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NAS CECIL FIELD
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LETTER SUBMITTING DRAFT SAMPLING AND ANALYSIS PLAN FOR PETROLEUM SITES NORTH SOUTH APRON, BUILDING 82, BP WELL SITE, HANGAR 815 WASH RACK, TANKS 81, A B, AND C, SOUTH FUEL FARM, OCALA CRASH SITE NAS CECIL FIELD FL
1/30/2013
RESOLUTIONS

7775 Baymeadows Way, Suite 104
Jacksonville, Florida 32256
T. 904/367-4324
F. 904/367-4328

January 30, 2013

Mr. Art Sanford
BRAC Program Management Office
4130 Faber Place Drive
North Charleston, South Carolina 29405

Reference: CLEAN Contract No. N62470-11-D-8013
CTO JM34

Subject: Draft Sampling and Analysis Plan for Petroleum Sites – North-South Apron; Building 82, Tank G82; BP Wells; Hangar 815 Wash Rack; Tanks 81 A, B, and C; South Fuel Farm; and Ocala Crash Site
Former NAS Cecil Field
Jacksonville, Florida

Mr. Sanford:

Resolution Consultants is pleased to submit the Draft Sampling and Analysis Plan for Petroleum Sites – North-South Apron; Building 82, Tank G82; BP Wells; Hangar 815 Wash Rack; Tanks 81 A, B, and C; South Fuel Farm; and Ocala Crash Site at Former NAS Cecil Field, Jacksonville, Florida. This document has been reviewed by the Navy Chemist and her comments have been incorporated into the document.

Copies have been sent to the members of the NAS Cecil Field Partnering Team for their review and comment. Regulatory review and corresponding approval or comment letter is requested. Changes will be made based on any comments received, and incorporated into the Draft Final document. The Draft Final version will be reviewed and if any changes are approved, a Final version will be created and signed by all persons named on the title page prior to final distribution and implementation.

If you should have any questions, please feel free to contact me at (904) 367-4324 or via email at kwimble@ensafe.com.

Sincerely,

Resolution Consultants,

Kara F. Wimble

By: Kara F. Wimble
Project Manager

Enclosure

cc:

RESOLUTION CONSULTANTS

7775 Baymeadows Way, Suite 104
Jacksonville, Florida 32256
T. 904/367-4324
F. 904/367-4328

David Criswell (CD and electronic)
Art Sanford (CD and electronic)
Debbie Vaughn-Wright (Hardcopy and Electronic)
David Grabka (Hardcopy and Electronic)

Project File (EnSafe Project N8013-JM34-20130130)

RESOLUTION
CONSULTANTS

DRAFT
SAMPLING AND ANALYSIS PLAN
PETROLEUM SITES: NORTH-SOUTH APRON; BUILDING 82, TANK G82; BP WELLS; HANGAR 815 WASH RACK; TANKS 81 A, B, C; SOUTH FUEL FARM; AND OCALA F-18 CRASH SITE

FORMER NAVAL AIR STATION CECIL FIELD
JACKSONVILLE, FLORIDA

Version Number: 0

Prepared For:

Department of the Navy
BRAC Program Management Office Southeast
4130 Faber Place Drive
North Charleston, South Carolina 29405

and

Naval Facilities Engineering Command Southeast
Bldg. 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 JM34

January 2013

SAP WORKSHEET #1: TITLE AND APPROVAL PAGE

(UFP-QAPP Manual Section 2.1)

SAMPLING AND ANALYSIS PLAN
PETROLEUM SITES: NORTH-SOUTH APRON;
BUILDING 82, TANK G82;
BP WELLS; HANGAR 815 WASH RACK; TANKS 81 A, B, C;
SOUTH FUELFARM; AND OCALA F-18 CRASH SITE

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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 JM34

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

NAVFAC Atlantic Chemist
QA Officer/Chemist/Date

SANFORD.ARTHUR.F.1229009083 Digitally signed by SANFORD.ARTHUR.F.1229009083 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=CONTRACTOR, cn=SANFORD.ARTHUR.F.1229009083 Date: 2013.01.29 15:07:49 -05'00'

Kara Wimble, Resolution Consultants
Task Order Manager/Date

Art Sanford, NAVFAC Southeast
Remedial Project Manager/Date

David Grabka, FDEP
Remedial Project Manager/Date

EXECUTIVE SUMMARY

Resolution Consultants has prepared this Uniform Federal Policy Sampling and Analysis Plan (SAP) for long-term monitoring (LTM) for petroleum sites at the former Naval Air Station (NAS) Cecil Field, under Contract No. N62470-08-D-1001, Comprehensive Long-term Environmental Action Navy, Contract Task Order JM34. These sites include: North-South Apron Plume (NSAP); Building 82, Tank G82; British Petroleum (BP) Wells; Hangar 815 Wash Rack; Tanks 81 A, B, C; the South Fuel Farm (SFF); and the Ocala F-18 Crash site located in the Ocala National Forest, near Ocala, Florida.

This SAP follows the format of the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) and was prepared to address several ongoing LTM activities at the former NAS Cecil Field, including the F-18 Crash site in the Ocala National Forest in Ocala, Florida. The sites addressed in this SAP are under the Florida Department of Environmental Protection (FDEP) Petroleum Program based on the contaminants of concern at the sites.

- The NSAP is located on the north-south flight line, east of Building 815, on the eastern edge of the apron. Benzene was detected in one direct push technology groundwater sample in this area during sampling for the *Sampling and Analysis Outline and Report for the Main Base Open Area 18* (Harding Lawson and Associates, 1999). The groundwater concentrations of benzene continue to exceed the Florida Department of Environmental Protection (FDEP) Groundwater Cleanup Target Level (GCTL) in the intermediate zone of the surficial aquifer. Annual monitoring is conducted to verify that the contaminant does not migrate off site.

  The Building 82, Tank G82 site is comprised of an air traffic control tower and underground storage tank (UST), which was used to store diesel fuel for emergency generators. Tank G82 was removed in June 1997. Soil and groundwater have been impacted near the UST as a result of leaks originating from Tank G82. The groundwater concentrations of polynuclear aromatic hydrocarbons and volatile organic compounds (VOCs) exceed their respective FDEP GCTL in the shallow zone of the surficial aquifer. Semi-annual monitoring is conducted to verify that contaminants do not migrate offsite.

- The British Petroleum (BP) Wells area is located on the north-south flight line, southeast of Building 880, on the western edge of the apron. The BP Wells area is associated with an area formerly consisting of secondary containment for several large above ground storage tanks (ASTs) that served to refuel planes and other vehicles. The ASTs and secondary containment have been removed and a newly constructed hangar is located on top of the

current plume. Active remediation occurred at the site using DPT via injections in 2011. Post remediation monitoring is currently being conducted at the site to monitor the effectiveness of the remediation activities.

- Building 815 is a maintenance hangar and is located at the northern end of the flight line, at the eastern end of Lake Newman Street (formerly 6th Street). There was an aircraft wash rack to the north of the hangar on a concrete apron. Naphthalene contamination, most likely due to residual petroleum products in the runoff, was identified in the groundwater monitoring wells at the wash rack in the 1999 *Sampling and Analysis Report for Hangar 815 (TtNUS, 1999)*. There are no tanks associated with this particular area of contamination. Annual monitoring is conducted to verify that the contaminant does not migrate offsite.

- Former Tanks 81 A, B, and C were three ASTs located northwest of Building 81. Tanks 81 A, B, and C were contained in a secondary concrete containment pit that was approximately 2 feet deep. There is limited available information about the construction or possible contents of the three ASTs kept in this pit. No structