The person releasing the sample and the person receiving the sample each will retain a copy of the form each time a sample transfer occurs.

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

The Resolution Consultants FOL is responsible for the care and custody of the samples collected until they are delivered to the laboratory or are entrusted to a carrier. When transferring samples, the individuals relinquishing and receiving them will sign, date, and note the time on the chain-of-custody form. This record documents the sample custody transfer from the sampler to the laboratory, often through another person or agency (common carrier). Upon arrival at the laboratory, internal sample custody procedures will be followed as defined in the laboratory SOPs, copies of which are available upon request.

27.5 Laboratory Chain Of Custody — Chemtech and Empirical

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

SAP WORKSHEET #28: LABORATORY QC SAMPLES TABLE

(UFP-QAPP Manual Section 3.4)

Resolution Consultants is adopting Worksheet #28, Section 11.0, pages 103-107 in the Final Tier II SAP (Tetra Tech, 2012) in its entirety.

SAP WORKSHEET #29: PROJECT DOCUMENTS AND RECORDS TABLE

(UFP-QAPP Manual Section 3.5.1)

Document	Where Maintained
Sample Collection Documents and Records Project personnel sign-off record Field logbook (and sampling notes) Field sample forms (e.g., sample log sheets, drilling logs, etc.) Chain-of-custody records Sample shipment air bills Equipment calibration logs Photographs Sampling and Analysis Plans including field sampling standard operating procedures Safe work permit forms	Sample collection documents and records (may include printed copy as well as electronic information) will be maintained at the Resolution Consultants office at 5724 Summer Trees Drive, Memphis, Tennessee 38134. These files will be retained for 50 years after the last decision document is signed for NAS Jacksonville.
Analytical Results Documents and Records Sample receipt/log-in forms Sample preparation logs Equipment calibration logs Sample analysis run logs Reported field sample results Reported results for standards, quality control checks Reported results for standards, quality control samples Data completeness checklists Data validation memoranda	Analytical results, documents and records will be provided by the laboratory in printed and electronic formats. Although available in the Administrative Record file, laboratory reports are typically filed at a separate location and are available upon request. Printed copies of laboratory data will be stored at a third-party secure professional document storage firm until transfer to the Federal Records Center (FRC). The records will be transferred to FRC 3 years after completion of a response action. These files will be retained for 50 years after the last decision document is signed for NAS Jacksonville. Electronic analytical results will also be verified, entered, and maintained in a database on a password protected Structured Query Language server. Data qualifiers will be added to the database during data validation. After validation, the validated data files will be transferred to the Navy's Naval NIRIS data management system.

Document	Where Maintained
Other Documents Personnel training records Health and Safety certifications Accident Prevention Plan Field Sampling Audit Checklist Analytical Audit Checklist	Personnel training records and health and safety certificates will be stored in personnel records and electronically in the Resolution Consultant's training database located at project file at 5724 Summer Trees Drive, Memphis, Tennessee 38134. Plans and reports will be stored in printed version and electronically in the Administrative Record file. Printed copies will be stored at a third-party secure professional document storage firm until transfer to the FRC. The records will be transferred to FRC 3 years after completion of a response action. These files will be retained for 50 years after the last decision document is signed for NAS Jacksonville. Field Audit Checklists are not considered part of the Administrative Record file and will be stored in the Resolution Consultants project file at 5724 Summer Trees Drive, Memphis, Tennessee 38134, and electronically in the server library. Analytical Audit Checklists will be retained by the respective accreditation authorities.
Final Document/Records Repository Administrative Record files Site files Post decision Files Analytical data Spatial data Maps	All final documents/Records repositories will be stored in accordance with in the NAVFAC Environmental Restoration Recordkeeping Manual. Printed copies will be stored at a third-party secure professional document storage firm until transfer to the FRC, and electronic copies will be maintained, verified, and stored on the Navy's NIRIS data management system. The records will be transferred to FRC 3 years after completion of a response action. These files will be retained for 50 years after the last decision document is signed for NAS Jacksonville.

Notes:

FRC = Federal Records Center
NIRIS = Naval Installation Restoration Information Solution
NAS = Naval Air Station

SAP WORKSHEET #30: ANALYTICAL SERVICES TABLE

(UFP-QAPP Manual Section 3.5.2.3)

Resolution Consultants is adopting Worksheet #30, Section 8.6, page 92 in the Final Tier II SAP (Tetra Tech, 2012) in its entirety.

SAP WORKSHEET #31: PLANNED PROJECT ASSESSMENTS TABLE

(UFP-QAPP Manual Section 4.1.1)

Resolution Consultants is adopting Appendix G, WS#31 in the Final Tier II SAP (Tetra Tech, 2012) in its entirety.

SAP WORKSHEET #32: ASSESSMENT FINDINGS AND CORRECTIVE ACTION RESPONSES TABLE

(UFP-QAPP Manual Section 4.1.2)

Resolution Consultants is adopting Appendix G, WS#32 in the Final Tier II SAP (Tetra Tech, 2012) in its entirety.

SAP WORKSHEET #33: QUALITY ASSURANCE MANAGEMENT REPORTS TABLE

(UFP QAPP Manual Section 4.2)

Type of Report	Frequency (daily, weekly monthly, quarterly, annually, etc.)	Projected Delivery Date(s)	Person(s) Responsible for Report Preparation (title and organizational affiliation)	Report Recipient(s) (title and organizational affiliation)
Data Validation	Report per data package	Within 4 weeks of receipt of laboratory data	Resolution Consultants project chemist or designee	PM, project file, Resolution Consultants
Major Analysis Problem Identification (Internal Resolution Consultants Memorandum)	When persistent analysis problems are detected by Resolution Consultants that may impact data usability	Immediately upon detection of problem (same day)	Resolution Consultants quality assurance officer or project chemist	PM, program manager, contracts department, project file, Resolution Consultants
Progress Report	Monthly for duration of the project	Monthly	PM, Resolution Consultants	Navy RPM, program manager, project file, Resolution Consultants
Laboratory Quality Assurance Report	When significant plan deviations result from unanticipated circumstances	Immediately upon detection of problem (same day)	Laboratory quality assurance manager or project manager, Empirical Laboratory	PM, project chemist, project file, Resolution Consultants

Notes:
PM = Project manager
RPM = Remedial project manager

SAP WORKSHEETS #34-36: DATA VERIFICATION AND VALIDATION (STEPS I AND IIA/IIB) PROCESS TABLE

(UFP-QAPP Manual Section 5.2.1), (UFP-QAPP Manual Section 5.2.2), (Figure 37 UFP-QAPP Manual), (Table 9 UFP-QAPP Manual)

Data Review Input	Description	Responsible for Verification (name, organization)	Step I/IIa/IIb [1]	Internal/ External [2]
Verification Chain-of-custody forms Sample Login/ Receipt	Review the sample shipment for completeness, integrity, and sign accepting the shipment. All sample labels will be checked against the chain-of-custody form, and any discrepancies will be identified, investigated, and corrected. The samples will be logged in at every storage area and work station required by the designated analyses. Individual analysts will verify the completeness and accuracy of the data recorded on the forms.	Laboratory sample custodians and analysts, Chemtech and Empirical Laboratories	I	Internal
Verification Chain-of-custody forms	Check that the chain-of-custody form was signed/dated by the sampler relinquishing the samples and by the laboratory sample custodian receiving the samples for analyses.	Project chemist or data validators, Resolution Consultants	I	External
Verification SAP sample tables	Verify that all proposed samples listed in the SAP tables have been collected.	FOL or designee, Resolution Consultants	I	External
Verification Sample log sheets and field notes	Verify that information recorded in the log sheets and field notes are accurate and complete.	FOL or designee, Resolution Consultants	I	External
Verification Field QC samples	Check that field QC samples, described in Worksheet #12 and listed in Worksheet #20 were collected as required.	FOL or designee, Resolution Consultants	I	External
Verification Analytical data package	Verify all analytical data packages will be verified internally for completeness by the laboratory performing the work. The laboratory project manager (or designee) will sign the case narrative for each data package.	Laboratory project manager, Chemtech and Empirical Laboratories	I	Internal
Verification Analytical data package	Verify the data package for completeness. Missing information will be requested from the laboratory and validation (if performed) will be suspended until missing data are received.	FOL, project chemist or data validators, Resolution Consultants	I	External
Verification Electronic data deliverables	Verify the electronic data against the chain-of-custody and hard copy data package for accuracy and completeness.	Data manager and/or validator, Resolution Consultants	I	External
Validation Chain-of-custody	Examine the traceability of the data from time of sample collection until reporting of data. Ensure that the custody and integrity of the samples were maintained from collection to analysis and the custody records are complete and any deviations are recorded.	Project chemist or data validators, Resolution Consultants	IIa	External

Data Review Input	Description	Responsible for Verification (name, organization)	Step I/IIa/IIb [1]	Internal/ External [2]
Validation Holding Times	Review that the samples were shipped and stored at the required temperature and sample pH for chemically-preserved samples meet the requirements listed in Worksheet #19. Ensure that the analyses were performed within the holding times. If holding times were not met, confirm that deviations were documented.	Project chemist or data validators, Resolution Consultants	IIa	External
Validation Laboratory data results for accuracy	Ensure that the laboratory QC samples were analyzed and that the MPC, listed in Worksheet #28, were met for all field samples and QC analyses. Check that specified field QC samples were collected and analyzed, as listed in Worksheet #12, and that the analytical QC criteria were met.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Field and laboratory duplicate analyses for precision	Check the field sampling precision by calculating the RPD for field duplicate samples. Check the laboratory precision by reviewing the RPD or percent difference values from laboratory duplicate analyses; MS/MSDs; and LCS/LCSDs. Ensure compliance with the precision goals listed in Worksheets #12 and 28.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Sample results for representativeness	Check that the laboratory recorded the temperature at sample receipt and the pH of the chemically preserved samples to ensure sample integrity from sample collection to analysis.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Project action limits	Assess and document the impact on matrix interferences or sample dilutions performed because of the high concentration of one or more contaminant, on the other target compounds reported as undetected.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Data quality assessment report	Summarize deviations from methods, procedures, or contracts. Qualify data results based on method or QC deviation and explain all the data qualifications. Present tabular qualified data and data qualifier codes and summarize data qualification outliers. Determine if the data met the MPC and determine the impact of any deviations on the technical usability of the data.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation SAP QC sample documentation	Ensure that all QC samples specified in the SAP were collected and analyzed and that the associated results were within acceptance limits.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Analytical data deviations	Determine the impact of any deviation from sampling or analytical methods and laboratory SOP requirements and matrix interferences effect on the analytical results.	Project chemist or data validators, Resolution Consultants	IIb	External
Validation Project quantitation limits for sensitivity	Ensure that the project detection limits were achieved.	Project chemist or data validators, Resolution Consultants	IIb	External

Data Review Input	Description	Responsible for Verification (name, organization)	Step I / IIa / IIb [1]	Internal / External [2]
Validation Groundwater, Surface Water, Soil, Sediment — Nitroglycerin	Assess nitroglycerin data against MPC identified in Worksheets #12, 19, 24, and 28. *U.S. EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review*, (June 2008) will be used as a guidance as applicable on applying qualifiers when MPC identified in Worksheets #12, 19, 24, and 28 are not met, including identifying when samples will be qualified estimated or rejected and when individual or all samples in a batch will be qualified. As described in Worksheet #14, checklists will not be used for validation because it will be performed using a combination of electronic automated data review and data package review. All findings will be documented on the DVA workbook and in the data validation report.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Groundwater, Surface Water, Soil, Sediment — Select metals: antimony, arsenic, copper, lead, zinc	Assess metals data against MPC identified in Worksheets #12, 19, 24, and 28. *U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review*, (January 2010) will be used as a guidance as applicable on applying qualifiers when MPC identified in Worksheets #12, 19, 24, and 28 are not met, including identifying when samples will be qualified estimated or rejected and when individual or all samples in a batch will be qualified. As described in Worksheet #14, checklists will not be used for validation because it will be performed using a combination of electronic automated data review and data package review. All findings will be documented on the DVA workbook and in the data validation report.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External

<table>
<tr><th>Data Review Input</th><th>Description</th><th>Responsible for Verification (name, organization)</th><th>Step I/IIa/IIb [1]</th><th>Internal/ External [2]</th></tr>
<tr><td>Validation
Data qualifiers</td><td>Qualifiers that will be applied during the data validation process are summarized below and, as indicated, results will be considered usable for interpretation unless the results are rejected when extreme data quality indicator failures are noted.

<table>
<tr><th>Data Qualifier</th><th>Qualifier Definition</th><th>Interpret Result As a Detection?</th><th>Result Usable?</th><th>Potential Result Bias</th></tr>
<tr><td>no qualifier</td><td>Acceptable</td><td>Yes</td><td>Yes</td><td>None expected</td></tr>
<tr><td>I</td><td>Estimated</td><td>Yes</td><td>Yes</td><td>High or Low</td></tr>
<tr><td>IJ</td><td>Estimated</td><td>Yes</td><td>Yes</td><td>High or Low</td></tr>
<tr><td>J</td><td>Estimated</td><td>Yes</td><td>Yes</td><td>High or Low</td></tr>
<tr><td>U</td><td>Undetected</td><td>No</td><td>Yes</td><td>None expected</td></tr>
<tr><td>UJ</td><td>Undetected and Estimated</td><td>No</td><td>Yes</td><td>High or Low</td></tr>
<tr><td>UR</td><td>Undetected and Rejected</td><td>No</td><td>No</td><td>Unspecified</td></tr>
<tr><td>R</td><td>Rejected</td><td>No</td><td>No</td><td>Unspecified</td></tr>
</table>

Note:
Both the I and J qualifiers indicate an estimated value. The I-qualifier, applied by the laboratory, is defined by Florida Department of Environmental Protection as the result is an estimated value between the detection limit and the quantitation limit. The I-qualifier, applied by the laboratory, will remain on the result to provide the end user additional information that the value is estimated below the quantitation limit. The J-qualifier will be applied during validation to indicate a value is estimated.</td><td>Project chemist or data validators, Resolution Consultants</td><td>IIa/IIb</td><td>External</td></tr>
</table>

Notes:
[1] IIa = Compliance with methods, procedures, and contracts [see Table 10, page 117, UFP-QAPP manual, V.1, March 2005.]
[1] IIb = Comparison with measurement performance criteria in the SAP [see Table 11, page 118, UFP-QAPP manual, V.1, March 2005]
[2] Internal or external in relation to the data generator.
SAP = Sampling and analysis plan
FOL = Field operations leader
QC = Quality control
RPD = Relative percent difference
MS/MSD = Matrix spike/Matrix Spike duplicate
LCS/LCSD = Laboratory control sample/laboratory control sample duplicate
SOP = Standard operating procedure
U.S. EPA = U.S. Environmental Protection Agency
MPC = Measurement performance criteria
DVA = Data Validation Assistant

SAP WORKSHEET #37: USABILITY ASSESSMENT

(UFP-QAPP Manual Section 5.2.3)

Data Review

The usability of the data directly affects whether project objectives can be achieved. Data usability will be assessed using the guidance provided in *Process for Assessing Data Usability* (FDEP, 2008) and the characteristics described below will be evaluated at a minimum. The results of these evaluations will be included in the project report. The data usability assessment will, at a minimum, constitute evaluation of the following characteristics to ensure that the amount, type, and quality of data are sufficient to achieve project objectives. The means of conducting these evaluations will vary depending on the nature of the data. For example, soil borings and well construction logs will generally be evaluated qualitatively or semi-quantitatively, whereas precision, accuracy, and sensitivity of analytical data will generally be evaluated quantitatively and may be based on, or may supplement, data validation findings. Examples include:

- Comparing actual to intended sampling locations and verifying that the correct datum was used to delineate contamination.
- Evaluating trends across sample delivery groups or sampling events.
- Assessing quantitative relationships between parameters (e.g., relative magnitudes of lead and other MC metals).
- Identifying potential errant or outlier data points.
- Assessing planning assumption validity.
- Evaluating the potential for contamination of samples by samplers.

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 —** Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected to be obtained under correct normal conditions. It is expected that 100% of the planned sampling points will be

collected. The completeness goal for field measurements will be greater than 90%. Laboratory analysis for this project will have a completeness goal greater than 95% to account for unanticipated results that may be rejected during data validation. Completeness can be calculated using the following equation.

$$\%Completeness = \frac{No.\ of\ Valid\ Tests}{Total\ Tests\ Taken} x100$$

The FOL, acting on behalf of the Project Team, will determine whether deviations from the scheduled sample collection or analyses occurred. If they have occurred and the Resolution Consultants PM determines that the deviations compromise the ability to meet project objectives he will consult with the Navy RPM and other project team members, as necessary (determined by the Navy RPM), to develop appropriate corrective actions.

- **Precision —** Precision measures the reproducibility of measurements and methods, and is defined for qualitative data as a group of values' variability compared with its average value. To assess the precision of the measurement systems used in this project, field duplicates will be obtained and analyzed with the samples collected. Precision of laboratory analysis will be assessed by comparing the relative percent difference (RPD) of analytical results between MS and MSDs (or sample duplicates) and the measurement quality objectives will be those cited in Worksheets #12 and #28. The RPD will be calculated for each pair of duplicate analysis using the following equation:

$$RPD = \frac{(S - D)}{(S + D)/2} x100$$

Where:

S = sample result
D = duplicate result

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 Worksheets #12 and #28. This will also include a comparison of field and laboratory precision with the expectation that laboratory duplicate results will be no less precise than field duplicate results. If the goals are not met or data have been flagged as estimated (J qualifier) limitations on the use of the data will be described in the project report.

- **Accuracy —** Accuracy is the degree to which a given result agrees with the true value. The accuracy of an entire measurement system is an indication of any bias that exists. Spiked sample results provide information needed to assess the accuracy of analyses. Specifically, surrogate spike, MS/MSD, and laboratory control sample (LCS) percent recoveries (%Rs) are used to assess accuracy. Every organic sample is spiked with known quantities of non-target surrogate compounds. Five percent of all samples analyzed are spiked with target chemicals for the MS/MSD (or sample duplicates). If the calculated %Rs for the known spike concentrations are within defined control limits set by each method, the reported sample concentrations are considered accurate. The accuracy measurement quality objectives will be those cited in Worksheets #12 and #28. Accuracy is calculated using the following equation:

$$\%R = \frac{(SSR - SR)}{SA} x100$$

Where:

SSR	=	spike sample recovery
SR	=	sample recovery
SA	=	concentration of spike added

The project chemist, acting on behalf of the Project Team, will determine whether the accuracy/bias goals were met for project data. This assessment will include an evaluation of field and laboratory contamination; instrument calibration variability; and analyte recoveries for surrogates, matrix spike, matrix spike duplicate, and laboratory control samples against the goals identified in worksheets #24 and #28. If the goals are not met, limitations on the use of the data will be described in the project report. Bias of the qualified results and a description of the impact of identified non-compliances on a specific data package or on the overall project data will be described in the project report.

- **Representativeness —** A project scientist, identified by the Resolution Consultants 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 analyzed in accordance with this 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 for each matrix and analytical fraction. This will not require quantitative comparisons unless professional judgment of the project scientist indicates that a quantitative analysis is required.

- **Comparability —** The project chemist, acting on behalf of the Project Team, will determine whether the data generated under this project are sufficiently comparable to historical property data generated by different methods and for samples collected using different procedures and under different property conditions. This will be accomplished by comparing overall precision and bias among data sets for each matrix and analytical fraction. This will not require quantitative comparisons unless 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 #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.

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

After completion of the data validation, the data and data quality will be reviewed to determine whether sufficient data of acceptable quality are available for decision making. In addition to the evaluations described above, a series of inspections and statistical analyses will be performed to estimate these characteristics. The statistical evaluations will include simple summary statistics for target analytes, such as maximum concentration, minimum concentration, number of samples exhibiting non-detected results, number of samples exhibiting positive results, and the proportion of samples with detected and non-detected results. The Project Team members, identified by the Resolution Consultants 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 missing or rejected data can be compensated by other data or whether addition data collection is necessary.

If significant data quality deficiencies are detected that prevent the attainment of project objectives, the limitations on the affected data will be described in the RI Report. The Resolution Consultants PM will bring these deficiencies to the attention of the Partnering Team for their evaluation and the Partnering Team will determine an appropriate corrective action depending on the circumstances.

Identify the personnel responsible for performing the usability assessment:

The Resolution Consultants PM, project chemist, and FOL will be responsible for conducting the listed data usability assessments. The data usability assessment will be reviewed with the Project Team. 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 report and reviewed during the normal document review cycle.

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

The data will be presented in tabular format, including data qualifications such as estimation (J, UJ) or rejection (R). The project report will identify and describe the data usability limitations and suggest re-sampling or other corrective actions, if necessary. Graphical presentations of the data such as concentration tag maps will be generated as part of the overall data evaluation process.

REFERENCES

United States Department of Defense. Department of Defense Quality Systems Manual for Environmental Laboratories. Version 4.1. November 2010.

Florida Department of Environmental Protection. Standard Operating Procedures for Field Activities. DEP-SOP-001/01. 3 December 2008

Occupational Safety and Health Administration General Industry Standards, Chapter 29, Code of Federal Regulations (CFR) 1910.120.

Naval Facilities Engineering Command. Final Environmental Restoration Recordkeeping Manual. Naval Facilities Engineering Command; Washington, DC. 2009.

Tetra Tech. Quality Assurance Project Plan Sampling and Analysis Plan (SAP) for Munitions Response Program Site Inspections at the Former Machine Gun Range Complex, Revision 0, Naval Air Station, Jacksonville. June 2009.

Tetra Tech. Final Tier II Sampling and Analysis Plan for the Munitions Response Program Remedial Investigation of the Former Machine Gun Range Complex, Naval Air Station, Jacksonville. December 2012.

U.S. EPA. U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review. EPA-540-R-08-01, OSWER 9240.1-48, Office of Emergency and Remedial Response, Washington, DC. 2008.

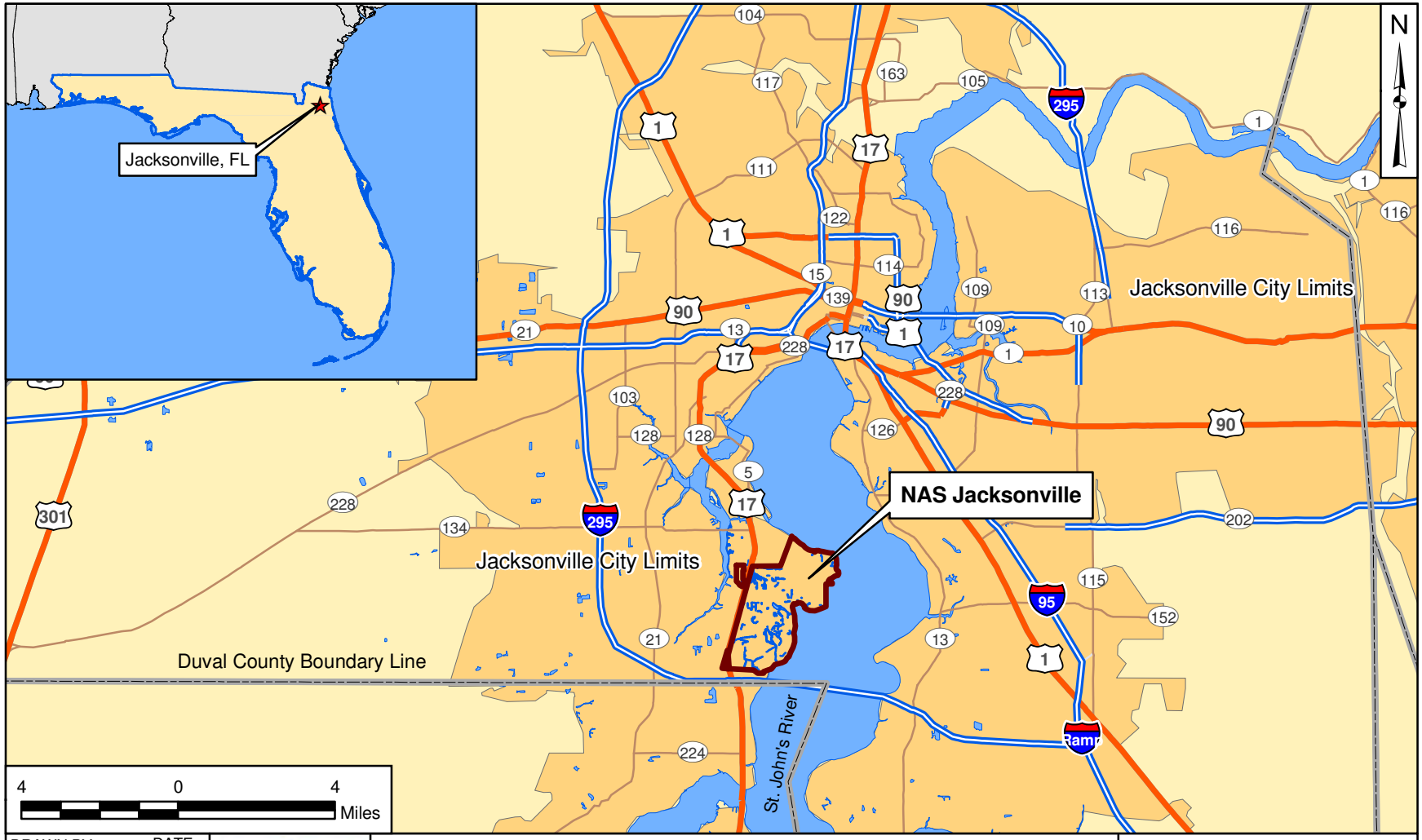
— Guidance for Quality Assurance Project Plans, EPA QA/G-5. EPA 240-R-02-009. December 2002.

— U.S. EPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review. EPA-540-R-10-011, OSWER 9240.1-51, Office of Solid Waste and Emergency Response. 2010.

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

Appendix A
Figures from the Final Tier II SAP (Tetra Tech, 2012)

P:\GIS\JACKSONVILLE_NAS\MXD\SITE_VICINITY.MXD 08/30/11 SS

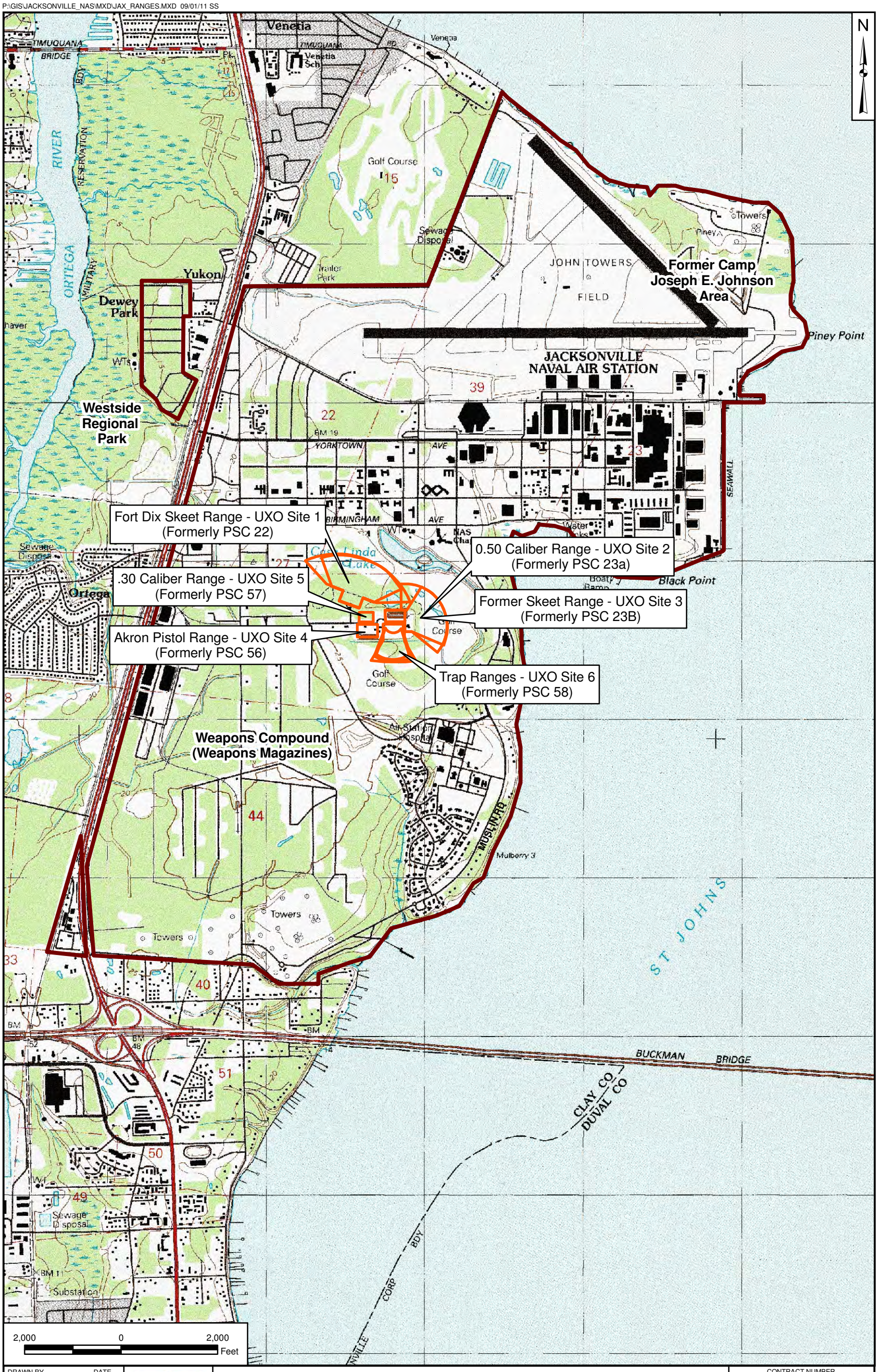


DRAWN BY T. WHEATON	DATE 06/14/10	GENERAL LOCATION MAP NAS JACKSONVILLE JACKSONVILLE, FLORIDA
CHECKED BY B. BECKER	DATE 08/30/11	
COST/SCHEDULE AREA		
SCALE AS NOTED		

NAVFAC

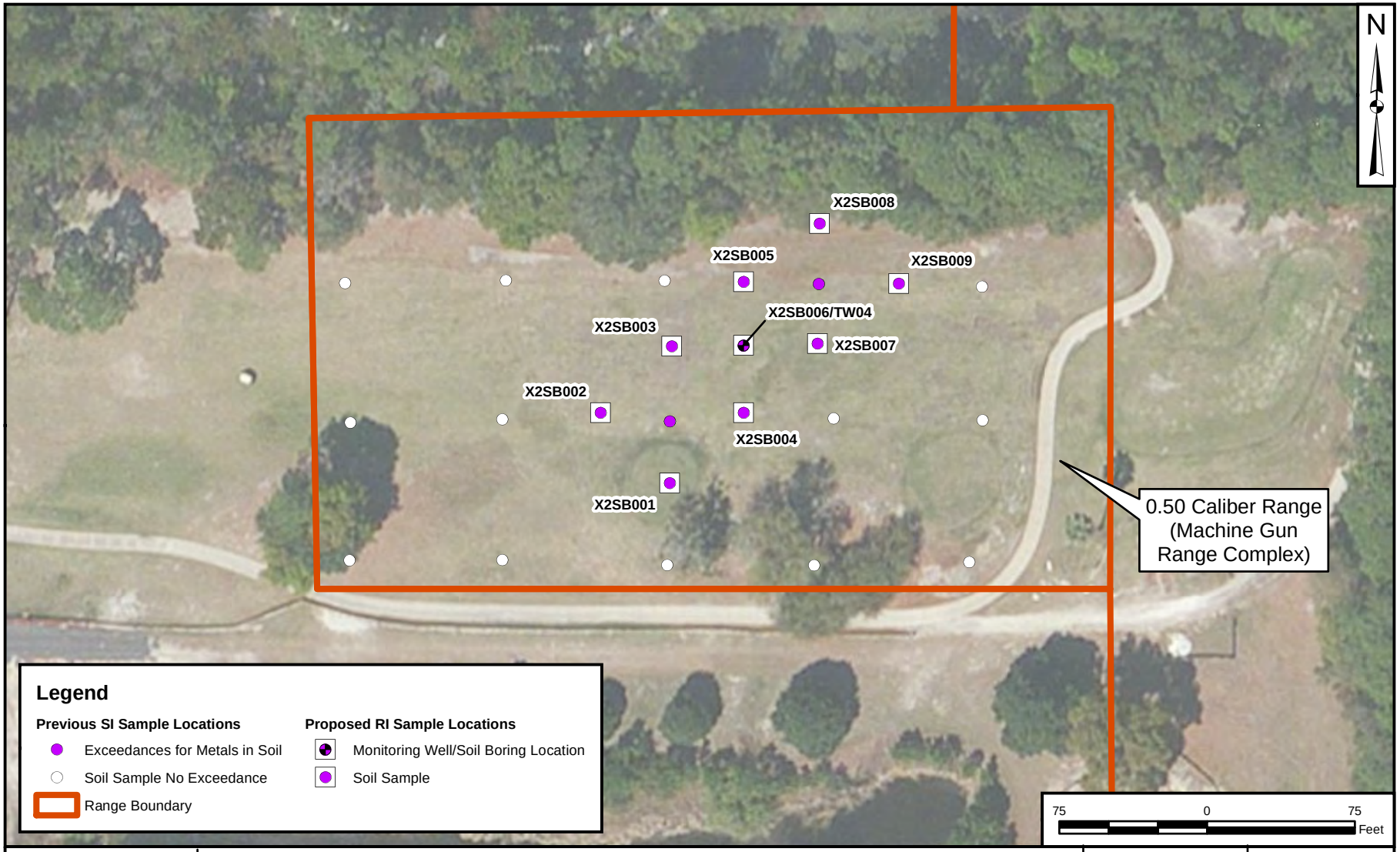
CONTRACT NUMBER CTO JM55	
APPROVED BY ___	DATE ___
APPROVED BY ___	DATE ___
FIGURE NO. FIGURE ES-1	REV 0

P:\GIS\JACKSONVILLE_NAS\MXD\JAX_RANGES.MXD 09/01/11 SS



DRAWN BY T. WHEATON	DATE 06/15/10	RANGES ASSOCIATED WITH THE FORMER MACHINE GUN COMPLEX NAS JACKSONVILLE JACKSONVILLE, FLORIDA	CONTRACT NUMBER CTO JM55
CHECKED BY B. BECKER	DATE 09/01/11		APPROVED BY ___ DATE ___
REVISED BY ___	DATE ___		APPROVED BY ___ DATE ___
SCALE AS NOTED			FIGURE NO. FIGURE ES-2 REV 0

PGH P:\GIS\JACKSONVILLE_NAS\MXD\PSC23A_PROPLOCS_2012.MXD 09/14/12 JN



DRAWN BY J. ENGLISH	DATE 07/17/12	TETRA TECH	CONTRACT NUMBER 3621 / CTO NUMBER JM55
CHECKED BY M. TRAXLER	DATE 09/14/12	PROPOSED SAMPLING LOCATIONS UXO 2 - .50 CALIBER RANGE MACHINE GUN RANGE COMPLEX NAS JACKSONVILLE JACKSONVILLE, FLORIDA	APPROVED BY — DATE —
REVISED BY J. NOVAK	DATE 09/14/12		APPROVED BY — DATE —
SCALE AS NOTED			FIGURE NO. FIGURE 7-2 / REV 0

x:\Navy\NAS_JAX\UXO4_ProposedSamples.mxd

Previous SI Sample Locations

- Exceedances for Metals Only in Soil
- Exceedances for Metals Only in Sediment
- Soil Sample No Exceedance

Proposed RI Sample Locations

- Soil Sample for Metals Only
- Monitoring Well/Soil Boring Location for Metals O*
- Soil Sample for Nitroglycerin Only

- Range Boundary
- Berm

*Vertical Delineation of Previous SI Sample Location (Previous Location ID in Parentheses)

0 25 50 75 100 Feet

FIGURE 7-4
PROPOSED SAMPLING LOCATIONS
UXO 4 - AKRON ROAD PISTOL RANGE
MACHINE GUN RANGE COMPLEX
NAS JACKSONVILLE
JACKSONVILLE, FLORIDA

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUESTED BY: T HAVERKOST	DATE: 8/5/2013
DRAWN BY: azimmerman	TASK ORDER NUMBER: JM55

PGH P:\GIS\JACKSONVILLE_NAS\MXD\PSC58_PROPLOCS_2012.MXD 09/14/12 JN

Note: Imagery obtained from the ESRI Bing Maps map service layer from ArcGIS Online. Aerial photograph was taken in March of 2011.

N

Trap Range
(Machine Gun Range Complex)

X6SB007
X6SB008
X6SB006
X6SB009
X6SB005
X6SB010
X6SB011
X6SB004
X6SB001/TW06 *
(JAX-58-SBSS028)
X6SW003/X6SD003
X6SB003
X6SB002
X6SW002/X6SD002
X6SW001/X6SD001

Legend

Previous SI Sample Locations

- Exceedances for Select Metals/PAH in Soil
- Exceedances for PAH Only in Soil
- Exceedances for Metals Only in Soil
- Exceedances for Select Metals/PAH in Sediment
- Exceedances for PAH Only in Sediment
- Exceedances for Metals Only in Sediment
- Soil Sample No Exceedance
- Sediment Sample No Exceedance

Proposed RI Sample Locations

- Monitoring Well/Soil Boring Location for Metals Only
- Soil Sample for Metals Only
- Surface Water/Sediment Sample for Metals Only
- Range Boundary
- Wastewater Reuse Area

* Vertical Delineation of Previous SI Sample Location (Previous Location ID in Parentheses)

100 0 100 Feet

DRAWN BY: J. ENGLISH	DATE: 07/16/12	TETRA TECH	CONTRACT NUMBER: 3621 / CTO NUMBER: JM55
CHECKED BY: B. BECKER	DATE: 09/14/12	PROPOSED SAMPLE LOCATIONS UXO 6 - TRAP RANGES MACHINE GUN RANGE COMPLEX NAS JACKSONVILLE JACKSONVILLE, FLORIDA	APPROVED BY: — / DATE: —
REVISED BY: J. NOVAK	DATE: 09/14/12		APPROVED BY: — / DATE: —
SCALE: AS NOTED			FIGURE NO.: FIGURE 7-5 / REV: 0

PGH P:\GIS\JACKSONVILLE_NAS\MXD\MACH_GUN_COMPLEX_TW_LOCS.MXD 09/14/12 JN

DRAWN BY / DATE	S. STROZ 09/01/11
CHECKED BY / DATE	B. BECKER 09/14/12
REVISED BY / DATE	J. NOVAK 09/14/12
SCALE	AS NOTED

TETRA TECH

TEMPORARY WELL LOCATIONS
MACHINE GUN RANGE COMPLEX
NAS JACKSONVILLE
JACKSONVILLE, FLORIDA

CONTRACT NUMBER	CTO NUMBER JM55
APPROVED BY / DATE	— / —
APPROVED BY / DATE	— / —
FIGURE NO.	FIGURE 7-6
REV	0

Appendix B

CD-ROM containing the Final Tier II Sampling and Analysis Plan (SAP) for the Munitions Response Program (MRP) Remedial Investigation (RI) of the Former Machine Gun Range Complex (Tetra Tech, 2012)

Appendix C
Resolution Consultants Standard Operating Procedures

Utility Clearance

Procedure 3-01

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes the process for determining the presence of subsurface utilities and other cultural features at locations where planned site activities involve the physical disturbance of subsurface materials.

1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).

1.3 The procedure applies to the following activities: soil gas surveying, excavating, trenching, drilling of borings and installation of monitoring and extraction wells, use of soil recovery or slide-hammer hand augers, and all other intrusive sampling activities.

1.4 The primary purpose of the procedure is to minimize the potential for damage to underground utilities and other subsurface features, which could result in physical injury, disruption of utility service, or disturbance of other subsurface cultural features.

1.5 If there are procedures, whether it be from Resolution Consultants, state, and/or federal, that are not addressed in this SOP and are applicable to utility clearance, those procedures should be added as an appendix to the project specific SAP.

1.6 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

2.1 Field and subcontractor personnel shall adhere to a site-specific health and safety plan (HASP).

3.0 Terms and Definitions

3.1 **Utility**

For the proposes of this SOP, a utility is defined as a manmade underground line or conduit, cable, pipe, vault or tank that is, or was, used for the transmission of material or energy (e.g., gas, electrical, telephone, steam, water or sewage, product transfer lines, or underground storage tanks).

3.2 **As-Built Plans**

As-built plans are plans or blueprints depicting the locations of structures and associated utilities on a property.

3.3 **One-Call**

The Utility Notification Center is the one-call agency for nationwide call before you dig. The Utility Notification Center is open 24 hours a day, and accepts calls from anyone planning to dig. The phone number 811 is the designated call before you dig phone number that directly connects you to your local one-call center. Additional information can be found at www.call811.com.

Calling before you dig ensures that any publicly owned underground lines will be marked so that you can dig around them safely. Having the utility lines marked not only prevents accidental damage to the lines, but prevents property damage and personal injuries that could result in breaking a line.

The following information will need to be provided when a call is placed to One-Call:

- Your name, phone number, company name (if applicable), and mailing address.
- What type or work is being done.
- Who the work is being done for.
- The county and city the work is taking place in.
- The address or the street where the work is taking place.
- Marking instructions, (specific instructions as to where the work is taking place).

Under normal circumstances it takes between 2 to 5 days from the time you call (not counting weekends or holidays) to have the underground lines marked. Because these laws vary from state to state, exactly how long it will take depends on where your worksite is located. You will be given an exact start time and date when your locate request is completed, which will comply with the laws in your area.

In the event of an emergency (any situation causing damage to life or property, or a service outage), lines can be marked sooner than the original given time if requested.

3.4 **Toning**

Toning is the process of surveying an area utilizing one or more surface geophysical methods to determine the presence or absence of underground utilities. Typically, toning is conducted after identifying the general location of utilities and carefully examining all available site utility plans. Each location is marked according to the type of utility being identified. In addition, areas cleared by toning are flagged or staked to indicate that all identified utilities in a given area have been toned.

4.0 Training and Qualifications

4.1 The **Contract Task Order (CTO) Manager** is responsible for verifying that these utility locating procedures are performed prior to the initiation of active subsurface exploration.

4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.3 The **Field Manager** is responsible for ensuring that all utility locating activities are performed in accordance with this procedure.

4.4 All **Field Personnel** are responsible for the implementation of this procedure.

5.0 Equipment and Supplies

5.1 Equipment and supplies necessary for locating subsurface utilities will be provided by the subcontractor; however, the project **Field Manager/Field Personnel** will provide any additional equipment and supplies as needed as well as maintain information regarding the utility clearance activities in the field logbook.

6.0 Procedure

Proceed wtih the following steps where subsurface exploration will include excavations, drilling, or any other subsurface investigative method that could damage utilities at a site. In addition to the steps outlined below, always exercise caution while conducting subsurface exploratory work.

6.1 **Prepare Preliminary Site Plan**

- Prepare a preliminary, scaled site plan depicting the proposed exploratory locations as part of the project specific Sampling and Analysis Plan (SAP) or Work Plan. Include as many of the cultural and natural features as practical in this plan.

6.2 **Review Background Information**

- Search existing plan files to review the as-built plans to identify the known location of utilities at the site. Plot the locations of utilities identified onto a preliminary, scaled site plan. Inform the CTO Manager if utilities lie within close proximity to a proposed exploration or excavation location. The CTO Manager will determine if it is necessary to relocate proposed sampling or excavation locations.
- Include the utility location information gathered during previous investigations (e.g., remedial investigation or remedial site evaluation) in the project design documents for removal or remedial actions. In this manner, information regarding utility locations collected during implementation of a CTO can be shared with the subcontractor during implementation of a particular task order. In many instances, this will help to reduce the amount of additional geophysical surveying work the subcontractor may have to perform.
- Conduct interviews with onsite and facility personnel familiar with the site to obtain additional information regarding the known and suspected locations of underground utilities. In addition, if appropriate, contact shall be made with local utility companies to request their help in locating underground lines. Pencil in the dimensions, orientation, and depth of utilities, other than those identified on the as-built plans, at their approximate locations on the preliminary plans. Enter the type of utility, the personnel who provided the information, and the date the information was provided into the field log.
- During the pre-field work interviewing process, the interviewer will determine which site personnel should be notified in the event of an incident involving damage to existing utilities. Record this information in the field logbook with the corresponding telephone numbers and addresses.

6.3 **Site Visit/Locate Utilities/Toning**

- Prior to the initiation of field activities, the Field Task Manager or similarly qualified field personnel shall visit the site and note existing structures and evidence of associated utilities, such as fire hydrants, irrigation systems, manhole and vault box covers, standpipes, telephone switch boxes, free-standing light poles, gas or electric meters, pavement cuts, and linear depression. Compare notes of the actual site configuration to the preliminary site plan. Note deviations in the field logbook and on the preliminary site plan. Accurately locate or survey and clearly mark with stakes, pins, flags, paint, or other suitable devices all areas where subsurface exploration is proposed. These areas shall correspond with the locations drawn on the preliminary site plan.
- Following the initial site visit by the Field Task Manager, a trained utility locating subcontractor will locate, identify, and tone all utilities depicted on the preliminary site plan. The Field Task Manager or similarly qualified field personnel shall visit the site and identify the areas of subsurface disturbance with white spray paint, chalk, white pin flags or some other easily identifiable marking. The utility locator should utilize appropriate sensing equipment to attempt to locate utilities that might not have appeared on the as-built plans. At a minimum, the utility subcontractor should utilize a metal detector and/or magnetometer; however, it is important to consider the possibility that non-metallic utilities or tanks might be present at the site. Use other appropriate surface geophysical methods such as Ground Penetrating Radar, Radiodetection, etc. as appropriate. Clear proposed exploration areas of all utilities in the immediate area where subsurface exploration is proposed. Clearly tone all anomalous areas. Clearly identify all toned areas on the preliminary site plan. All utilities near the area of subsurface disturbance should also be marked out by the utility subcontractor using the universal colors for subsurface utilities (i.e., red – electric; blue – water; green – sewer; yellow – gas; etc.). After toning the site and plotting all known or suspected buried utilities on the preliminary site plan, the utility locator shall provide the Field Task Manager with a copy of the completed preliminary

site plan. Alternatively, the Field Task Manager or designee shall document the results of the survey on the preliminary site plan.

- Report to the Field Task Manager anomalous areas detected and toned that are in close proximity to the exploration or excavation areas. The Field Task Manager shall determine the safe distance to maintain from the known or suspected utility. It may be necessary to relocate the proposed exploration or excavation areas. If this is required, the Field Task Manager or designee shall relocate them and clearly mark them using the methods described above. Completely remove the markings at the prior location. Plot the new locations on the site plan and delete the prior locations from the plan. In some instances, such as in areas extremely congested with subsurface utilities, it may be necessary to dig by hand or use techniques such as air knife to determine the location of the utilities.

6.4 **Prepare Site Plan**

- Prior to the initiation of field activities, draft a final site plan that indicates the location of subsurface exploration areas and all known or suspected utilities present at the site. Provide copies of this site plan to the Navy Technical Representative (NTR), the CTO Manager, and the subcontractor who is to conduct the subsurface exploration/excavation work. Review the site plan with the NTR to verify its accuracy prior to initiating subsurface sampling activities.

7.0 Quality Control and Assurance

7.1 Utility locating must incorporate quality control measures to ensure conformance to these and the project requirements.

8.0 Records, Data Analysis, Calculations

8.1 A bound field logbook will be kept detailing all activities conducted during the utility locating procedure.

8.2 The logbook will describe any changes and modifications made to the original exploration plan. The trained utility locator shall prepare a report and keep it in the project file. Also, a copy of the final site plan will be kept in the project file.

9.0 Attachments or References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual.* Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Author	Reviewer	Revisions (Technical or Editorial)
Caryn DeJesus Senior Scientist	Bob Shoemaker Senior Scientist	Rev 0 – Initial Issue (June 2012)

Logbooks

Procedure 3-02

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes the activities and responsibilities pertaining to the identification, use, and control of logbooks and associated field data records.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

2.1 In order to keep the logbook clean, store it in a clean location and use it only when outer gloves used for PPE have been removed.

3.0 Terms and Definitions

3.1 **Logbook**

A logbook is a bound field notebook with consecutively numbered, water-repellent pages that is clearly identified with the name of the relevant activity, the person assigned responsibility for maintenance of the logbook, and the beginning and ending dates of the entries.

3.2 **Data Form**

A data form is a predetermined format utilized for recording field data that may become, by reference, a part of the logbook (e.g., soil boring logs, trenching logs, surface soil sampling logs, groundwater sample logs, and well construction logs are data forms).

4.0 Training and Qualifications

4.1 The **Contract Task Order (CTO) Manager** or **designee** is responsible for determining which team members shall record information in field logbooks and for obtaining and maintaining control of the required logbooks. The **CTO Manager** shall review the field logbook on at least a monthly basis. The **CTO Manager** or **designee** is responsible for reviewing logbook entries to determine compliance with this procedure and to ensure that the entries meet the project requirements.

4.2 A knowledgeable individual such as the **Field Manager**, **CTO Manager**, or **Program Quality Manager** shall perform a technical review of each logbook at a frequency commensurate with the level of activity (weekly is suggested, or, at a minimum, monthly). Document these reviews by the dated signature of the reviewer on the last page or page immediately following the material reviewed.

4.3 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.4 The **Field Manager** is responsible for ensuring that all **field personnel** follow these procedures and that the logbook is completed properly and daily. The **Field Manager** is also responsible for submitting copies to the **CTO Manager**, who is responsible for filing them and submitting a copy (if required by the CTO Statement of Work).

4.5 The **logbook user** is responsible for recording pertinent data into the logbook to satisfy project requirements and for attesting to the accuracy of the entries by dated signature. The **logbook user** is also responsible for safeguarding the logbook while having custody of it.

4.6 All **field personnel** are responsible for the implementation of this procedure.

5.0 Equipment and Supplies

5.1 Field logbooks shall be bound field notebooks with water-repellent pages.

5.2 Pens shall have indelible black ink.

6.0 Procedure

6.1 The field logbook serves as the primary record of field activities. Make entries chronologically and in sufficient detail to allow the writer or a knowledgeable reviewer to reconstruct the applicable events. Store the logbook in a clean location and use it only when outer gloves used for personal protective equipment (PPE) have been removed.

6.2 Individual data forms may be generated to provide systematic data collection documentation. Entries on these forms shall meet the same requirements as entries in the logbook and shall be referenced in the applicable logbook entry. Individual data forms shall reference the applicable logbook and page number. At a minimum, include names of all samples collected in the logbook even if they are recorded elsewhere.

6.3 Enter field descriptions and observations into the logbook, as described in Attachment 1, using indelible black ink.

6.4 Typical information to be entered includes the following:

- Dates (month/day/year) and times (military) of all on-site activities and entries made in logbooks/forms;
- Site name and description;
- Site location by longitude and latitude, if known;
- Weather conditions, including temperature and relative humidity;
- Fieldwork documentation, including site entry and exit times;
- Descriptions of, and rationale for, approved deviations from the work plan (WP) or field sampling plan;
- Field instrumentation readings;
- Names, job functions, and organizational affiliations of on-site personnel;
- Photograph references;
- Site sketches and diagrams made on site;
- Identification and description of sample morphology, collection locations, and sample numbers;
- Sample collection information, including dates (month/day/year) and times (military) of sample collections, sample collection methods and devices, station location numbers, sample collection depths/heights, sample preservation information, sample pH (if applicable), analysis requested (analytical groups), etc., as well as chain-of-custody (COC) information such as sample identification numbers cross-referenced to COC sample numbers;
- Sample naming convention;
- Field quality control (QC) sample information;
- Site observations, field descriptions, equipment used, and field activities accomplished to reconstruct field operations;

- Meeting information;
- Important times and dates of telephone conversations, correspondence, or deliverables;
- Field calculations;
- PPE level;
- Calibration records;
- Contractor and subcontractor information (address, names of personnel, job functions, organizational affiliations, contract number, contract name, and work assignment number);
- Equipment decontamination procedures and effectiveness;
- Laboratories receiving samples and shipping information, such as carrier, shipment time, number of sample containers shipped, and analyses requested; and
- User signatures.

6.5 The logbook shall reference data maintained in other logs, forms, etc. Correct entry errors by drawing a single line through the incorrect entry, then initialing and dating this change. Enter an explanation for the correction if the correction is more than for a mistake.

6.6 At least at the end of each day, the person making the entry shall sign or initial each entry or group of entries.

6.7 Enter logbook page numbers on each page to facilitate identification of photocopies.

6.8 If a person's initials are used for identification, or if uncommon acronyms are used, identify these on a page at the beginning of the logbook.

6.9 At least weekly and preferably daily, the **preparer** shall photocopy and retain the pages completed during that session for backup. This will prevent loss of a large amount of information if the logbook is lost.

7.0 Quality Control and Assurance

7.1 Review per Section 4.2 shall be recorded.

8.0 Records, Data Analysis, Calculations

8.1 Retain the field logbook as a permanent project record. If a particular CTO requires submittal of photocopies of logbooks, perform this as required.

8.2 Deviations from this procedure shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

9.0 Attachments or References

9.1 Attachment 1 – Description of Logbook Entries

9.2 Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue

Attachment 1
Description of Logbook Entries

Logbook entries shall be consistent with Section A.1.4 *Field Documentation SOPs* of the UFP-QAPP Manual (DoD 2005) and contain the following information, as applicable, for each activity recorded. Some of these details may be entered on data forms, as described previously.

Name of Activity	For example, Asbestos Bulk Sampling, Charcoal Canister Sampling, Aquifer Testing.
Task Team Members and Equipment	Name all members on the field team involved in the specified activity. List equipment used by serial number or other unique identification, including calibration information.
Activity Location	Indicate location of sampling area as indicated in the field sampling plan.
Weather	Indicate general weather and precipitation conditions.
Level of PPE	Record the level of PPE (e.g., Level D).
Methods	Indicate method or procedure number employed for the activity.
Sample Numbers	Indicate the unique numbers associated with the physical samples. Identify QC samples.
Sample Type and Volume	Indicate the medium, container type, preservative, and the volume for each sample.
Time and Date	Record the time and date when the activity was performed (e.g., 0830/08/OCT/89). Use the 24-hour clock for recording the time and two digits for recording the day of the month and the year.
Analyses	Indicate the appropriate code for analyses to be performed on each sample, as specified in the WP.
Field Measurements	Indicate measurements and field instrument readings taken during the activity.
Chain of Custody and Distribution	Indicate chain-of-custody for each sample collected and indicate to whom the samples are transferred and the destination.
References	If appropriate, indicate references to other logs or forms, drawings, or photographs employed in the activity.
Narrative (including time and location)	Create a factual, chronological record of the team's activities throughout the day including the time and location of each activity. Include descriptions of general problems encountered and their resolution. Provide the names and affiliations of non-field team personnel who visit the site, request changes in activity, impact the work schedule, request information, or observe team activities. Record any visual or other observations relevant to the activity, the contamination source, or the sample itself. It should be emphasized that logbook entries are for recording data and chronologies of events. The logbook author must include observations and descriptive notations, taking care to be objective and recording no opinions or subjective comments unless appropriate.
Recorded by	Include the signature of the individual responsible for the entries contained in the logbook and referenced forms.
Checked by	Include the signature of the individual who performs the review of the completed entries.

Sample Labeling and Chain of Custody Procedures

Procedure 3-03A

1.0 Purpose and Scope

1.1 The purpose of this standard operating procedure is to establish standard protocols for all field personnel for use in maintaining field and sampling activity records, labeling samples, ensuring that proper sample custody procedures are utilized, and completing chain-of-custody/analytical request forms.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

Not applicable

3.0 Definitions

3.1 **Logbook**

A logbook is a bound field notebook with consecutively numbered, water-repellent pages that is clearly identified with the name of the relevant activity, the person responsible for maintenance of the logbook, and the beginning and ending dates of the entries.

3.2 **Chain-of-Custody**

Chain-of-custody (COC) is documentation of the process of custody control. Custody control includes possession of a sample from the time of its collection in the field to its receipt by the analytical laboratory, and through analysis and storage prior to disposal.

4.0 Training and Qualifications

4.1 The **CTO Manager**, or designee, is responsible for determining which team members shall record information in the field logbook and for checking sample logbooks and COC forms to ensure compliance with these procedures. The **CTO Manager**, or designee, shall review COC forms at the completion of each sampling event.

4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.3 The **Field Manager** is responsible for ensuring that all field equipment is decontaminated according to this procedure.

4.4 The **Project Chemist**, or designee, is responsible for verifying that the COC/analytical request forms have been completed properly and match the sampling and analytical plan. The **Project Chemist**, or designee, is responsible for notifying the laboratory, data managers, and data validators in writing if analytical request changes are required as a corrective action. These small changes are different from change orders, which involve changes to the scope of the subcontract with the laboratory and must be made in accordance with a respective contract.

4.5 All **Field Personnel** are are responsible for recording pertinent data onto the COC forms to satisfy project requirements and for attesting to the accuracy of the entries by dated signature.

5.0 Procedure

This procedure provides standards for labeling the samples, documenting sample custody, and completing COC/analytical request forms. The standards presented in this section shall be followed to ensure that samples collected are maintained for their intended purpose and that the conditions encountered during field activities are documented.

5.1 Sample Labeling

Affix a waterproof sample label with adhesive backing to each individual sample container. Record the following information with a waterproof marker on each label:

- Project name or number (optional)
- COC sample number
- Date and time of collection
- Sampler's initials
- Matrix (optional)
- Sample preservatives (if applicable)
- Analysis to be performed on sample (This shall be identified by the method number or name identified in the subcontract with the laboratory)

These labels may be obtained from the analytical laboratory or printed from a computer file onto adhesive labels.

5.2 Custody Procedures

For samples intended for chemical analysis, sample custody procedures shall be followed through collection, transfer, analysis, and disposal to ensure that the integrity of the samples is maintained. A description of sample custody procedures is provided below.

Sample Collection Custody Procedures

According to the EPA guidelines, a sample is considered to be in custody if one of the following conditions is met:

- It is in one's actual physical possession or view
- It is in one's physical possession and has not been tampered with (i.e., it is under lock or official seal)
- It is retained in a secured area with restricted access
- It is placed in a container and secured with an official seal such that the sample cannot be reached without breaking the seal

Place custody seals on shipping coolers (and sample jars, if required) if the cooler/container is to be removed from the sampler's custody. Place a minimum of two custody seals in such a manner that they must be broken to open the containers or coolers. Label the custody seals with the following information:

- Sampler's name or initials
- Date and time that the sample/cooler was sealed

These seals are designed to enable detection of sample tampering. An example of a custody seal is shown in Attachment 1.

Field personnel shall also log individual samples onto COC forms (carbon copy or computer generated) when a sample is collected. These forms may also serve as the request for analyses. Procedures for completing these forms are discussed in Section 0, indicating sample identification number, matrix, date and time of collection, number of containers, analytical methods to be performed on the sample, and preservatives added (if any). The samplers will also sign the COC form signifying that they were the personnel who collected the samples. The COC form shall accompany the samples from the field to the laboratory. When a cooler is ready for shipment to the analytical laboratory, the person delivering the samples for transport will sign and indicate the date and time on the accompanying COC form. One copy of the COC form will be retained by the sampler and the remaining copies of the COC form shall be placed inside a self-sealing bag and taped to the inside of the cooler. Each cooler must be associated with a unique COC form. Whenever a transfer of custody takes place, both parties shall sign and date the accompanying carbon copy COC forms, and the individual relinquishing the samples shall retain a copy of each form. One exception is when the samples are shipped; the delivery service personnel will not sign or receive a copy because they do not open the coolers. The laboratory shall attach copies of the completed COC forms to the reports containing the results of the analytical tests. An example COC form is provided in Attachment 2.

5.3 Completing COC/Analytical Request Forms

COC form/analytical request form completion procedures are crucial in properly transferring the custody and responsibility of samples from field personnel to the laboratory. This form is important for accurately and concisely requesting analyses for each sample; it is essentially a release order from the analysis subcontract.

Attachment 2 is an example of a completed COC/analytical request form that may be used by field personnel, with box numbers identified and discussed in text below. Multiple copies may be tailored to each project so that much of the information described below need not be handwritten each time. Each record on the form (Attachment 2) is identified with a bold number corresponding to the instructions given below.

1. Record the project name, site location.
2. Record the site location, including the state.
3. Record the Contract Task Order number
4. Record the Resolution Consultants Task Order Manager
5. Record the sampler/site phone or cell number (if applicable).
6. Record the laboratory name where the samples were sent.
7. Record the requested turnaround time, in days. If a specific turnaround time is required to meet project objectives, but was not indicated on the laboratory service request form submitted to the purchasing department, the sampler, project manager, or site manager should contact the purchasing department so the laboratory contract can be modified.
8. Record the COC number that is defined by the sampler and should be unique throughout the project's history. An example would be to use the sampler's initials followed by the data. If multiple custodies are generated on a given day, use a unique sequential identifier. Example: CRC040105A, CRC040105B
9. Record the purchase order number provided by the purchasing department.
10. Record the page and total number of COC forms used in a shipment.
11. Record the project, and phase applicable to the sampling task.
12. Record the two-character code corresponding to the *chemical* preservation type, which is found on the bottom of the COC form. If no chemical preservation was added to the sample, the field should be left blank. Temperature preservation need not be documented at this location, but will be indicated elsewhere on the COC form (see 33).

13. List the requested analysis. Whenever possible, list the corresponding analytical method. (e.g., VOCs, 8260).

14. For Lab identification use only.

15. Record the full *unique* sample identification as detailed in the Site's Sampling and Analysis Plan.

16. Record the location identification, which is a shortened ID used for presentation and mapping, as detailed in the Site's Sampling and Analysis Plan.

17. Record the sample date using the format mm/dd/yy.

18. Record the sample time using the military format of hhmm.

19. Record the matrix code of the sample, which is located at the bottom of the COC form. The matrix code is a crucial element of the Navy's data management system. For simplicity, only typical matrix codes are listed on the bottom COC form, but below is a complete listing of all applicable Navy matrix codes:

Table 1
Navy Matrix Codes

Matrix Code	Matrix Code Description	Matrix Code	Matrix Code Description
AA	Ambient air	RK	Rock
AC	Composite air sample	SB	Bentonite
AD	Air - Drilling	SBS	Sub-surface soil (> 6")
AIN	Integrated air sample (under sample form of gas)	SC	Cement/Concrete
AQ	Air quality control matrix	SD	Drill cuttings — solid matrix
AQS	Aqueous	SE	Sediment
ASB	Asbestos	SEEP	SEEP
ASBF	Asbestos-Fibrous	SF	Filter sand pack
ASBNF	Asbestos-Non-Fibrous	SJ	Sand
AVE	Air-Vapor extraction, effluent	SK	Asphalt
AX	Air sample from unknown origin	SL	Sludge
BK	Brick	SM	Water filter (solid material used to filter water)
BS	Brackish sediment	SN	Miscellaneous solid/building materials
CA	Cinder ash	SO	Soil
CK	Caulk	SP	Casing (PVC, stainless steel, cast iron, iron pipe
CN	Container	SQ	Soil/Solid quality control matrix
CR	Carbon (usually for a remediation system)	SS	Scrapings
DF	Dust/Fallout	SSD	Subsurface sediment
DR	Debris/rubble	STKG	Stack gas
DS	Storm drain sediment	STPM	Stripper Tower Packing Media
DT	Trapped debris	SU	Surface soil (less than 6 inches)
EF	Emissions flux	SW	Swab or wipe
EW	Elutriate water	SZ	Wood
FB	Fibers	TA	Animal tissue
FL	Forest litter	TP	Plant tissue
GE	Soil gas effluent — stack gas (from system)	TQ	Tissue QC
GI	Soil gas influent (into system)	TX	Tissue
GL	Headspace of liquid sample	UNK	Unknown
GQ	Gaseous or Headspace QC	W	Water (not groundwater, unspecified)
GR	Gravel	WA	Drill cuttings - aqueous mix
GS	Soil gas	WB	Brackish Water

Table 1
Navy Matrix Codes

Matrix Code	Matrix Code Description	Matrix Code	Matrix Code Description
GT	Grit	WC	Drilling water (used for well construction)
IC	IDW Concrete	WD	Well development water
IDD	IDW Solid	WF	Freshwater (not groundwater)
IDS	IDW soil	WG	Ground water
IDW	IDW Water	WH	Equipment wash water
IW	Interstitial water	WI	Ground water influent (into system)
LA	Aqueous phase of a multiphase liquid/soil	WL	Leachate
LF	Product (floating or free)	WM	Marine water
LQ	Organic liquid quality control matrix	WN	Pore water
MA	Mastic	WO	Ocean water
MO	Mortar	WP	Drinking water
MR	Marine sediment	WQ	Water for QC samples
MS	Metal shavings	WR	Ground water effluent (from system)
NS	Near-surface soil	WS	Surface water
PA	Paper	WT	Composite groundwater sample
PC	Paint Chips	WU	Storm water
PP	Precipitate	WW	Waste water
RE	Residue		

Field QC blanks will require matrix codes that identify the type of blank associated with parent sample. Aqueous field QC blanks are not automatically identified with a matrix code of "WQ," indicating a water quality control blank; they are only identified with a matrix code of "WQ" if the associated samples are also aqueous. Trip blanks, field blanks, and equipment rinsate blanks collected in association with ***soil*** samples will be identified with a matrix code of "SQ," even though the actual matrix is aqueous, because the blanks were collected to assess potential contamination imparted during decontamination activities or transport of ***soil*** samples.

20. Record the sample type code, which is located at the bottom of the COC form. The sample type is a crucial element of the EQuIS data management system. For simplicity, only typical sample type codes are listed on the bottom of the COC form, but below is a list of all applicable Navy field sample type codes:

Table 2
Navy Sample Type Codes

Sample Type Code	Sample Type Code Description
AB	Ambient condition blank
BIOCON	Bioassay control sample
BS	Blank spike
BSD	Blank spike duplicate
EB	Equipment blank
EBD	Equipment blank/rinsate duplicate
FB	Field blank
FD	Field duplicate
FS	Field spike
IDW	Purge and rinsate water
LB	Lab Blank

Table 2
Navy Sample Type Codes

Sample Type Code	Sample Type Code Description
LR	Lab Replicate
MB	Material blank
MIS	Multi-Incremental Sample
MS	Matrix spike
N	Normal (Regular)
PE	Performance evaluation
PURGE	Purge water sample
RD	Regulatory duplicate
SB	Source blank
SBD	Source blank duplicate
SCREEN	Screening Sample
SD	Matrix spike duplicate
SPLIT	Sample split
SRM	Standard reference material
TB	Trip Blank
TBD	Trip blank duplicate
TBR	Trip blank replicate

Field duplicate samples — Field duplicates will be identified using the format detailed in the Site's Sampling and Analysis Plan. However, field duplicates will also be differentiated from the parent sample on the chain-of-custody form. The parent sample will have a sample type code of "N," for normal environmental sample; while its duplicate will have a sample type code of "FD."

21. Record whether the sample is field filtered with a "Y" or not field filtered with an "N." If a project requires collecting samples for both total and dissolved constituents, the same sample and location ID is used for both (see 15 and 16); however, the sampler will indicate whether the sample is field filtered at this location on the COC form. This field must always be filled out; even when soil samples are collected (where "N" appropriately applies, in most cases).

22. Record the total number of containers that are submitted for all of the tests. This must add up to the total number of containers listed for each individual test in 23.

23. Record the number of containers for each test. Do not use Xs, rather indicate the number of containers submitted for each test listed in 14. For example, Sample 010MW007002 requires analysis for VOCs (8260), and SVOCs (8270). Record 3 under the VOC analysis and 2 under the SVOC (assuming 3 containers were submitted for VOCs and 2 were submitted for SVOCs). The total number of containers in this example is 5, which should be the total number of containers listed in 22. Extra containers submitted for matrix spike/matrix spike duplicates (MS/MSDs) will be appropriately recorded.

24. Indicate if extra sample volume was included for MS/MSD analysis using an "X." Samples to be used for MS/MSDs will use the same sample ID and location ID (see 15 and 16), but will be collected in triplicate, particularly for liquid samples, to ensure the analytical laboratory receives sufficient volume for the analyses.

25. Indicate if the samples should be held by the laboratory for future testing using an "X."

26. Record any field comments.

27. Reserved for laboratory comments.

28. Indicate the total number of coolers in each shipment. *Note*: When multiple coolers are submitted, each should contain a COC form.

29. Signature(s) of the person(s) relinquishing sample custody.

30. Signature(s) of the person(s) receiving sample custody.

31. Indicate whether the samples are iced, by checking the appropriate response.

32. Indicate the method of shipment (e.g., FedEx, hand-delivered, laboratory courier).

33. Record the airbill number when a commercial courier is used. This is particularly important when multiple coolers are sent in the same shipment or when the laboratory is sent the COC form in advance of receiving samples because it aids in tracking lost coolers.

34. Record the date the coolers were shipped.

COC forms tailored to each CTO can be drafted and printed onto multiple forms. This eliminates the need to rewrite the analytical methods column headers each time. It also eliminates the need to write the project manager, name, and number; QC Level; turnaround time; and the same general comments each time.

Complete one COC form per cooler. Whenever possible, place all volatile organic analyte vials into one cooler in order to reduce the number of trip blanks. Complete all sections and be sure to sign and date the COC form. One copy of the COC form must remain with the field personnel.

6.0 Records

The COC/analytical request form shall be faxed or emailed approximately daily to the Project Chemist, or designee for verification of accuracy. Following the completion of sampling activities, the sample logbook and COC forms will be transmitted to the CTO Manager for storage in project files. The original COC/analytical request form shall be submitted by the laboratory along with the data delivered. Any changes to the analytical requests that are required shall be made in writing to the laboratory. A copy of this written change shall be sent to the data validators and placed in the project files. The reason for the change shall be included in the project files so that recurring problems can be easily identified.

7.0 References and Attachments

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/-fedfac/pdf/ufp_qapp_v1_0305.pdf.

Attachment 1: Chain-of-Custody Seal

Attachment 2: Generic Chain-of-Custody/Analytical Request Form

Author	Reviewer	Revisions (Technical or Editorial)
Tina Cantwell QA Officer	Ben Brantley Project Manager	Rev 0 — Initial Issue

Attachment 1
Chain-of-Custody Seal

EXAMPLE CHAIN-OF-CUSTODY SEAL

[LABORATORY]	SAMPLE NO.	DATE	SEAL BROKEN BY
	SIGNATURE		DATE
	PRINT NAME AND TITLE *(Inspector, Analyst or Technician*		

Attachment 2
Example Chain-of-Custody / Analytical Request Form

RESOLUTION CONSULTANTS

CHAIN OF CUSTODY AND ANALYTICAL REQUEST RECORD

COC No. 7 | Page of 9

Project Name: 1 | PO No. 8 | Project No. 10

Site Location: 2 | Lab Name 11

Contract Task Order No. 3 | **Sample Analysis Requested** (Enter number of containers for each test)

Sampler/Site Phone# 4

Send Results To: 5

Data Shipping Address: 6

Lab ID	Sample ID (sys_samp_code)	Location ID (sys_loc_code)	Date (mm/dd/yy)	Time (Military) (hhmm)	Matrix Code (1)	Sample Type (2)	Field Filtered (Y/N)	Total No. of Containers	12 / 13									Extra Volumen for MS/MSD	HOLD
14	15	16	17	18	19	20	21	22	23									24	25

Turnaround Time(specify): 26 **Final** _____ days **Email** (if applicable) _____ days | Deliverable(check): 27 Level 2_____ Level 3_____ Full/Level 4_____ TX TRRP-13_____

Field Comments: 28

Lab Comments: 29

Sample Shipment and Delivery Details

Number of coolers in shipment: 30

Relinquished by (signature)	Date	Time	Received by (signature)	Date	Time
1 31			1 32		
2			2		
3			3		

Samples Iced?(check) 33 Yes___ No___

Method of Shipment: 34

Airbill No: 35

Date Shipped: 36

(1) **AA**=Ambient air, **AQ**=Air quality control, **ASB**=Asbestos, **CK**=Caulk, **DS**=Storm drain sediment, **GS**=Soil gas, **IC**=IDW Concrete, **IDD**=IDW Solid, IDS=IDW soil, **IDW**=IDW Water, **LF**=Free Product, **MA**=Mastic, **PC**=Paint Chips, **SC**=Cement/Concrete, **SE**=Sediment, **SL**=Sludge, **SO**=Soil, **SQ**=Soil/Solid quality control, **SSD**=Subsurface sediment, **SU**=Surface soil (<6 in), **SW**=Swab or wipe, **TA**=Animal tissue, **TP**=Plant tissue, **TQ**=Tissue quality control, **WG**=Ground water, **WL**=Leachate, **WO**=Ocean water, **WP**=Drinking water, **WQ**=Water quality control, **WR**=Ground water effluent, **WS**=Surface water, **WU**=Storm water, **WW**=Waste water

(2) **Sample Type: AB**=Ambient Blk, **EB**=Equipment Blk, **FB**=Rinse Blk, **FD**=Field Duplicate Sample, **IDW**=Investigative-Derived Waste, **MIS**=Incremental Sampling Methodology, **N**=Normal Environmental Sample, **PE**=Performance Eval., **TB**=Trip Blk

(3) **Preservative added: HA**=Hydrochloric Acid, **NI**=Nitric Acid, **SH**=Sodium Hydroxide, **SA**=Sulfuric Acid, **AA**=Ascorbic Acid, **HX**=Hexane, **ME**=Methanol, **SB**=sodium bisulfate, **ST**=Sodium Thiosulfate, If **NO preservative** added leave blank

Sample Handling, Storage, and Shipping of Low Level Environmental Samples

Procedure 3-04A

1.0 Purpose and Scope

1.1 This Standard Operating Procedure (SOP) sets forth the methods for use by personnel engaged in handling, storing, and transporting low level environmental samples.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

2.1 To avoid lifting injuries associated with heavy coolers, use the large muscles of the legs, not the back. Use dollies if possible.

2.2 When using tools for cutting purposes, cut away from yourself. The use of appropriate, task specific cutting tools is recommended.

2.3 Wear proper gloves, such as blue nitrile and latex, as defined in the site-specific project health and safety plan, when handling sample containers to avoid contacting any materials that may have spilled out of the sample containers.

3.0 Terms and Definitions

DOT — Department of Transportation

4.0 Training and Qualifications

4.1 The **Contract Task Order** (CTO) **Manager** is responsible for verifying that these procedures are performed prior to the initiation of active subsurface exploration.

4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.3 The **Field Manager** is responsible for ensuring that sample handling, storage, and shipping are performed in accordance with this procedure.

4.4 All **Field Personnel** are responsible for the implementation of this procedure.

5.0 Procedures

5.1 Handling and Packaging

Environmental samples should be packaged prior to shipment using the following procedures:

1. Allow sufficient headspace in all bottles (except volatile organic analysis containers with a septum seal) to compensate for any pressure and temperature changes (approximately 1 percent of the volume of the container).

2. Ensure that the lids on all bottles are tight (will not leak).

3. Glass bottles should be wrapped in bubble wrap — preferably sealable bubble wrap sample bags, if available. Place bottles in separate and appropriately-sized polyethylene bags and seal the bags.

4. Select a sturdy cooler in good repair. Secure and tape the drain plug with fiber or duct tape inside and outside. Line the cooler with a large heavy-duty plastic bag.

5. Place cushioning/absorbent material in the bottom of the cooler, if available, and then place the containers in the cooler with sufficient space to allow for the addition of cushioning between the containers.

6. Put "blue ice" (or ice that has been "double bagged" in heavy-duty polyethylene bags and properly sealed) on top of and/or between the containers. Fill all remaining space between the containers with bubble wrap or other suitable absorbent material.

7. Securely fasten the top of the large garbage bag with packaging tape.

8. Place the completed Chain-of-Custody (COC) Record into a sealed plastic bag, and tape the bag to the inner side of the cooler lid.

9. Close the cooler and securely tape (preferably with fiber tape) the top of the cooler shut. COC seals should be affixed to opposing sides of the cooler within the securing tape so that the cooler cannot be opened without breaking the seal.

5.2 Shipping

Follow all appropriate DOT regulations (e.g., 49 Code of Federal Regulations, Parts 171-179) for shipment of air, soil, water, and other samples. Elements of these procedures are summarized in the following subsections.

5.2.1 Non-hazardous Materials Shipment

If the samples are suspected to be non-hazardous based on previous site sample results, field screening results, or visual observations, if applicable, then samples may be shipped as non-hazardous.

When a cooler is ready for shipment to the laboratory, prepare standard air bill paperwork for shipment of the samples to the laboratory. Write the shippers tracking/airbill number on the COC form. Place two copies of the COC form inside a self-sealing bag and tape it to the inside of the cooler. Seal the cooler with waterproof tape and label it with “Fragile,” “This-End-Up” (or directional arrows pointing up), or other appropriate notices. Affix a label stating the destination (laboratory address) to each cooler. Personnel should be aware of carrier weight or other policy restrictions.

5.2.2 Hazardous Materials Shipment

Shipment of Hazardous Material is not covered in this SOP; all samples handled under this SOP are anticipated to be non-hazardous or not dangerous goods. The CTO Manager, or designee, is responsible for determining if samples collected during a specific field investigation meet the definitions for dangerous goods. If a sample is collected of a material that is listed in the Dangerous Goods List, Section 4.2, of International Air Transport Authority (IATA), then that sample must be identified, packaged, marked,

labeled, and shipped according to the instructions given for that material. If the composition of the collected sample(s) is unknown, and the project leader knows or suspects that it is a regulated material (dangerous goods), the sample may not be offered for air transport. If the composition and properties of a waste sample or a highly contaminated soil, sediment, or water sample are unknown, or only partially known, the sample may not be offered for air transport.

6.0 Records

Maintain all copies of chain of custodies and air bills with the project file. .

7.0 Attachments or References

International Air Transport Authority (IATA). Dangerous Goods Regulations

http://www.iata.org/whatwedo/cargo/dangerous_goods/Documents/DGR52-significant-changes.pdf

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Author	Reviewer	Revisions (Technical or Editorial)
Ben Brantley	Tina Cantwell	Rev 0 — Initial Issue
Program Manager	QA Officer	

Investigation Derived Waste Management

Procedure 3-05

1.0 Purpose and Scope

This standard operating procedure (SOP) describes activities and responsibilities of the United States (U.S.) Navy Environmental Restoration (ER) Program, Naval Facilities Engineering Command, Atlantic (NAVFAC Atlantic) with regard to management of investigation-derived waste (IDW). The purpose of this procedure is to provide guidance for the minimization, handling, labelling, temporary storage, inventory, classification, and disposal of IDW generated under the ER Program. This procedure will also apply to personal protective equipment (PPE), sampling equipment, decontamination fluids, non-IDW trash, non-indigenous IDW, and hazardous waste generated during implementation of removal or remedial actions. The information presented will be used to prepare and implement work plans (WPs) for IDW-related field activities. The results from implementation of WPs will then be used to develop and implement final IDW disposal plans.

If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to IDW then those procedures may be added as an appendix to the project specific SAP.

This procedure applies to all Navy ER projects performed in the NAVFAC Atlantic Area of Responsibility.

This procedure shall serve as management-approved professional guidance for the ER Program and is consistent with protocol in the Uniform Federal Policy-Quality Assurance Project Plan (DoD 2005). As professional guidance for specific activities, this procedure is not intended to obviate the need for professional judgment during unforeseen circumstances. Deviations from this procedure while planning or executing planned activities must be approved by both the Contract Task Order (CTO) Manager and the Quality Assurance (QA) Manager or Technical Director, and documented.

This procedure was developed to serve as management-approved professional guidance for the management of IDW generated under the ER Program. It focuses on the requirements for minimizing, segregating, handling, labeling, storing, and inventorying IDW in the field. Certain drum inventory requirements related to the screening, sampling, classification, and disposal of IDW are also noted in this procedure.

2.0 Safety

The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the CTO WP and/or direction from the **Site Safety Officer (SSO)**.

All **Field Personnel** responsible for IDW management must adhere to the HASP and must wear the PPE specified in the site-specific HASP. Generally, this includes, at a minimum, steel-toed boots or steel-toed rubber boots, safety glasses, American National Standards Institute-standard hard hats, and hearing protection (if heavy equipment is in operation). If safe alternatives are not achievable, discontinue site activities immediately.

3.0 Terms and Definitions

None.

4.0 Training and Qualifications

4.1 The **CTO Manager** is responsible for ensuring that IDW management activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all personnel involved in IDW management shall have the appropriate education, experience, and training to perform their assigned tasks.

4.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

4.3 The **Field Manager** is responsible for ensuring that all IDW is managed according to this procedure.

4.4 All **Field Personnel** are responsible for the implementation of this procedure.

5.0 Equipment and Supplies

The equipment and supplies required for implementation of this SOP include the following:

- Containers for waste (e.g., [U.S. Department of Transportation] DOT approved 55-gallon open and closed top drums) and material to cover waste to protect from weather (e.g., plastic covering);
- Hazardous /non-hazardous waste drum labels (weatherproof);
- Permanent marking pens;
- Inventory forms for project file;
- Plastic garbage bags, zip lock storage bags, roll of plastic sheeting; and
- Steel-toed boots, chemical resistant gloves, coveralls, safety glasses, and any other PPE required in the HASP.

6.0 Procedure

The following procedures are used to handle the IDW.

6.1 Drum Handling

6.1.1 IDW shall be containerized using DOT approved drums. The drums shall be made of steel or plastic, have a 55-gallon capacity, be completely painted or opaque, and have removable lids (i.e., United Nations Code 1A2 or 1H2). Typically 55-gallon drums are used, however small drums may be used depending on the amount of waste generated. New steel drums are preferred over recycled drums.

6.1.2 Recycled drums should not be used for hazardous waste, PCBs or other regulated shipments. For short-term storage of liquid IDW prior to discharge, double-walled bulk steel or plastic storage tanks may be used. For this scenario, consider the scheduling and cost-effectiveness of this type of bulk storage, treatment, and discharge system versus longer-term drum storage.

6.1.3 For long-term IDW storage at other project locations, the DOT approved drums with removable lids are recommended. Verify the integrity of the foam or rubber sealing ring located on the underside of some drum lids prior to sealing drums containing IDW liquids.

6.1.4 If the ring is only partially attached to the drum lid, or if a portion of the ring is missing, select another drum lid with a sealing ring that is in sound condition.

6.1.5 To prepare IDW drums for labeling, wipe clean the outer wall surfaces and drum lids of all material that might prevent legible and permanent labeling. If potentially contaminated material adheres to the outer surface of a drum, wipe that material from the drum, and segregate the paper towel or rag used to remove the material with visibly soiled PPE and

disposable sampling equipment. Label all IDW drums and place them on pallets prior to storage.

6.2 Labelling

6.2.1 Containers used to store IDW must be properly labelled. Two general conditions exist: 1) from previous studies or on-site data, waste characteristics are known to be either hazardous or nonhazardous; or 2) waste characteristics are unknown until additional data are obtained.

6.2.2 For situations where the waste characteristics are known, the waste containers should be packaged and labelled in accordance with state regulations and any federal regulations that may govern the labelling of waste.

6.2.3 The following information shall be placed on all non-hazardous waste labels:

- Description of waste (i.e., purge water, soil cuttings);
- Contact information (i.e., contact name and telephone number);
- Date when the waste was first accumulated.

6.2.4 The following information shall be placed on all hazardous waste labels:

- Description of waste (i.e., purge water, soil cuttings);
- Generator information (i.e., name, address, contact telephone number);
- EPA identification number (supplied by on-site client representative);
- Date when the waste was first accumulated.

6.2.5 When the final characterization of a waste is unknown, a notification label should be placed on the drum with the words “waste characterization pending analysis” and the following information included on the label:

- Description of waste (i.e., purge water, soil cuttings);
- Contact information (i.e., contact name and telephone number);
- Date when the waste was first accumulated.

6.2.6 Once the waste has been characterized, the label should be changed as appropriate for a nonhazardous or hazardous waste.

6.2.7 Waste labels should be constructed of a weatherproof material and filled out with a permanent marker to prevent being washed off or becoming faded by sunlight. It is recommended that waste labels be placed on the side of the container, since the top is more subject to weathering. However, when multiple containers are accumulated together, it also may be helpful to include labels on the top of the containers to facilitate organization and disposal.

6.2.8 Each container of waste generated shall be recorded in the field notebook used by the person responsible for labelling the waste. After the waste is disposed of, either by transportation off-site or disposal on-site in an approved disposal area, an appropriate record shall be made in the same field notebook to document proper disposition of IDW.

6.3 Types of Site Investigation Waste

Several types of waste are generated during site investigations that may require special handling. These include solid, liquid, and used PPE, as discussed further below.

Solid Waste

Soil cuttings from boreholes will typically be placed in containers unless site specific requirements allow for soil cuttings to be placed back into the borehole after drilling is complete. Drilling mud generated during investigation activities shall be collected in containers. Covers should be included on the containers and must be secured at all times and only open during filling activities. The containers shall be labelled in accordance with this SOP. An inventory containing the source, volume, and description of material put in the containers shall be logged on prescribed forms and kept in the project file.

Non-hazardous solid waste can be disposed on-site in the designated site landfill or in a designated evaporation pond if it is liquefied. Hazardous wastes must be disposed off-site at an approved hazardous waste landfill.

Liquid Waste

Groundwater generated during monitoring well development, purging, and sampling can be collected in truck-mounted containers and/or other transportable containers (i.e., 55-gallon drums). Lids or bungs on drums must be secured at all times and only open during filling or pumping activities. The containers shall be labelled in accordance with this SOP. Non-hazardous liquid waste can be disposed of in one of the designated lined evaporation ponds on-site. Hazardous wastes must be handled separately and disposed off-site at an approved hazardous waste facility.

Personal Protective Equipment

PPE that is generated throughout investigation activities shall be placed in plastic garbage bags. If the solid or liquid waste that was being handled is characterized as hazardous waste, then the corresponding PPE should also be disposed as hazardous waste. If not, all PPE should be disposed as non-hazardous waste in the designated on-site landfill. Trash that is generated as part of field activities may be disposed of in the landfill as long as the trash was not exposed to hazardous media.

6.4 Waste Accumulation On-Site

6.4.1 Solid, liquid, or PPE waste generated during investigation activities that are classified as nonhazardous or “characterization pending analysis” should be disposed of as soon as possible. Until disposal, such containers should be inventoried, stored as securely as possible, and inspected regularly, as a general good practice.

6.4.2 Solid, liquid, or PPE waste generated during investigation activities that are classified as hazardous shall not be accumulated on-site longer than 90 days. All hazardous waste containers shall be stored in a secured storage area. The following requirements for the hazardous waste storage area must be implemented:

- Proper hazardous waste signs shall be posted as required by any state or federal statutes that may govern the labelling of waste;
- Secondary containment to contain spills;
- Spill containment equipment must be available;
- Fire extinguisher;
- Adequate aisle space for unobstructed movement of personnel.

6.4.3 Weekly storage area inspections shall be performed and documented to ensure compliance with these requirements. Throughout the project, an inventory shall be maintained to itemize the type and quantity of the waste generated.

6.5 Waste Disposal

6.5.1 Solid, liquid, and PPE waste will be characterized for disposal through the use of client knowledge, laboratory analytical data created from soil or groundwater samples gathered during the field activities, and/or composite samples from individual containers.

6.5.2 All waste generated during field activities will be stored, transported, and disposed of according to applicable state, federal, and local regulations. All wastes classified as hazardous will be disposed of at a licensed treatment storage and disposal facility or managed in other approved manners.

6.5.3 In general, waste disposal should be carefully coordinated with the facility receiving the waste. Facilities receiving waste have specific requirements that vary even for non-hazardous waste, so characterization should be conducted to support both applicable regulations and facility requirements.

6.6 Regulatory Requirements

The following federal and state regulations shall be used as resources for determining waste characteristics and requirements for waste storage, transportation, and disposal:

- Code of Federal Regulations (CFR), Title 40, Part 261;
- CFR, Title 49, Parts 172, 173, 178, and 179.

6.7 Waste Transport

A state-certified hazardous waste hauler shall transport all wastes classified as hazardous. Typically, the facility receiving any waste can coordinate a hauler to transport the waste. Shipped hazardous waste shall be disposed of in accordance with all RCRA/USEPA requirements. All waste manifests or bills of lading will be signed either by the client or the client's designee.

7.0 Quality Control and Assurance

7.1 Management of IDW must incorporate quality control measures to ensure conformance to these and the project requirements.

8.0 Records, Data Analysis, Calculations

8.1 Maintain records as required by implanting the procedures in this SOP.

8.2 Deviations from this procedure or the sampling and analysis plan shall be documented in field records. Significant changes shall be approved by the **Program Quality Manager**.

9.0 Attachments or References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual.* Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/-fedfac/pdf/ufp_qapp_v1_0305.pdf.

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1998. *Management of Remediation Waste under RCRA*. EPA/530-F-98-026. Office of Solid Waste and Emergency Response. October.

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NAVFAC NW Standard Operating Procedure Number I-D-1, *Drum Sampling.*

NAVFAC NW Standard Operating Procedure Number I-F, *Equipment Decontamination.*

NAVFAC NW Standard Operating Procedure Number III-D, *Logbooks.*

Author	Reviewer	Revisions (Technical or Editorial)
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

Land Surveying

Procedure 3-07

1.0 Purpose and Scope

1.1 The purpose of this document is to define the standard operating procedure (SOP) for acquiring land surveying data to facilitate the location and mapping of geologic, hydrologic, geotechnical data, and analytical sampling points and to establish topographic control over project sites.

1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).

1.3 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review. If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to surface water sampling then those procedures may be added as an appendix to the project specific SAP.

1.4 It is fully expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Program Quality Manager. Deviations to this SOP will be documented in the field records.

1.5 If there are procedures, whether it be from Resolution Consultants, state and/or federal, that are not addressed in this SOP and are applicable to land surveying then those procedures may be added as an appendix to the project specific Sampling and Analysis Plan (SAP).

2.0 Safety

2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to conducting fieldwork. All **field sampling personnel** must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the specific field tasks. Conduct preliminary area monitoring to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor and liquid phase through the use of respirators and disposable clothing.

2.2 In addition, observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves, rubberized steel-toed boots, and an American National Standards Institute-standard hard hat. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations, and shall always be available on site.

2.3 Daily safety briefs will be conducted at the start of each working day before any work commences. These daily briefs will be facilitated by the **Site Safety Officer (SSO)** or designee to discuss the day's events and any potential health risk areas covering every aspect of the work to be completed. Weather conditions are often part of these discussions. As detailed in the HASP, everyone on the field team has the authority to stop work if an unsafe condition is perceived until the conditions are fully remedied to the satisfaction of the SSO.

2.4 The health and safety considerations for the work associated with land surveying include:

- Slip, trips and falls associated with work in the field;

- Biological hazards associated with work in the field; and,
- Potential hazards associated with contaminants of concern (COC) that may be located in the survey area,

3.0 Terms and Definitions

3.1 Boundary Survey

Boundary surveys are conducted by Certified Land Surveyors in order to delineate a legal property line for a site or section of a site.

3.2 Global Positioning System (GPS)

A system of satellites, computers, and receivers that is able to determine the latitude and longitude of a receiver on Earth by calculating the time difference for signals from different satellites to reach the receiver.

4.0 Interferences

4.1 Commercially available GPS units typically have a level of precision of (±) 3 to 5 meters. Field corrections can be made as described in Section 8.3 below.

5.0 Training and Qualifications

5.1 Qualifications and Training

5.1.1 The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

5.2.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that land surveying activities comply with this procedure. The CTO Manager is responsible for ensuring that all field sampling personnel involved in land surveying shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

5.2.3 The **Field Manager (FM)** is responsible for ensuring that all field personnel follow these procedures. In virtually all cases, subcontractors will conduct these procedures. The FM or designee is responsible for overseeing the activities of the subcontractor and ensuring that sampling points and topographic features are properly surveyed.

6.0 Equipment and Supplies

6.1 The following equipment list contains materials that may be needed in carrying out the procedures outlined in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Personal protective equipment (PPE) and other safety equipment, as required by the HASP;
- Commercially available GPS unit; and,
- Field Logbook.

7.0 Calibration or Standardization

7.1 An authorized manufacturer's representative shall inspect and calibrate survey instruments in accordance with the manufacturer's specifications regarding procedures and frequencies. At a minimum, instruments shall be calibrated no more than six months prior to the start of the survey work.

7.2 Standards for all survey work shall be in accordance with National Oceanic and Atmospheric Administration standards and, at a minimum, with accuracy standards set forth below. The horizontal accuracy for the location of all grid intersection and planimetric features shall be (±) 0.1 feet. The horizontal accuracy for boundary surveys shall be 1 in 10,000 feet (1:10,000). The vertical accuracy for ground surface elevations shall be (±) 0.1 feet. Benchmark elevation accuracy and elevation of other permanent features, including monitoring wellheads, shall be (±) 0.01 feet.

8.0 Procedure

8.1 Theodolite/Electronic Distance Measurement (EDM)

Follow the procedures listed below during theodolite/EDM land surveying conducted under the NAVFAC CLEAN Program:

- A land surveyor registered in the state or territory in which the work is being performed shall directly supervise all surveying work.
- Reference surveys to the local established coordinate systems and base all elevations and benchmarks established on U.S. Geological Survey datum, 1929 general adjustment.
- Reference surveyed points to Mean Sea Level (Lower Low Water Level).
- Jointly determine appropriate horizontal and vertical control points prior to the start of survey activities. If discrepancies in the survey (e.g., anomalous water level elevations) are observed, the surveyor may be required to verify the survey by comparison to a known survey mark. If necessary, a verification survey may be conducted by a qualified third party.
- All field notes, sketches, and drawings shall clearly identify the horizontal and vertical control points by number designation, description, coordinates, and elevations. Map all surveyed locations using a base map or other site mapping, as specified by the project Work Plan or SAP.
- Begin and end all surveys at the designated horizontal and vertical control points to determine the degree of accuracy of the surveys.
- Iron pins used to mark control points shall be made of reinforcement steel or an equivalent material and shall be 18 inches long with a minimum diameter of 5/8 inch. Drive pins to a depth of 18 inches into the soil.
- Stakes used to mark survey lines and points shall be made from 3-foot lengths of 2-inch by 2-inch lumber and pointed at one end. Clearly mark them with brightly colored weatherproof flagging and paint.
- Clearly mark the point on a monitoring well casing or well riser that is surveyed by filing grooves into the casing/riser on either side of the surveyed point, or by marking the riser with a permanent ink marker.

8.2 Global Positioning System (GPS) to Conduct Land Survey

Follow the procedures listed below during land surveying using GPS:

- A land surveyor registered in the state or territory in which the work is being performed shall directly supervise all surveying work.
- Reference surveys to the local established coordinate systems and base all elevations and benchmarks established on U.S. Geological Survey datum, 1929 general adjustment.

- All field notes, sketches, and drawings shall clearly identify the horizontal and vertical control points by number designation, description, coordinates, and elevations. Map all surveyed locations using a base map or other site mapping, as specified in the project Work Plan or SAP.
- Begin and end all surveys at the designated horizontal and vertical control points (as applicable) to determine the degree of accuracy of the surveys.
- Iron pins used to mark control points shall be made of reinforcement steel or an equivalent material and shall be 18 inches long with a minimum diameter of 5/8 inch. Drive pins to a depth of 18 inches into the soil.
- Stakes used to mark survey lines and points shall be made from 3-foot lengths of 2-inch by 2-inch lumber and pointed at one end. Clearly mark them with brightly colored weatherproof flagging and paint.
- Clearly mark the point on a monitoring well casing that is surveyed by filing grooves into the casing on either side of the surveyed point.

8.3 Global Positioning System (GPS) to Position Sample Locations or Locate Site Features

Experienced field personnel may use a GPS system unit to position sample locations (e.g. grid positioned samples, soil boring locations) at a site. The decision to use field personnel or a licensed land surveyor will depend on the objectives of the survey (e.g. vertical elevation is not required) and the levels of precision required. Typically when a level of precision greater than (±) 3 to 5 meters is required, a licensed surveyor will be required. When a level of precision of (±) 3 to 5 meters is sufficient to meet project requirements (i.e. when laying sampling grids, identifying significant site features, or locating features identified in GIS figures) experienced field personnel may use commercially available, consumer-grade GPS units. Follow the procedures listed below to locate samples or site features using GPS:

- A commercially available GPS unit with Wide Angle Averaging System (WAAS), topographic map display, and waypoint storage capabilities should be used.
- If waypoints are to be imported into a GIS database, the same grid projection system should be used.
- If a permanent reference point near the site is available, it is recommended that a waypoint at this location be taken every day waypoints are stored.
- When laying out a sampling grid from a GIS map, upload the coordinates from GIS to the GPS unit, including coordinates for an easily identified, permanent, nearby feature (i.e. building corner, roadway intersection, or USGS benchmark).
- If during the initial site walk, the permanent feature identified does not overlay within (±) 5 meters as identified in the GPS unit, field corrections of the waypoints should be made.
- Field corrections can be made by adding/subtracting the difference in x,y coordinates between the field measurement of the permanent site feature and the anticipated x,y coordinates. This correction should then be applied to the x,y coordinates for each sampling location to be marked. Corrected x,y coordinates can then be uploaded into the GPS unit.
- Sampling points and site features can then be located in the field using the GPS units “Go To” function. When the distance to the sampling point or feature remains close to zero, the location can be marked.
- If no field corrections to the sampling location need to be made, or if sampling locations are to be surveyed by a licensed surveyor at a later date, no additional waypoints need to be taken. If significant changes to the sampling location are made, GPS coordinates at the corrected location shall be stored and labeled.

- It is recommended that GPS coordinates be uploaded to a storage device such as PC at the end of each day.
- Field logs shall indicate manufacturer and model number for GPS unit used, map datum and projection used, and any field corrections made. If the GPS unit cannot lock onto a WAAS system at the site, this should also be noted.

9.0 Quality Control and Assurance

None.

10.0 Data and Records Management

The surveyor shall record field notes daily using generally accepted practices. The data shall be neat, legible, in indelible ink, and easily reproducible. Copies of the surveyor's field notes and calculation forms generated during the work shall be obtained and placed in the project files.

Surveyor's field notes shall, at a minimum, clearly indicate:

- The date of the survey;
- General weather conditions;
- The name of the surveying firm;
- The names and job titles of personnel performing the survey work;
- Equipment used, including serial numbers; and,
- Field book designations, including page numbers.

A land surveyor registered in the state or territory in which the work was done shall sign, seal, and certify the drawings and calculations submitted by the surveyor.

Dated records of land surveying equipment calibration shall be provided by the surveyor and placed in the project files. Equipment serial numbers shall be provided in the calibration records.

11.0 Attachments or References

Department of Defense, United States (DoD). 2005. *Uniform Federal Policy for Quality Assurance Project Plans, Part 1: UFP-QAPP Manual*. Final Version 1. DoD: DTIC ADA 427785, EPA-505-B-04-900A. In conjunction with the U. S. Environmental Protection Agency and the Department of Energy. Washington: Intergovernmental Data Quality Task Force. March. On-line updates available at: http://www.epa.gov/fedfac/pdf/ufp_qapp_v1_0305.pdf.

Author	*Reviewer*	*Revisions (Technical or Editorial)*
Robert Shoemaker Senior Scientist	Naomi Ouellette, Project Manager	Rev 0 – Initial Issue

Monitoring Well Installation

Procedure 3-12

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes the methods to be used during the installation of groundwater monitoring wells. It describes the components of monitoring well design and installation and sets forth the rationale for use of various well installation techniques in specific situations.

1.2 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

2.1 The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) Work Plan (WP) and/or direction from the **Site Safety Officer (SSO)**.

2.2 Before well installation commences, appropriate entities (e.g. DigSafe, local public works departments, company facilities) must be contacted to assure the anticipated well locations are marked for utilities, including electrical, telecommunications, water, sewer, and gas.

2.3 Physical Hazards Associated with Well Installation

- Stay clear of all moving equipment and avoid wearing loose fitting clothing.
- When using an approved retractable-blade knife, always cut away from one self and make sure there are no other people in the cutting path or the retractable-blade knife.
- To avoid slip/trip/fall conditions during drilling activities, keep the area clear of excess soil cuttings and groundwater. Use textured boots/boot cover bottoms in muddy areas.
- To avoid heat/cold stress as a result of exposure to extreme temperatures and personal protective equipment (PPE), drink electrolyte replacement fluids (1 to 2 cups per hour is recommended) and, in cases of extreme cold, wear fitted insulating clothing.
- To avoid hazards associated with subsurface utilities, ensure all sampling locations have been properly surveyed as described in SOP 3-01, Utility Clearance.
- Be aware of restricted mobility caused by PPE.

3.0 Terms and Definitions

3.1 **Annulus:** The annulus is the down-hole space between the borehole wall and the well casing and screen.

3.2 **Bridge:** A bridge is an obstruction in the drill hole or annulus. A bridge is usually formed by caving of the wall of the well bore, by the intrusion of a large boulder, or by the placement of filter pack materials during well completion. Bridging can also occur in the formation during well development.

3.3 **Filter Pack:** Filter pack is sand or gravel that is smooth, uniform, clean, well-rounded, and siliceous. It is placed in the annulus of the well between the borehole wall and the well screen to prevent formation materials from entering the well and to stabilize the adjacent formation.

3.4 **Grout:** Grout is a fluid mixture of cement and water that can be forced through a tremie pipe and emplaced in the annular space between the borehole and casing to form an impermeable seal. Various additives, such as sand, bentonite, and polymers, may be included in the mixture to meet certain requirements.

3.5 **Heaving (Running) Sands:** Loose sands in a confined water-bearing zone or aquifer which tend to rise up into the drill stem when the confining unit is breached by the drill bit. Heaving sands occur when the water in the aquifer has a pressure head great enough to cause upward flow into the drill stem with enough velocity to overcome the weight of the sand.

3.6 **Sieve Analysis:** Sieve analysis is the evaluation of the particle-size distribution of a soil, sediment, or rock by measuring the percentage of the particles that will pass through standard sieves of various sizes.

4.0 Interferences

4.1 Heaving sands may be problematic in unconsolidated sands encountered below the water table.

4.2 Rotary drilling methods requiring bentonite-based drilling fluids should be used with caution to drill boreholes that will be used for monitoring well installation. The bentonite mud builds up on the borehole walls as a filter cake and permeates the adjacent formation, potentially reducing the permeability of the material adjacent to the well screen.

4.3 If water or other drilling fluids have been introduced into the boring during drilling or well installation, samples of these fluids should be obtained and analyzed for chemical constituents that may be of interest at the site. In addition, an attempt should be made to recover the quantity of fluid or water that was introduced, either by flushing the borehole prior to well installation and/or by overpumping the well during development.

4.4 Track-mounted drill rigs are suitable for travelling on many types of landscapes that truck-mounted units cannot access, but may have limitations on extremely uneven or soft terrain.

4.5 Care should be taken to prevent cross-contamination between well locations. All drilling equipment coming in contact with potentially contaminated soil and/or groundwater will be decontaminated by the drilling subcontractor prior to initial drilling activities and between drilling locations in accordance with SOP 3-06, Equipment Decontamination.

5.0 Training and Qualifications

5.1 **Qualifications and Training**

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 **Responsibilities**

5.2.1 **Contract Task Order (CTO) Managers** are responsible for issuing sampling and analysis plans (SAPs) that reflect the procedures and specifications presented in this procedure. Individual municipalities, county agencies, and possibly state regulatory agencies enforce regulations that may include well construction and installation requirements. The **CTO Manager** shall be familiar with current local and state regulations, and ensure that these regulations are followed. The **CTO Manager** is responsible for ensuring that all personnel involved in monitoring well installation shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

5.2.3 The **Field Manager** is responsible for direct supervision of the installation of monitoring wells and ensuring that procedures and specifications are implemented in the field in accordance with the approved SAP and well installation permits. The qualifications for the **Field Manager** must be in accordance with local jurisdictions with authority over the operations conducted.

5.2.4 All field personnel are responsible for the implementation of this procedure.

5.2.5 The on-site hydrogeologist/engineer is expected to obtain a description of the lithologic samples obtained during the excavation and construction of a monitoring well. These data are often required to provide guidance regarding the installation of specific components of the monitoring well. Guidance for lithologic sample collection and sample description is contained within SOP 3-16, Soil and Rock Classification.

6.0 Equipment and Supplies

6.1 Materials provided by the drilling contractor may include:

- Drill rig, drill rods, hollow stem augers, etc.
- Decontamination equipment (e.g., steam cleaner, high-pressure washer, brushes, etc.)
- Decontamination pad materials
- Well screen/riser pipe with flush-threaded couplings including riser and bottom caps
- Clean, filter sand
- Bentonite chips or pellets
- Cement grout and tremie pipe
- Portland cement for well pad completion
- Steel protective riser covers and locking caps
- Weighted calibrated tape
- Split-spoon samplers
- 55-gallon drums or containers for drill cuttings, decontamination fluids, etc.

6.2 In addition to those materials provided by the drilling contractor, equipment and materials required by the project geologist/engineer may include, but is not limited to, the following:

- Photoionization Detector (PID)
- Spill kit, including at a minimum sorbent pads and shovel (if not provided by subcontractor)

- Plastic sheeting
- Teaspoon or spatula
- Resealable plastic bags
- Boring Log Records
- Decontamination materials (per SOP No. 3-06 - Equipment Decontamination)
- Weighted measuring tape for depth measurement
- Soil logging materials (e.g. USCS classification field card, millimeter rule, hand lens, etc.)
- Survey lathes or pin flags
- Digital camera
- PPE as required by the HASP
- Planning documents including the site-specific HASP and SAP
- Large indelible ink or paint pen
- Field logbook/field forms/site maps (water proof)

7.0 Procedure

7.1 General Procedures

- Specific drilling, sampling, and installation equipment and methodology will be dictated by the type of well to be installed (e.g., single case (Type II), double case (Type III), bedrock, etc.), geologic characteristics of the site, the type of contaminants being monitored, and local and state regulations.
- For access to locations when travelling over difficult terrain, an appropriate line should be chosen before mobilizing the drill rig or other support vehicles. If clearing of trees or ground cover is required, perform these activities in advance to avoid down time. Avoid wet or soft areas where possible or use ground mats and/or timbers to aid in supporting the rig as it travels. If drilling on soft material, place geomatting and ground mats under the rig tracks or stabilizers prior to drilling.
- A utility locate must be conducted to identify all underground utilities at the site prior to drilling (refer to SOP 3-01, Utility Clearance*)*. Proper clearance procedures for aboveground/overhead utilities must also be followed as specified in the HASP.
- Although new well materials (well screen and riser pipe) generally arrive at the site boxed and sealed within plastic bags, it is sometimes necessary to decontaminate the materials prior to their use. Well materials should be inspected by the project geologist/engineer upon delivery to check for cleanliness. If the well materials appear dirty, or if local or regional regulatory guidance requires decontamination, then well material decontamination should be performed by the drilling subcontractor in accordance with SOP 3-06, Equipment Decontamination.
- The diameter of the borehole must be a minimum of 2 inches greater than the outside diameter of the well screen or riser pipe used to construct the well. This is necessary so that sufficient annular space is available to install filter packs, bentonite seals, and grout seals, and allow the passage of tremie pipe where grouting at depth is required. Bedrock wells may require reaming after coring in order to provide a large enough borehole diameter for well installation.
- When soil sampling is required (refer to the SAP), soil samples will be collected for visual logging by advancing split-spoon samplers through the augers. The soil will be visually logged by a field geologist and include lithologic characteristics (i.e., soil type, color, density, moisture content, etc.) using the the

methods described in SOP 3-16, Soil and Rock Classification. This information will be recorded on a boring/well log form, along with well construction details.

7.2 Drilling Techniques

Drilling of monitoring well boreholes may be accomplished by a variety of methods as described below. Preferred methods include those that temporarily case the borehole during drilling (i.e., hollow stem auger and sonic methods) using an override system. Other methods can be used where specific subsurface conditions or well design criteria dictate.

- Hollow stem auger (HSA) – Borings are advanced by rotating steel hollow stem augers with an attached cutting head. Soil cuttings are displaced by the cutting head and transported to the surface via continuous spiral flights attached to each auger stem. This method is widely used for unconsolidated soils that have a tendency to collapse within the boring. A bottom plug can be placed in the bottom auger to prevent soils from entering and clogging the auger, especially in the case of heaving sands. However, a bottom plug cannot be used when soil samples are to be collected through the augers. Soil plugs that accumulate in the bottom of the auger must be removed or knocked out prior to sampling or well installation.
- Solid stem auger – This type of drilling method is similar to HSA drilling using a solid stem or sealed hollow stem auger flights to advance the boring. Solid stem, continuous flight auger use is limited to semi-consolidated sediments or to cohesive or semi-cohesive unconsolidated sediments that don't have a tendency to collapse when disturbed.
- Sonic methods – Sonic drilling consists of advancing concentric hollow drill casings (inner and outer) using rotation in conjunction with axial vibration of the drill casing. Once the casings are advanced to the appropriate depth, the inner string is removed with a core of drill cuttings while the outer casing remains in place to keep the borehole open. Cuttings are removed from the inner casing relatively intact for logging or sampling purposes. This drilling method is used for a variety of soil types, from heaving sands to consolidated or indurated formations. Smearing of the formation along the borehole walls is minimal since moderate vibration and rotation techniques are used to advance the casings. Since the total borehole diameter in sonic drilling is only incrementally larger than the inner casing diameter, care should be taken during installation of the monitoring well to ensure the well is centered and adequate space is available for annular materials.
- Rotary methods (water or mud) – Rotary drilling methods consist of drill rods coupled to a drill bit that rotates and cuts through the soils to advance the borehole. Water or drilling fluid ("mud") is forced through the hollow drill rods and drill bit as the rods are rotated. The soil cuttings are forced up the borehole with the drilling fluids to the surface and the fluids recirculated. The drilling fluid provides a hydrostatic pressure that reduces or prevents the borehole from collapsing. Clean, potable water must be used for water-rotary drilling to prevent introducing trace contaminants. A sample of the potable water should be collected during the course of well installation for analysis of the same parameters defined for the groundwater samples. If mud-rotary is used to advance boreholes, potable water and bentonite drilling mud should only be used. No chemical additives shall be mixed in the drilling fluid to alter viscosity or lubricating properties. Adequate well development is essential for removal of drilling mud and fluids from the formation materials and ensure collection of representative groundwater samples.
- Rotary methods (Air) – Air rotary methods are similar to water rotary but use high air velocities in place of drilling fluids to rotate the drill bit and carry the soil cuttings up the borehole to the surface. Care must be taken to ensure that contaminants are not introduced into the air stream from compressor oils, etc. Most compressor systems are compatible with a coalescing filter system. Cuttings exiting the borehole under pressure must be controlled, especially when drilling in a zone of potential contamination. This can be accomplished by using an air diverter with hose or pipe to carry the cuttings to a waste container. Letting the cuttings blow uncontrolled from the borehole is not acceptable.

7.3 Well Construction and Installation

- If rotary drilling techniques are used, the borehole should be flushed or blown free of material prior to well installation. If hollow stem augers are used, the soil or bottom plug should be removed and the augers raised approximately six inches above the bottom of the borehole, while slowly rotating the augers to remove cuttings from the bottom of the boring. The depth of the borehole should be confirmed with a weighted, calibrated tape.
- The riser pipe and screen should be connected with flush-threaded joints and assembled wearing clean, disposable gloves. No solvent or anti-seize compound should be used on the connections. The full length of the slotted portion of the well screen and unslotted riser pipe should be measured and these measurements recorded on a well construction form (Attachment 1).
- If placed in an open borehole, the assembled well should be carefully lowered and centered in the borehole so that the well is true, straight, and vertical throughout. Centering can also be accomplished with the use of centralizers, if necessary. However, centralizers should be placed so that they do not inhibit the installation of filter sand, bentonite seal, and annular grout. Wells less than 50 deep generally do not require centralizers.
- If hollow stem augers are used, the well should be lowered through the augers and each auger flight removed incrementally as the filter sand, bentonite seal, and grout are tremmied or poured into the annular space of the well. The well should be temporarily capped before filter sand and other annular materials are installed.
- Clean, silica sand should be placed around the well screen to at least 1 foot above the top of the screen. The filter sand should be appropriately graded and compatible with the selected screen size and surrounding formation materials. In general, the filter pack should not extend more than 3 feet above the top of the screen to limit the thickness of the monitoring zone. As the filter pack is placed, a weighted tape should be lowered in the annular space to verify the depth to the top of the layer. This measurement will be recorded on the well construction form (Attachment 1). If necessary, to eliminate possible bridging or creation of voids, placement of the sand pack may require the use of a tremie pipe. Tremie pipe sandpack installations are generally suggested for deeper wells and for wells which are screened some distance beneath the water table.
- A minimum 2-foot thick layer of bentonite pellets or slurry seal will be installed immediately above the filter sand to prevent vertical flow within the boring from affecting the screened interval. Bentonite chips/pellets must be hydrated if place above the water table prior to grouting. If bridging is of concern as in the case of deep wells, powdered bentonite may be mixed with water into a very thick slurry and a tremie pipe used to place the seal to the desired depth. Placement of the bentonite seal in the borehole will be recorded on the well construction form (Attachment 1).
- The remaining annular space around the well will be grouted from the top of the bentonite seal to the surface with a grout composed of neat cement, a bentonite cement mixture, or high solids sodium bentonite grout.
- Each well riser will be secured with an expandable, locking cap (vented if possible). Optionally, a hole can be drilled in the upper portion of the riser to allow venting of the well.
- The well will be completed within a concrete well pad consisting of a Portland cement/sand mixture. Well pads are generally 3 feet by 3 feet square but may be larger or smaller depending on site conditions and state-specific well construction standards. Round concrete well pads are also acceptable. A minimum of 1 inch of the finished pad should be below grade to prevent washing and undermining by soil erosion.
- If completed as a flush-mount well, the well riser will be cut off approximately 4 to 6 inches below ground surface and an expandable, locking cap placed on the well riser. The area around the riser is dug out and a steel well vault or manhole cover placed over the riser and set almost flush to the ground

to protect the well. The manhole cover should be water-tight and secured with bolts to prevent casual access. The well pad will then be constructed around the well vault and slightly mounded at the center and sloping away to prevent surface water from accumulating in the well vault.

- If completed as a stick-up well, the well riser is cut approximately 2.5 to 3 feet above the ground surface and an expandable, locking cap placed on the well riser. A steel guard pipe with hinged, locking cap is placed over the well riser as a protective casing. The bottom of the guard pipe will be set approximately 2 feet below ground surface and sealed by pouring concrete from the top of the annular grout around the pipe to grade. The concrete well pad should be completed at the same time. Weep holes will be drilled in the base of the guard pipe to facilitate draining of rainwater or purge water from inside the guard pipe.
- Bumper posts or bollards may be necessary for additional well protection, especially in high traffic areas. The bumper posts should be placed around the well pad in a configuration that provides maximum protection to the well and extend a minimum of 3 feet above the ground.

7.4 Double Cased Wells

Under certain site conditions, the use of a double-cased or telescoping (Type III) well may be necessary. Installation of double-cased wells may be required to prevent the interconnection of two separate aquifers, seal off a perched aquifer without creating a vertical hydraulic conduit, prevent cross-contamination during construction of wells in deeper aquifers hydro-stratigraphically below impacted aquifers, or case off highly impacted soils present above the aquifer to prevent potential “dragging down” of contaminants.

Similar to conventional wells, construction of double-cased wells can be accomplished using a varety of drilling methods. Well construction is initiated by “keying” a large diameter, outer casing into a stratigraphic zone of low permeability (clay layer or bedrock). The size of the outer casing should be a minimum of 2 inches greater than the outside diameter of the inner casing to allow installation of annular seal materials during well completion. A pilot borehole should be drilled through the overburden soil and/or contaminated zone into a clay confining layer or bedrock. The borehole for the outer casing should be of sufficient size to contain the outer casing with a minimum of 2 inches around the outside diameter to allow sufficient annular space for tremie or pressure grouting. The boring should extend a minimum of 2 feet into a clay layer and a minimum of 1 foot into bedrock, if possible, to ensure an adequate seal. The boring should never breach a confining layer or keyed zone under any circumstances.

Once the boring is completed, the outer casing can be set in the borehole and sealed with grout. The outer casing can be set two ways, with or without a bottom cap. If no bottom cap is applied, the casing is usually driven approximately 6 inches into the clay confining unit. A grout plug is generally placed in the bottom of the casing and once set, standing water in the casing is evacuated prior to drilling below the casing. As an alternative, a cap can be placed on the bottom of the casing and if set below the water table, the casing can be filled with clean, potable water to hold down the casing in the boring. Grouting should be conducted using tremie-grouting or pressure-grouting methods by pumping grout into the annular space between the outer casing and the borehole wall from the bottom of the casing to the ground surface. Grout around the casing should be allowed to cure at least 24 hours before attempting to drill through the bottom.

Once the grout is cured, a smaller diameter drill pipe/bit is used to bore through the grout plug or bottom cap to the desired well depth. The well is then constructed as described in Section 7.3 above.

7.5 Post Installation Procedures

- Wells should be permanently labelled or marked for identification. Well tags can be used to record the site name, well number, total depth, installation date, etc. At a minimum, the well number will be written in indelible marker or paint on both the outside of the protective casing and inside beneath the casing lid, as well as on the riser pipe.

- A measuring point will be marked on the top of the riser pipe for taking water level measurements. The measuring point can be notched using a knife or saw or can be marked with a waterproof marker or paint. The measuring point will also be the point which will be surveyed for vertical elevation data.
- Upon completion, the following measurements will be taken by the field geologist/engineer and recorded on the well construction diagram.
    - Depth to static water level
    - Depth of non-aqueous phase liquid (NAPL), if present
    - Total depth of well measured from top of casing (TOC)
    - Height of well casing above ground surface
    - Height of protective casing above ground surface
- All monitoring wells will be surveyed for horizontal and vertical control by a licensed surveyor.
- Investigation-derived waste (IDW) including drill cuttings, spent materials (e.g., PPE), and decontamination water should be properly managed in accordance with SOP 3-05, IDW Management.

8.0 Quality Control and Assurance

8.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the SAP. Certain quality control (QC) measures should be taken to ensure proper well installation and construction in accordance with this SOP, project specific SAP, and applicable well standards.

8.2 The borehole will be checked for total open depth, and extended by further drilling or shortened by backfilling, as required before installation of the well materials.

8.3 Water level and NAPL presence will be checked during well installation to ensure that the positions of well screen, filter sand, and seals relative to water level conform to project requirements

8.4 The depth to top of each layer of annular materials (i.e., filter sand, bentonite, grout) will be verified and adjusted as necessary for proper placement.

9.0 Records, Data Analysis, Calculations

All field information will be recorded in the field logbook and/or standardized field forms by field personnel. Field data recorded will include drilling contractor information, drilling methods, well material and construction information provided on the boring logs and well construction forms, observations or problems encountered during drilling, fluid level data, and any deviations from the procedures in this SOP and other project plans. Well Construction Forms (Attachment 1) will provide visual and descriptive information the monitoring well and are often the most critical form of documentation generated during the installation of a monitoring well. The field logbook is kept as a general log of activities and should not be used in place of the boring log.

10.0 Attachments or References

10.1 Attachment 1 – Monitoring Well Construction Form

10.2 Environmental Protection Agency, United States (EPA). 1987. *A Compendium of Superfund Field Operations Methods*. Office of Solid Waste and Emergency Response. EPA/540/P-87/001.

10.3 EPA. 1990. *Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells*. EPA/600/4-89/034. Office of Research and Development, Washington. March.

10.4 EPA. 1992. *RCRA Groundwater Monitoring Draft Technical Guidance*. EPA/530/R-93/001. Office of Solid Waste. November.

10.5 EPA, 2008. SESD Operating Procedure SESDGUID-101-R0: *Design and Installation of Monitoring Wells*. USEPA, Science and Ecosystem Support Division (SESD), Athens, Georgia. Effective Date February 18, 2008.

10.6 U.S. Army Corps of Engineers. 2008. Manual No. EM 385-1-1. *Safety and Health Requirements*. 15 November 2008. http://140.194.76.129/publications/eng-manuals/em385-1-1/2008_English/toc.html.

10.7 SOP 3-01, *Utility Clearance*.

10.8 SOP 3-05, *IDW Management*

10.9 SOP 3-06, *Equipment Decontamination*.

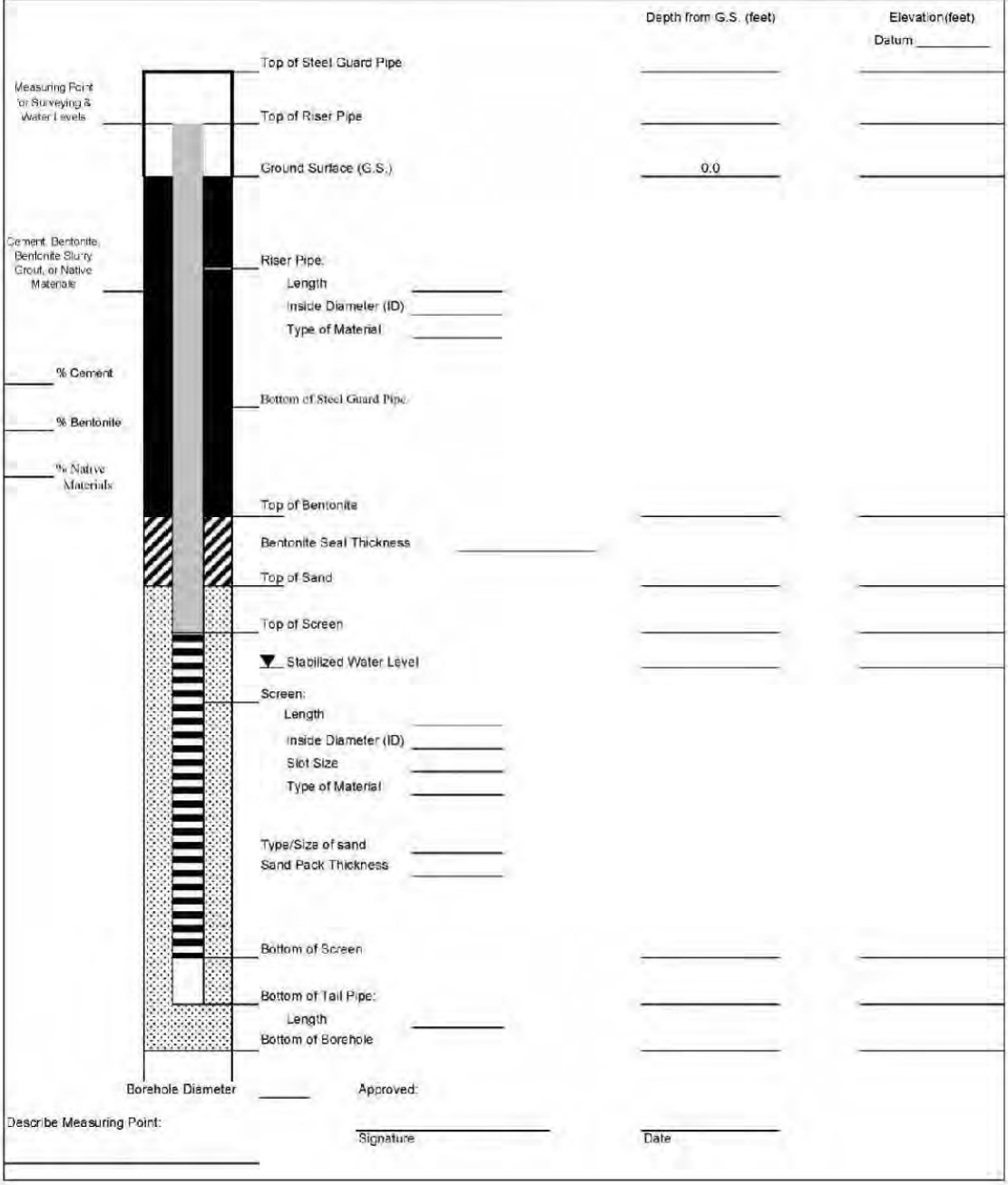
10.10 SOP 3-16, *Soil and Rock Classification.*

Author	*Reviewer*	*Revisions (Technical or Editorial)*
Mark Kromis Program Chemist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (May 2012)

Attachment 1
Monitoring Well Construction Form

RESOLUTION CONSULTANTS	*Client:*	***WELL ID:***
	Project Number:	
	Site Location:	*Date installed:*
	Well Location: *Coords:*	*Inspector:*
	Method:	*Contractor:*

MONITORING WELL CONSTRUCTION DETAIL



Monitoring Well Development

Procedure 3-13

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes the procedures used for developing newly installed monitoring wells and/or redeveloping existing wells.

1.2 The purpose of well development is to remove interferences from a well to provide better connection between the well and the formation, to improve pumping performance of the well, and to be able to collect more representative information from the well (e.g., samples, test results, etc.). Proper well development will:

- Remove drilling residuals (e.g., water, mud) from the borehole and surrounding formations;
- Improve or restore hydraulic conductivity of the surrounding formations which may have been disturbed during the drilling process;
- Remove residual fines from the well screen and sand pack (filter pack) materials, thus reducing turbidity of groundwater and permitting the collection of more representative groundwater samples.

1.3 There may be circumstances where well development is not desirable, for example, in the presence of non-aqueous phase liquids (NAPL) or other significant contamination if development could worsen the contaminant impact. If NAPL begins to intrude during development, the development process will be halted. This situation will be considered a cause for sample modification requiring approval by the CTO Manager and other stakeholders, as applicable.

1.4 The applicable well development procedures for a particular site may be subject to State or local regulatory requirements. In all cases, the project team should consult their local regulatory requirements and document the selected well development procedure in the project-specific Sampling and Analysis Plan (SAP). For project-specific information refer to the SAP, which takes precedence over these procedures.

1.5 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).

1.6 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review.

2.0 Safety

2.1 The health and safety considerations for the work associated with this SOP, including both potential physical and chemical hazards, will be addressed in the project Health and Safety Plan (HASP). In the absence of a HASP, work will be conducted according to the Contract Task Order (CTO) SAP and/or direction from the Site Safety Officer (SSO).

2.2 Monitoring well development may involve chemical hazards associated with potential contaminants in the soil or aquifer being characterized and may involve physical hazards associated with use of well development equipment.

3.0 Terms and Definitions

None.

4.0 Interferences

4.1 Equipment/materials used for development may react with the groundwater during development. Appropriate development equipment has been selected for the anticipated condition of the groundwater.

4.2 Appropriate development methods such as using a surge-block to flush suspended fines in the groundwater in and out of the well screen can improve the yield of wells and improve their potential to be developed successfully. However, the effectiveness of development can be significantly reduced in wells that do not yield sufficient water to allow this flushing to take place.

4.3 For formations with a significant content of fine-grained materials (silts and clays), or wells with improperly sized screens, it may not be possible to reduce turbidity to commonly acceptable levels. Possible solutions may include collecting a sample even if excessively turbid, or installing a replacement well.

4.4 Development itself disturbs the surrounding formation and disrupts equilibrium conditions within the well. Groundwater samples will not be collected until a minimum of 24 hours after a well is developed to allow conditions to stabilize. For sites with fine-grained formations (silts and clays) and highly sorptive contamination, a longer time period between development and sampling should be considered.

5.0 Training and Qualifications

5.1 Qualifications and Training

The individual executing these procedures must have read, and be familiar with, the requirements of this SOP.

5.2 Responsibilities

5.2.1 The **CTO Manager** is responsible for ensuring that well development activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all personnel involved in well development shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

5.2.3 The **Field Manager** is responsible for ensuring that all well development activities are conducted according to the either this procedure or the applicable procedure presented in the project-specific SAP.

5.2.4 **Field sampling personnel** are responsible for the implementation of this procedure.

5.2.5 The field sampler and/or task manager is responsible for directly supervising the well development procedures to ensure that they are conducted according to this procedure and for recording all pertinent data collected during sampling.

6.0 Equipment and Supplies

6.1 This equipment list was developed to aid in field organization and should be used in planning and preparation. Depending on the site-specific requirements and the development method selected, additional or alternative material and equipment may be necessary. In addition, for sites where groundwater is expected to be contaminated, the materials to be placed down the well and in contact with groundwater should be evaluated so that they are compatible with the chemical conditions expected in the well.

6.2 Equipment and materials used for well development may include, but is not limited to:

Well development equipment

- Surge block

- Disposable Teflon bailers, appropriate to the diameter of the well(s): 1-inch to 1.5-inch for 2-inch inside diameter (ID) monitoring wells.
- Watterra® footvalve
- Electric submersible pump
- 12-volt power source for electric pump
- High density polyethylene (HDPE) tubing appropriately sized for Watterra® footvalve and/or electric submersible pump
- Drums or containers for storage of purge water
- Nephelometer to measure turbidity
- Multi-parameter water quality meter(s) to measure temperature, pH, conductivity, dissolved oxygen (DO), oxidation reduction potential (ORP)
- Instrument calibration solutions
- Water level meter
- Oil/water interface probe

General equipment

- Project-specific plans including the site-specific HASP and SAP
- Field notebook/field forms/site maps
- Indelible markers/pens
- 5-gallon buckets

Equipment decontamination supplies (refer to SOP 3-06, Equipment Decontamination)

- Health and safety supplies, including personal protective equipment (PPE)
- Appropriate hand tools
- Keys or combinations to access monitoring wells
- Distilled/deionized water supply
- Disposable bailer string (polypropylene)
- Plastic trash bags

7.0 Procedure

Development generally consists of removing water and entrained sediment from the well until the water is clear (to the extent feasible) and the turbidity is reduced, which indicates the well is in good hydraulic connection with the surrounding formation. In addition to simply removing water, development can be improved when flushing through the well screen and gravel pack takes place in both directions, that is, both into the well and into the formation. This action breaks down sediment bridges that can occur in the formation or sand pack, which reduce the connection between the well and the formation

7.1 General Preparation

- All down-well equipment should be decontaminated prior to use and between well locations in accordance with SOP 3-06, Equipment Decontamination
- Although equipment is decontaminated between well locations, if wells are known or suspected to be contaminated based on observations during well installation, it is recommended that well development be conducted in order from the least contaminated to the most contaminated well to minimize the chances of cross-contamination.
- Management of investigation-derived waste (IDW), including development purge water and miscellaneous expendable materials generated during the development process, will be conducted in accordance with SOP 3-05, IDW Management.

- Prior to accessing the well, the wellhead should be cleared of debris and/or standing water. Nothing from the ground surface should be allowed to enter the well.
- The depth to water and total well depth should be measured with a water level meter and recorded in the field logbook or on a Well Development Record (Attachment 1). This information will be used to calculate the volume of standing water (i.e., the well volume) within the well, and plan the specific details of the well development. If wells are suspected to contain NAPL, an oil/water interface probe should be used to measure liquid levels and depth to bottom of the well.
- Permanent monitoring wells will be developed no sooner than 24 hours after well installation is completed in order to allow well completion materials to set properly.

7.2 Monitoring Well Development Procedures

Generally, development will begin by gently surging the well with a surge block or bailer as described in Sections 7.2.1 and 7.2.2, respectively. Surging can become more vigorous as development progresses but initially the well must be gently surged to allow material blocking the screen to become suspended without damaging the well. Next, a bailer can be used to remove the sediment settled at the base of the well. A bailer, Watterra® pump, or electric submersible pump will then be used to purge the well, per Sections 7.2.2, 7.2.3, or 7.2.4, respectively. The well will be purged until the removed water becomes less turbid or per the requirements of the project-specific SAP, or State or local requirements. At this point the well will be surged again with a surge block or bailer. The well can be surged more vigorously at this point. After surging, the well will be purged again until the turbidity once again decreases. The surge/purge cycle should be completed at least three times during the development process. After the last surge, the well will be purged until the development completion criteria outlined in 7.3.2 or per the project-specific SAP are met.

7.2.1 Surge Block

The default method of well development is the use of a surge block in conjunction with pumping or bailing to remove sediment-laden water.

- The construction of the surge block must be appropriate for the diameter of the well. The surge block must be mounted on rods or other stiff materials to extend it to the appropriate depths and to allow for the surge block to be moved up and down in the well.
- Insert the surge block into the well and lower it slowly to the screened or open interval below the static water level. Start the surge action by slowly and gently moving the surge block up and down in the well. A slow initial surging, using plunger strokes of approximately 1 meter or 3 feet, will allow material which is blocking the screen to separate and become suspended.
- After 5 to 10 plunger strokes, remove water from the well using a separate bailer (Section 7.2.2) or pumping techniques (Sections 7.2.3 or 7.2.4). The returned water should be heavily laden with suspended fines. The water will be discharged to 5-gallon buckets or 55-gallon drums to be managed per the requirements presented in the project-specific SAP.
- In some cases, the bailer or Watterra® foot valve can act as a surge block, flushing water in and out of the well screen as groundwater is removed.
- Repeat the process of surging and pumping/bailing. As development continues, slowly increase the depth of surging to the bottom of the well screen. Surging within the riser portion of the well is neither necessary nor effective.

7.2.2 Bailer

- Tie a string or other cable securely to the bailer. Lower it to the screened or open interval of the monitoring well below the static water level.
- The bailer may be raised and lowered repeatedly within the screened interval to attempt to simulate the action of a surge block by pulling fines through the well screen, and pushing water out into the formation to break down bridging.

- With the bailer full of water, remove it from the well and discharge the water into 5-gallon buckets or 55-gallon drums to be managed per the requirements presented in the project-specific SAP.
- The Watterra® system (Section 7.2.3) or electric submersible pump (Section 7.2.4) may be used as a complementary development method to the bailer, especially when removal of additional water at a faster rate is beneficial.
- Continue alternately surging and bailing, monitoring the purge water periodically (Section 7.3.1) until development completion criteria are met (Section 7.3.2).

7.2.3 Watterra® system

- Attach high-density polyethylene (HDPE) tubing to the decontaminated Watterra® pump foot valve
- Lower the foot valve and tubing assembly near the bottom of the well.
- Lift and lower the tubing to allow water to enter the Watterra® foot valve and travel up the tubing and discharge the water into 5-gallon buckets or 55-gallon drums to be managed per the requirements presented in the project-specific SAP.
- The lifting and lowering action of the Watterra® sysem will cause some surging action to aid in breaking up fine material in the surrounding formation.
- A bailer (Section 7.2.2) may be used as a complementary development method to the Watterra® system, especially during the initial stages of development when a high volume of sediment may be required to be removed.
- An electric submersible pump (Section 7.2.4) may also be used as a complementary development method to the Watterra® system, especially when more volume of water is desired to be pumped or the turbidity criteria cannot be met due to the surging action of the Watterra® system.
- Continue alternately surging and pumping, monitoring the purge water periodically (Section 7.3.1) until well development completion criteria are met (Section 7.3.2).

7.2.4 Electric Submersible Pump

- Attach HDPE tubing to the decontaminated electric submersible pump.
- Lower the pump and tubing assembly near the bottom of the well, at least a few inches above the well total depth.
- Begin pumping, discharging the water into 5-gallon buckets or 55-gallon drums to be managed per the requirements presented in the project-specific SAP.
- Continue alternately surging and pumping, monitoring the purge water discharge periodically (Section 7.3.1) until well development completion criteria are met (Section 7.3.2).

7.3 Discharge Monitoring

7.3.1 Monitoring the Progress of Development

The progress of the development is evaluated through visual observation of the suspended sediment load and measurement of the turbidity and other parameters in the purged diischarge water. As development progresses, the water should become clearer, measured turbidity should decrease, and specific capacity (pumping rate divided by drawdown) should stabilize. Water quality parameters, including DO, conductivity, ORP, pH, temperature, and turbidity may be measured and recorded periodically to determine the progress of development using the criteria outlined in Section 7.3.2 or per the project-specific SAP. Water quality parameters should be measured on each well volume removed.

7.3.2 Completion of Development

The well will be considered developed when the following criteria are met or per the criteria set forth in the project-specific SAP:

- A minimum of three times the standing water volume in a well (to include the well screen and casing plus saturated annulus, assuming 30 percent porosity) is removed.

- Groundwater parameters for three consecutive standing water volumes are within the following:
    - pH – within ± 0.2 units
    - Specific conductivity – within ± 3%
    - ORP – within ± 10 mV
    - Temperature – within ±1 degree Celsius
    - Turbidity – at or below 10 nephelometric turbidity units (NTU) or within ± 10% if above 10 NTU.
- The sediment thickness remaining within the well is less than 1 percent of the screen length or less than 30 millimeters (0.1 ft) for screens equal to or less than 10 feet long.

Dissolved oxygen (DO) readings may be recorded but DO readings will not be used as development completion criteria because DO may not stabilize.

If the well has slow groundwater recharge and is purged dry, the well will be considered developed when bailed or pumped dry three times in succession and the turbidity has decreased, or per the requirements set forth in the project-specific SAP. Water quality parameters may be recorded if feasible using the flow-through cell.

If any water is added to the well's borehole during development or drilling, three times the volume of water added will also be removed during well development, or per the requirements set forth in the project-specific SAP.

7.4 Development of Wells with Low Yield

Water is the primary mechanism to remove fines and flush water through the gravel pack for effective development. Therefore, development can be a challenge in wells that do not yield sufficient water to recharge when water is removed. However, often these wells are the most in need of development to improve their performance as they are typically installed in low permeability formations with a high content of fines. Development of these wells can improve their yield.

The surging portion of the development can be successfully performed in a well with standing water regardless of its yield. It is the subsequent removal of fine materials that is hindered when insufficient water is recharged to the well. When wells go dry or drawdown significantly during development, development can be performed intermittently, allowing sufficient water to recharge prior conducting the next stage of surging. These intermittent procedures can take place hours or even days apart, depending on project-specific time constraints.

7.5 Wells containing NAPL

Additional care should be taken when planning development of wells that contain NAPL. If the NAPL is flammable, there are health and safety as well as handling issues to consider. If NAPL in excess of a persistent sheen is noted, the recharge rate will be evaluated through hand bailing. In most cases, it is generally preferable to remove NAPL by bailing to the extent practical prior to performing development. Groundwater parameters, excluding turbidity, will not be collected during well development if NAPL or excessive sheen is noticed in the purged water during development to ensure the meter probes are not fouled or destroyed. Well development will be halted.

Development by surging or pumping the well dry can result in the spreading of NAPL vertically in the soil column around the well. These methods can be used, if information exists describing the vertical thickness of the NAPL smear zone around the well, and if the methods do not result in mounding or drawdown that exceeds this thickness. Alternate methods such as bailing may also be used, but any method should not allow the well to be pumped dry or result in significant drawdown that would spread the NAPL vertically.

7.6 Temporary Well Points

For certain projects, temporary well points (TWPs) may be installed to collect groundwater samples at a site. Since no sand pack, bentonite chips, or bentonite grout are generally used in the construction of the TWPs, development can proceed as soon as sufficient water has entered the well to static conditions. Due to the small diameter of these wells, generally ¾-inch to 1-inch ID, development will be performed using either a small diameter (0.5-inch) bailer and/or a peristaltic pump with dedicated tubing. The TWPs will have minimal water column and may purge dry during development. However, attempts will be made to remove fines from the well prior to sampling. Purging and sampling may occur as soon as approximately 80% of the static water has re-entered the TWP, or per the requirements set forth in the project-specific SAP.

8.0 Quality Control and Assurance

8.1 Field personnel will follow specific quality assurance (QA) guidelines as outlined in the project-specific SAP.

8.2 Quality control (QC) requirements are dependent on project-specific sampling objectives. The project-specific SAP will provide requirements for equipment decontamination (frequency and materials) and IDW handling.

9.0 Records, Data Analysis, Calculations

9.1 All data and information (e.g., development method used) must be documented on field data sheets (Attachment 1) or within site logbooks with permanent ink. Data recorded may include the following:

- Well Location
- Weather conditions
- Date and Time
- Purge Method
- Reading/measurements obtained

10.0 Attachments or References

Attachment 1 – Well Development Record

SOP 3-05, *IDW Management*.

SOP 3-06, *Equipment Decontamination*.

Author	*Reviewer*	*Revisions (Technical or Editorial)*
Shawn Dolan Senior Scientist	Chris Barr Program Quality Manager	Rev 0 – Initial Issue (June 2012)

Attachment 1
Well Development Record

Well/Piezometer Development Record

Well ID:

Client: _____

Project No: _____ Date: _____ Developer: _____

Site Location: _____

Well/Piezometer Data

Well ☐ Piezometer ☐ Diameter _____ Material _____

Measuring Point Description _____ Geology at Screen Interval (if known) _____

Depth to Top of Screen (ft.) _____

Depth to Bottom of Screen (ft.) _____ Time of Water Level Measurement _____

Total Well Depth (ft.) _____ Calculate Purge Volume (gal.) _____

Depth to Static Water Level (ft.) _____ Disposal Method _____

Headspace _____

Original Well Development ☐ Redevelopment ☐ Date of Original Development _____

DEVELOPMENT METHOD _____

PURGE METHOD _____

Time	Total Volume Purged (gal.)	Flow Rate (gpm)	Turbidity (NTU)	Color	pH	Temp	Other

ACCEPTANCE CRITERIA (from workplan)

Minimum Purge Volume Required _____ gallons
Maximum Turbidity Allowed _____ NTUs
Stabilization of parameters _____%

	Yes	No	N/A
Has required volume been removed	☐	☐	☐
Has required turbidity been reached	☐	☐	☐
Has parameters stabilized	☐	☐	☐

If no or N/A explain below:

_____

_____

_____

Signature _____ Date: _____

Soil and Rock Classification

Procedure 3-16

1.0 Purpose and Scope

1.1 The purpose of this document is to define the standard operating procedure (SOP) to thoroughly describe the physical characteristics of the sample and classify it according to the Unified Soil Classification System (USCS).

1.2 This procedure is the Program-approved professional guidance for work performed by Resolution Consultants under the Comprehensive Long-Term Environmental Action Navy (CLEAN) contract (Contract Number N62470-11-D-8013).

1.3 As guidance for specific activities, this procedure does not obviate the need for professional judgment. Deviations from this procedure while planning or executing planned activities must be approved in accordance with Program requirements for technical planning and review. If there are procedures whether it be from Resolution Consultants, state and/or federal that are not addressed in this SOP and are applicable to surface water sampling then those procedures may be added as an appendix to the project specific SAP.

1.4 It is fully expected that the procedures outlined in this SOP will be followed. Procedural modifications may be warranted depending upon field conditions, equipment limitations, or limitations imposed by the procedure. Substantive modification to this SOP will be approved in advance by the Program Quality Manager. Deviations to this SOP will be documented in the field records.

2.0 Safety

2.1 Depending upon the site-specific contaminants, various protective programs must be implemented prior to sampling. All **field sampling personnel** responsible for sampling activities must review the project-specific health and safety plan (HASP) paying particular attention to the control measures planned for the sampling tasks. Conduct preliminary area monitoring to determine the potential hazard to field sampling personnel. If significant contamination is observed, minimize contact with potential contaminants in both the vapor and liquid phase through the use of respirators and disposable clothing.

2.2 In addition, observe standard health and safety practices according to the project-specific HASP. Suggested minimum protection during well sampling activities includes inner disposable vinyl gloves, outer chemical-protective nitrile gloves, rubberized steel-toed boots, and an American National Standards Institute-standard hard hat. Half-face respirators and cartridges and Tyvek® suits may be necessary depending on the contaminant concentrations, and shall always be available on site.

2.3 Daily safety briefs will be conducted at the start of each working day before any work commences. These daily briefs will be facilitated by the **Site Safety Officer (SSO)** or designee to discuss the day's events and any potential health risk areas covering every aspect of the work to be completed. Weather conditions are often part of these discussions. As detailed in the HASP, everyone on the field team has the authority to stop work if an unsafe condition is perceived until the conditions are fully remedied to the satisfaction of the SSO.

2.4 The health and safety considerations for the work associated with soil classification include:

- At no time during classification activities are personnel to reach for debris near machinery that is in operation, place any samples in their mouth, or come in contact with the soils/rocks without the use of gloves.
- Stay clear of all moving equipment and be aware of pinch points on machinery. Avoid wearing loose fitting clothing.
- When using cutting tools, cut away from yourself. The use of appropriate, task specific cutting tools is recommended.
- To avoid heat/cold stress as a results of exposure to extreme temperatures and PPE, drink electrolyte replacement fluids (1 to 2 cups per hour is recommended) and in case of extreme cold, wear insulating clothing.

3.0 Terms and Definitions

None.

4.0 Interference

None.

5.0 Training and Qualifications

5.1 The **Contract Task Order (CTO) Manager** is responsible for ensuring that the soil and rock classification procedures comply with this procedure. The **CTO Manager** is responsible for ensuring that all personnel involved in soil and rock classification shall have the appropriate education, experience, and training to perform their assigned tasks.

5.2 The **Program Quality Manager** is responsible for ensuring overall compliance with this procedure.

5.3 The **Field Manager** is responsible for ensuring that all project **field personnel** follow these procedures.

5.4 Field personnel are responsible for the implementation of this procedure. Minimum qualifications for **field sampling personnel** require that one individual on the field team shall have a minimum of 6 months of experience with soil and rock classification.

5.5 The **project geologist** and/or **task manager** is responsible for directly supervising the soil and rock classification procedures to ensure that they are conducted according to this procedure, and for recording all pertinent data collected. If deviations from the procedure are required because of anomalous field conditions, they must first be approved by the **Program Quality Manager** and then documented in the field logbook and associated report or equivalent document.

6.0 Equipment and Supplies

6.1 The following equipment list contains materials which may be needed in carrying out the procedures outlined in this SOP. Not all equipment listed below may be necessary for a specific activity. Additional equipment may be required, pending field conditions.

- Personal protective equipment (PPE) and other safety equipment, as required by the HASP
- Field log book and pen with indelible ink
- Boring log

- Munsell Soil Color Chart
- Scoopula, spatula, and/or other small hand tools
- California Sampler
- Hand-held penetrometer

7.0 Calibration or Standardization

None.

8.0 Procedure

8.1 Soil Classification

The basic purpose of the classification of soil is to thoroughly describe the physical characteristics of the sample and to classify it according to an appropriate soil classification system. The USCS was developed so that soils could be described on a common basis by different investigators and serve as a "shorthand" description of soil. A classification of a soil in accordance with the USCS includes not only a group symbol and name, but also a complete word description.

Describing soil on a common basis is essential so that soil described by different site qualified personnel is comparable. Site individuals describing soil as part of site activities *must* use the classification system described herein to provide the most useful geologic database for all present and future subsurface investigations and remedial activities.

The site geologist or other qualified individual shall describe the soil and record the description in a boring log, logbook, and/or electronic field data collection device. The essential items in any written soil description are as follows:

- Classification group name (e.g., silty sand)
- Color, moisture, and odor
- Range of particle sizes and maximum particle size
- Approximate percentage of boulders, cobbles, gravel, sand, and fines
- Plasticity characteristics of the fines
- In-place conditions, such as consistency, density, and structure
- USCS classification symbol

The USCS serves as ”shorthand“ for classifying soil into 15 basic groups:

GW[1] Well graded (poorly sorted) gravel (>50 percent gravel, <5percent fines)

GP[1] Poorly graded (well sorted) gravel (>50percent gravel, <5percent fines)

GM[1] Silty gravel (>50 percent gravel, >15 percent silt)

GC[1] Clayey gravel (>50 percent gravel, >15 percent clay)

SW[1] Well graded (poorly sorted) sand (>50 percent sand, <5 percent fines)

SP[1] Poorly graded (well sorted) sand (>50 percent sand, <5 percent fines)

[1] If percentage of fine is 5 percent to 15 percent, a dual identification shall be given (e.g., a soil with more than 50 percent poorly sorted gravel and 10 percent clay is designated GW-GC.

SM[1] Silty sand (>50 percent sand, >15 percent silt)

SC[1] Clayey sand (>50 percent sand, >15 percent clay)

ML[2] Inorganic, low plasticity silt (slow to rapid dilatancy, low toughness, and plasticity)

CL[2] Inorganic, low plasticity (lean) clay (no or slow dilatancy, medium toughness and plasticity)

MH[2] Inorganic elastic silt (no to slow dilatancy, low to medium toughness and plasticity)

CH[2] Inorganic, high plasticity (fat) clay (no dilatancy, high toughness, and plasticity)

OL Organic low plasticity silt or organic silty clay

OH Organic high plasticity clay or silt

PT Peat and other highly organic soil

Figure8-1 defines the terminology of the USCS. Flow charts presented in Figure 8-2 and indicate the process for describing soil. The particle size distribution and the plasticity of the fines are the two properties of soil used for classification. In some cases, it may be appropriate to use a borderline classification (e.g., SC/CL) if the soil has been identified as having properties that do not distinctly place the soil into one group.

8.1.1 Estimation of Particle Size Distribution

One of the most important factors in classifying a soil is the estimated percentage of soil constituents in each particle size range. Being proficient in estimating this factor requires extensive practice and frequent checking. The steps involved in determining particle size distribution are listed below:

1. Select a representative sample (approximately 1/2 of a 6-inch long by 2.5-inch diameter sample liner).
2. Remove all particles larger than 3 inches from the sample. Estimate and record the percent by volume of these particles. Only the fraction of the sample smaller than 3 inches is classified.
3. Estimate and record the percentage of dry mass of gravel (less than 3 inches and greater than 1/4 inch).
4. Considering the rest of the sample, estimate, and record the percentage of dry mass of sand particles (about the smallest particle visible to the unaided eye).
5. Estimate and record the percentage of dry mass of fines in the sample (do not attempt to separate silts from clays).
6. Estimate percentages to the nearest 5 percent. If one of the components is present in a quantity considered less than 5 percent, indicate its presence by the term “trace”.
7. The percentages of gravel, sand, and fines must add up to 100 percent. “Trace” is not included in the 100 percent total.

8.1.2 Soil Dilatancy, Toughness, and Plasticity

8.1.2.1 Dilatancy

To evaluate dilatancy, follow these procedures:

[2] If the soil is estimated to have 15 percent to 25 percent sand or gravel, or both, the words “with sand” or “with gravel” (whichever predominates) shall be added to the group name (e.g., clay with sand, CL; or silt with gravel, ML). If the soil is estimated to have 30 percent or more sand or gravel, or both, the words “sandy” or “gravely” (whichever predominates) shall be added to the group name (e.g., sandy clay, CL). If the percentage of sand is equal to the percent gravel, use “sandy.”

1. From the specimen, select enough material to mold into a ball about 1/2 inch (12 millimeters [mm]) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.
2. Smooth the soil ball in the palm of one hand with the blade of a knife or small spatula. Shake horizontally, striking the side of the hand vigorously against the other hand several times. Note the reaction of water appearing on the surface of the soil. Squeeze the sample by closing the hand or pinching the soil between the fingers, and note the reaction as none, slow, or rapid in accordance with the criteria in Table 8-1. The reaction is the speed with which water appears while shaking, and disappears while squeezing.

Table 8-1: Criteria for Describing Dilatancy

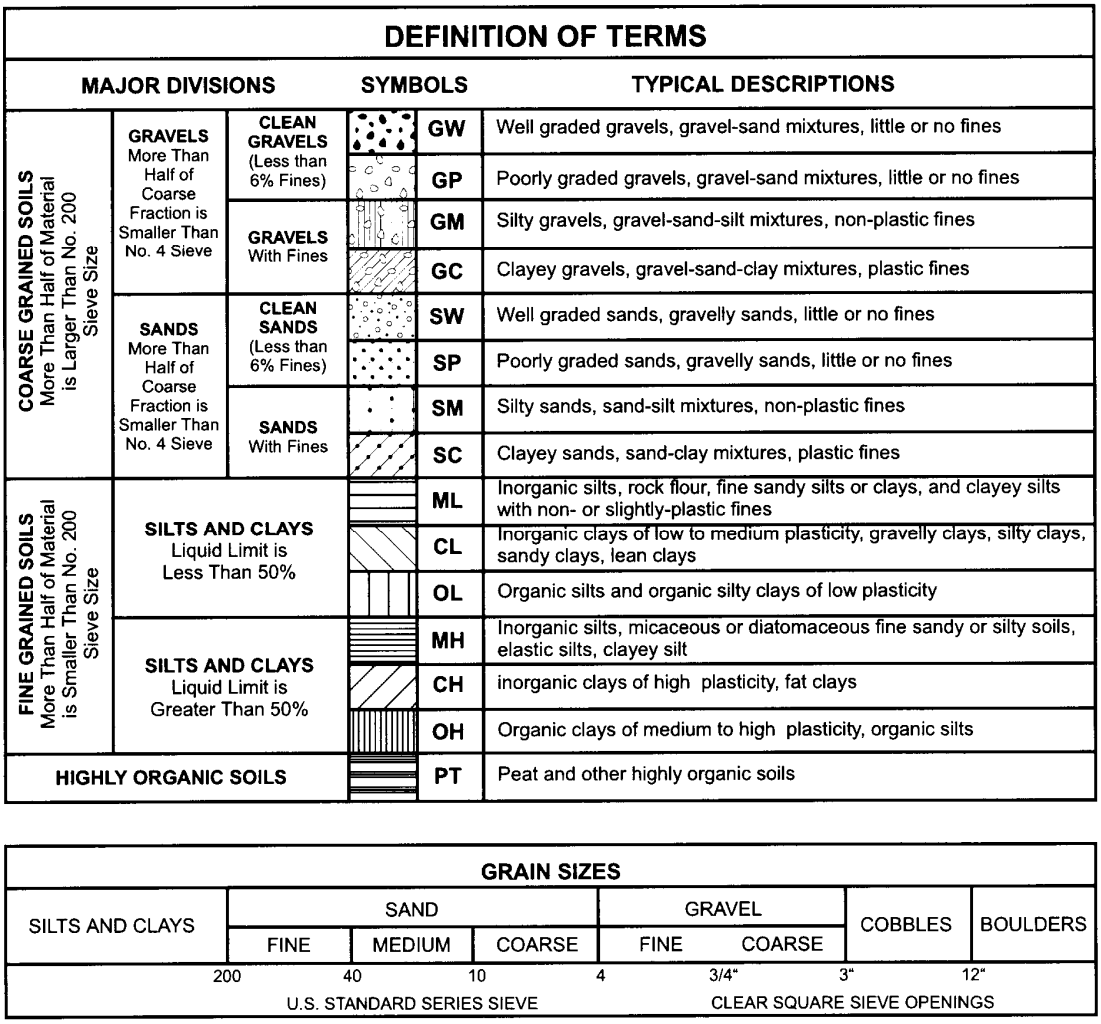
Description	Criteria
None	No visible change in specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

8.1.2.2 Toughness

Following the completion of the dilatancy test, shape the test specimen into an elongated pat and roll it by hand on a smooth surface or between the palms into a thread about 1/8 inch (3 mm) in diameter. (If the sample is too wet to roll easily, spread it into a thin layer and allow it to lose some water by evaporation.) Fold the sample threads and re-roll repeatedly until the thread crumbles at a diameter of about 1/8 inch. The thread will crumble at a diameter of 1/8 inch when the soil is near the plastic limit. Note the pressure required to roll the thread near the plastic limit. Also, note the strength of the thread. After the thread crumbles, lump the pieces together and knead it until the lump crumbles. Note the toughness of the material during kneading. Describe the toughness of the thread and lump as low, medium, or high in accordance with the criteria in Table 8-2.

Table 8-2: Criteria for Describing Toughness

Description	Criteria
Low	Only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and soft.
Medium	Medium pressure is required to roll the thread near the plastic limit. The thread and the lump have medium stiffness.
High	Considerable pressure is required to roll the thread near the plastic limit. The thread and the lump have very high stiffness.



DEFINITION OF TERMS

MAJOR DIVISIONS			SYMBOLS	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS More Than Half of Material is Larger Than No. 200 Sieve Size	GRAVELS More Than Half of Coarse Fraction is Smaller Than No. 4 Sieve	CLEAN GRAVELS (Less than 6% Fines)	GW	Well graded gravels, gravel-sand mixtures, little or no fines
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
		GRAVELS With Fines	GM	Silty gravels, gravel-sand-silt mixtures, non-plastic fines
			GC	Clayey gravels, gravel-sand-clay mixtures, plastic fines
	SANDS More Than Half of Coarse Fraction is Smaller Than No. 4 Sieve	CLEAN SANDS (Less than 6% Fines)	SW	Well graded sands, gravelly sands, little or no fines
			SP	Poorly graded sands, gravelly sands, little or no fines
		SANDS With Fines	SM	Silty sands, sand-silt mixtures, non-plastic fines
			SC	Clayey sands, sand-clay mixtures, plastic fines
FINE GRAINED SOILS More Than Half of Material is Smaller Than No. 200 Sieve Size	SILTS AND CLAYS Liquid Limit is Less Than 50%		ML	Inorganic silts, rock flour, fine sandy silts or clays, and clayey silts with non- or slightly-plastic fines
			CL	Inorganic clays of low to medium plasticity, gravelly clays, silty clays, sandy clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS Liquid Limit is Greater Than 50%		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts, clayey silt
			CH	inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils

GRAIN SIZES

SILTS AND CLAYS	SAND			GRAVEL		COBBLES	BOULDERS
	FINE	MEDIUM	COARSE	FINE	COARSE		

200 40 10 4 3/4" 3" 12"

U.S. STANDARD SERIES SIEVE — CLEAR SQUARE SIEVE OPENINGS

Figure8-1: Unclassified Soil Classification System (USCS)

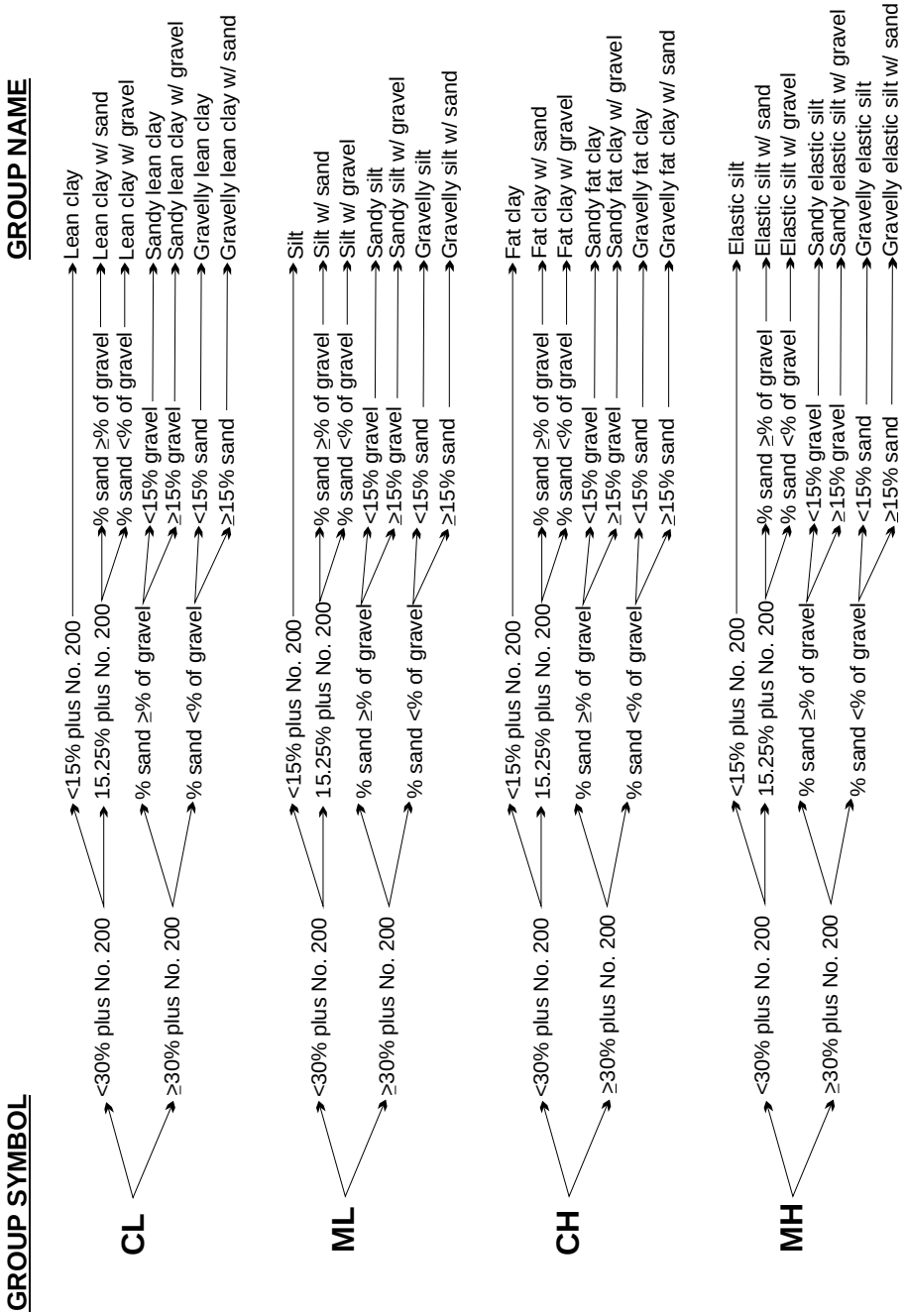


Figure 8-2: Flow Chart for Fine Grain Soil Classification

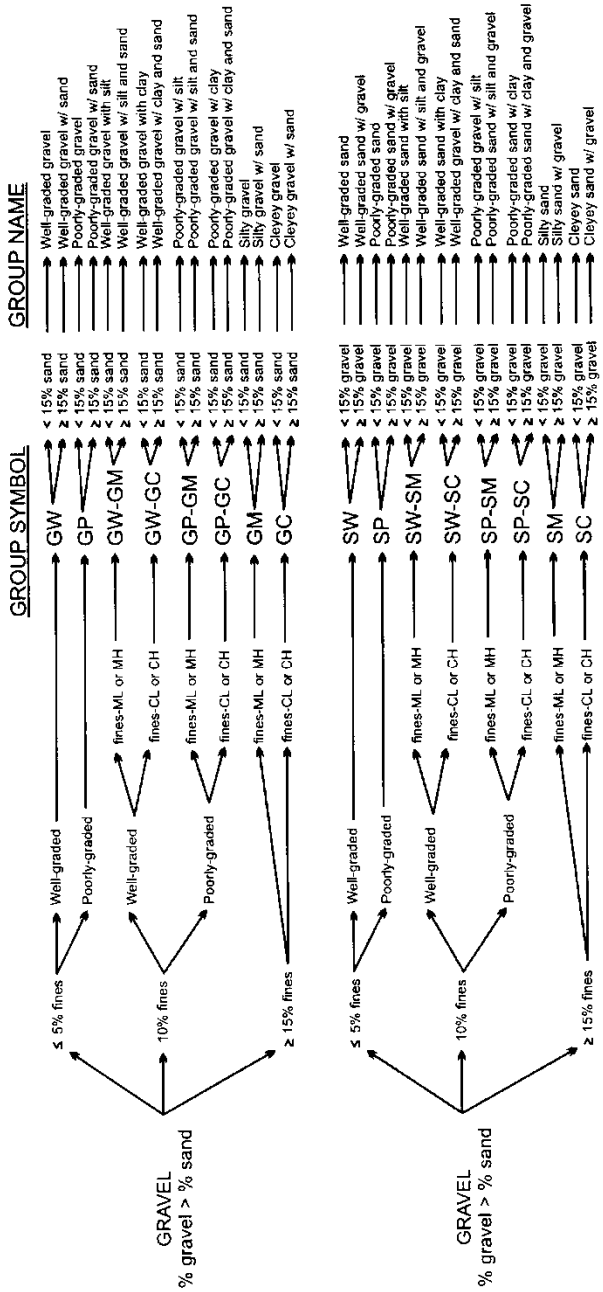


Figure 8-3: Flow Chart for Soil with Gravel

8.1.2.3 Plasticity

The plasticity of a soil is defined by the ability of the soil to deform without cracking, the range of moisture content over which the soil remains in a plastic state, and the degree of cohesiveness at the plastic limit. The plasticity characteristic of clays and other cohesive materials is defined by the liquid limit and plastic limit. The liquid limit is defined as the soil moisture content at which soil passes from the liquid to the plastic state as moisture is removed. The test for the liquid limit is a laboratory, not a field, analysis.

The plastic limit is the soil moisture content at which a soil passes from the plastic to the semi-solid state as moisture is removed. The plastic limit test can be performed in the field and is indicated by the ability to roll a 1/8-inch (0.125-inch) diameter thread of fines, the time required to roll the thread, and the number of times the thread can be re-rolled when approaching the plastic limit.

The plasticity tests are not based on natural soil moisture content, but on soil that has been thoroughly mixed with water. If a soil sample is too dry in the field, add water prior to performing classification. If a soil sample is too sticky, spread the sample thin and allow it to lose some soil moisture.

Table 8-3 presents the criteria for describing plasticity in the field using the rolled thread method.

Table 8-3: Criteria for Describing Plasticity

Description	Criteria
Non-Plastic	A 1/8-inch thread cannot be rolled.
Low Plasticity	The thread can barely be rolled.
Medium Plasticity	The thread is easy to roll and not much time is required to reach the plastic limit.
High Plasticity	It takes considerable time rolling the thread to reach the plastic limit.

8.1.3 **Angularity**

The following criteria describe the angularity of the coarse sand and gravel particles:

- **Rounded** particles have smoothly-curved sides and no edges.
- **Subrounded** particles have nearly plane sides, but have well-rounded corners and edges.
- **Subangular** particles are similar to angular, but have somewhat rounded or smooth edges.
- **Angular** particles have sharp edges and relatively plane sides with unpolished surfaces. Freshly broken or crushed rock would be described as angular.

8.1.4 **Color, Moisture, and Odor**

The natural moisture content of soil is very important. Table **8-4** shows the terms for describing the moisture condition and the criteria for each.

Table 8-4: Soil Moisture Content Qualifiers

Qualifier	Criteria
Dry	Absence of moisture, dry to the touch
Moist	Damp but no visible water
Wet	Visible water, usually soil is below water table

Color is described by hue and chroma using the Munsell Soil Color Chart (Munsell 2000). For uniformity, all site geologists shall utilize this chart for soil classification. Doing so will facilitate correlation of geologic units between boreholes logged by different geologists. The Munsell Color Chart is a small booklet of numbered color chips with names like “5YR 5/6, yellowish-red.” Note mottling or banding of colors. It is particularly important to note and describe staining because it may indicate contamination.

In general, wear a respirator if strong organic odors are present. If odors are noted, describe them if they are unusual or suspected to result from contamination. An organic odor may have the distinctive smell of decaying vegetation. Unusual odors may be related to hydrocarbons, solvents, or other chemicals in the subsurface. An organic vapor analyzer may be used to detect the presence of volatile organic contaminants.

8.1.5 In-Place Conditions

Describe the conditions of undisturbed soil samples in terms of their density/consistency (i.e., compactness), cementation, and structure utilizing the following guidelines:

8.1.5.1 Density/Consistency

Density and consistency describe a physical property that reflects the relative resistance of a soil to penetration. The term “density” is commonly applied to coarse to medium-grained sediments (i.e., gravels, sands), whereas the term “consistency” is normally applied to fine-grained sediments (i.e., silts, clays). There are separate standards of measure for both density and consistency that are used to describe the properties of a soil.

The density or consistency of a soil is determined by observing the number of blows required to drive a 1 3/8-inch (35 mm) diameter split barrel sampler 18 inches using a drive hammer weighing 140 lbs (63.5 kilograms [kg]) dropped over a distance of 30 inches (0.76 meters). Record the number of blows required to penetrate each 6 inches of soil in the field boring log during sampling. The first 6 inches of penetration is considered to be a seating drive; therefore, the blow count associated with this seating drive is recorded, but not used in determining the soil density/consistency. The sum of the number of blows required for the second and third 6 inches of penetration is termed the “standard penetration resistance,” or the “N-value.” The observed number of blow counts must be corrected by an appropriate factor if a different type of sampling device (e.g., Modified California Sampler with liners) is used. For a 2 3/8-inch inner diameter (I.D.) Modified California Sampler equipped with brass or stainless steel liners and penetrating a cohesionless soil (sand/gravel), the N-value from the Modified California Sampler must be divided by 1.43 to provide data that can be compared to the 1 3/8-inch diameter sampler data.

For a cohesive soil (silt/clay), the N-value for the Modified California Sampler should be divided by a factor of 1.13 for comparison with 1 3/8-inch diameter sampler data.

Drive the sampler and record blow counts for each 6-inch increment of penetration until one of the following occurs:

- A total of 50 blows have been applied during any one of the three 6-inch increments; a 50-blow count occurrence shall be termed “refusal” and noted as such on the boring log.
- A total of 150 blows have been applied.
- The sampler is advanced the complete 18 inches without the limiting blow counts occurring, as described above.

If the sampler is driven less than 18 inches, record the number of blows per partial increment on the boring log. If refusal occurs during the first 6 inches of penetration, the number of blows will represent the N-value for this sampling interval. Table 8-5 and Table 8-6 present representative descriptions of soil density/consistency vs. N-values.

Table 8-5: Measuring Soil Density with a California Sampler – Relative Density (Sands, Gravels)

Description	Field Criteria (N-Value)	
	1 3/8 in. ID Sampler	2 in. ID Sampler using 1.43 factor
Very Loose	0–4	0–6
Loose	4–10	6–14
Medium Dense	10–30	14–43
Dense	30–50	43–71
Very Dense	> 50	> 71

Table 8-6: Measuring Soil Density with a California Sampler – Fine Grained Cohesive Soil

Description	Field Criteria (N-Value)	
	1 3/8 in. ID Sampler	2 in. ID Sampler using 1.13 factor
Very Soft	0–2	0–2
Soft	2–4	2–4
Medium Stiff	4–8	4–9
Stiff	8–16	9–18
Very Stiff	16–32	18–36
Hard	> 32	> 36

For undisturbed fine-grained soil samples, it is also possible to measure consistency with a hand-held penetrometer. The measurement is made by placing the tip of the penetrometer against the surface of the soil contained within the sampling liner or shelby tube, pushing the penetrometer into the soil a distance specified by the penetrometer manufacturer, and recording the pressure resistance reading in pounds per square foot (psf). The values are as follows (Table 8-7):

Table 8-7: Measuring Soil Consistency with a Hand-Held Penetrometer

Description	Pocket Penetrometer Reading (psf)
Very Soft	0–250
Soft	250–500
Medium Stiff	500–1000
Stiff	1000–2000
Very Stiff	2000–4000
Hard	>4000

Consistency can also be estimated using thumb pressure using Table 8-8.

Table 8-8: Measuring Soil Consistency Using Thumb Pressure

Description	Criteria
Very Soft	Thumb will penetrate soil more than 1 inch (25 mm)
Soft	Thumb will penetrate soil about 1 inch (25 mm)
Firm	Thumb will penetrate soil about 1/4 inch (6 mm)
Hard	Thumb will not indent soil but readily indented with thumbnail
Very Hard	Thumbnail will not indent soil

8.1.5.2 *Cementation*

Cementation is used to describe the friability of a soil. Cements are chemical precipitates that provide important information as to conditions that prevailed at the time of deposition, or conversely, diagenetic effects that occurred following deposition. Seven types of chemical cements are recognized by Folk (1980). They are as follows:

- Quartz – siliceous
- Chert – chert-cemented or chalcedonic
- Opal – opaline
- Carbonate – calcitic, dolomitic, sideritic (if in doubt, calcareous should be used)
- Iron oxides – hematitic, limonitic (if in doubt, ferruginous should be used)
- Clay minerals – if the clay minerals are detrital or have formed by recrystallization of a previous clay matrix, they are not considered to be a cement. Only if they are chemical precipitates, filling previous pore space (usually in the form of accordion-like stacks or fringing radial crusts) should they be included as “kaolin-cemented,” “chlorite-cemented,” etc.
- Miscellaneous minerals – pyritic, collophane-cemented, glauconite-cemented, gypsiferous, anhydrite-cemented, baritic, feldspar-cemented, etc.

The degree of cementation of a soil is determined qualitatively by utilizing finger pressure on the soil in one of the sample liners to disrupt the gross soil fabric. The three cementation descriptors are as follows:

- Weak – friable; crumbles or breaks with handling or slight finger pressure
- Moderate – friable; crumbles or breaks with considerable finger pressure
- Strong – not friable; will not crumble or break with finger pressure

8.1.5.3 *Structure*

This variable is used to qualitatively describe physical characteristics of soil that are important to incorporate into hydrogeological and/or geotechnical descriptions of soil at a site. Appropriate soil structure descriptors are as follows:

- Granular – spherically shaped aggregates with faces that do not accommodate adjoining faces
- Stratified – alternating layers of varying material or color with layers at least 6 mm (1/4 inch) thick; note thickness
- Laminated – alternating layers of varying material or color with layers less than 6 mm (1/4 inch) thick; note thickness
- Blocky – cohesive soil that can be broken down into small angular or subangular lumps that resist further breakdown
- Lensed – inclusion of a small pocket of different soil, such as small lenses of sand, should be described as homogeneous if it is not stratified, laminated, fissured, or blocky. If lenses of different soil are present, the soil being described can be termed homogeneous if the description of the lenses is included
- Prismatic or Columnar – particles arranged about a vertical line, ped is bounded by planar, vertical faces that accommodate adjoining faces; prismatic has a flat top; columnar has a rounded top
- Platy – particles are arranged about a horizontal plane

8.1.5.4 Other Features

- Mottled – soil that appears to consist of material of two or more colors in blotchy distribution
- Fissured – breaks along definite planes of fracture with little resistance to fracturing (determined by applying moderate pressure to sample using thumb and index finger)
- Slickensided – fracture planes appear polished or glossy, sometimes striated (parallel grooves or scratches)

8.1.6 **Development of Soil Description**

Develop standard soil descriptions according to the following examples. There are three principal categories under which all soil can be classified. They are described below.

8.1.6.1 Coarse-grained Soil

Coarse-grained soil is divided into sands and gravels. A soil is classified as a sand if over 50 percent of the coarse fraction is "sand-sized." It is classified as a gravel if over 50 percent of the coarse fraction is composed of "gravel-sized" particles.

The written description of a coarse-grained soil shall contain, in order of appearance: Typical name including the second highest percentage constituent as an adjective, if applicable (underlined); grain size of coarse fraction; Munsell color and color number; moisture content; relative density; sorting; angularity; other features, such as stratification (sedimentary structures) and cementation, possible formational name, primary USCS classification, secondary USCS classification (when necessary), and approximate percentages of minor constituents (i.e., sand, gravel, shell fragments, rip-up clasts) in parentheses.

Example: POORLY-SORTED SAND WITH SILT, medium- to coarse-grained, light olive gray, 5Y 6/2, saturated, loose, poorly sorted, subrounded clasts, SW/SM (minor silt with approximately 20 percent coarse-grained sand-sized shell fragments, and 80 percent medium-grained quartz sand, and 5 percent to 15 percent ML).

8.1.6.2 Fine-grained Soil

Fine-grained soil is further subdivided into clays and silts according to its plasticity. Clays are rather plastic, while silts have little or no plasticity.

The written description of a fine-grained soil should contain, in order of appearance: Typical name including the second highest percentage constituent as an adjective, if applicable (underlined); Munsell color; moisture content; consistency; plasticity; other features, such as stratification, possible formation name, primary USCS classification, secondary USCS classification (when necessary), and the percentage of minor constituents in parentheses.

Example: SANDY LEAN CLAY, dusky red, 2.5 YR 3/2, moist, firm, moderately plastic, thinly laminated, CL (70 percent fines, 30 percent sand, with minor amounts of disarticulated bivalves [about 5 percent]).

8.1.6.3 Organic Soil

For highly organic soil, describe the types of organic materials present as well as the type of soil constituents present using the methods described above. Identify the soil as an organic soil, OL/OH, if the soil contains enough organic particles to influence the soil properties. Organic soil usually has a dark brown to black color and may have an organic odor. Often, organic soils will change color, (e.g., from black to brown) when exposed to air. Some organic soils will lighten in color significantly when air-dried. Organic soils normally will not have a high toughness or plasticity. The thread for the toughness test will be spongy.

8.2 Example: ORGANIC CLAY, black, 2.5Y, 2.5/1, wet, soft, low plasticity, organic odor, OL (100 percent fines), weak reaction to HCl.

8.3 Rock Classification

The purpose of rock classification is to thoroughly describe the physical and mineralogical characteristics of a specimen and to classify it according to an established system. The generalized rock classification system described below was developed because, unlike the USCS for soils, there is no universally accepted rock classification system. In some instances, a more detailed and thorough rock classification system may be appropriate. Any modifications to this classification system, or the use of an alternate classification system should be considered during preparation of the site work plan. Both the CTO Manager and the QA Manager or Technical Director must approve any modifications to this classification system, or the use of another classification system.

Describing rock specimens on a common basis is essential so that rocks described by different site geologists are comparable. Site geologists describing rock specimens as a part of investigative activities must use the classification system described herein, or if necessary, another more detailed classification system. Use of a common classification system provides the most useful geologic database for all present and future subsurface investigations and remedial activities.

In order to provide a more consistent rock classification between geologists, a rock classification template has been designated as shown in **Error! Reference source not found.**. The template includes classification of rocks by origin and mineralogical composition. When classifying rocks, all site geologists shall use this template.

The site geologist shall describe the rock specimen and record the description in a boring log or logbook. The items essential for classification include (i.e., metamorphic foliated):

- Classification Name (i.e., schist)
- Color
- Mineralogical composition and percent
- Texture/Grain size (i.e., fine-grained, pegmatitic, aphlitic, glassy)
- Structure (i.e., foliated, fractured, lenticular)
- Rock Quality Designation (sum of all core pieces greater than two times the diameter of the core divided by the total length of the core run, expressed as a percentage)
- Classification symbol (i.e., MF)

Example: Metamorphic foliated schist: Olive gray, 5Y, 3/2, Garnet 25 percent, Quartz 45 percent, Chlorite 15 percent, Tourmaline 15 percent, Fine-grained with Pegmatite garnet, highly foliated, slightly wavy, MF.

9.0 Quality Control and Assurance

None

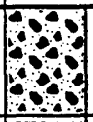
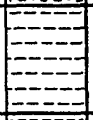
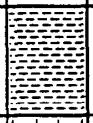
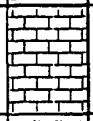
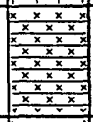
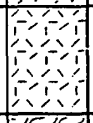
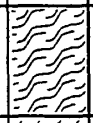
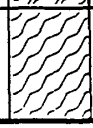
DEFINITION OF TERMS					
PRIMARY DIVISIONS			SYMBOLS		SECONDARY DIVISIONS
SEDIMENTARY ROCKS	Clastic Sediments	CONGLOMERATE		CG	Coarse-grained Clastic Sedimentary Rock types including: Conglomerates and Breccias
		SANDSTONE		SS	Clastic Sedimentary Rock types including: Sandstone, Arkose and Greywacke
		SHALE		SH	Fine-grained Clastic Sedimentary Rock types including: Shale, Siltstone, Mudstone and Claystone
	Chemical Precipitates	CARBONATES		LS	Chemical Precipitates including: Limestone, Crystalline Limestone, Fossiliferous Limestone Micrite and Dolomite
		EVAPORITES		EV	Evaporites including: Anhydrite, Gypsum, Halite, Travertine and Caliche
IGNEOUS ROCKS		EXTRUSIVE (Volcanic)		IE	Volcanic Rock types including: Basalt, Andesite, Rhyolite, Volcanic Tuff, and Volcanic Breccia
		INTRUSIVE (Plutonic)		II	Plutonic Rock types including: Granite, Diorite and Gabbro
METAMORPHIC ROCKS		FOLIATED		MF	Foliated Rock types including: Slate, Phyllite, Schist and Gneiss
		NON-FOLIATED		MN	Non-foliated Rock types including: Metaconglomerate, Quartzite and Marble

Figure 8-4: Rock Classification System

10.0 Data and Records Management

10.1 Document soil classification information collected during soil sampling onto the field boring logs, field trench logs, and into the field notebook. Copies of this information shall be sent to the **CTO Manager** for the project files.

10.2 Field notes will be kept during coring activities in accordance with SOP 3-03 – Recordkeeping, Sample Labeling, and Chain of Custody. The information pertinent to soil classification activities includes chronology of events, sample locations (x,y,z), time/date, sampler name, methods (including type of core liner/barrel, if applicable), sampler penetration and acceptability, sample observations, and the times and type of equipment decontamination. Deviations to the procedures detailed in the SOP should be recorded in the field logbook.

11.0 Attachments or References

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Author	*Reviewer*	*Revisions (Technical or Editorial)*
Robert Shoemaker Senior Scientist	Naomi Ouellette, Project Manager	Rev 0 – Initial Issue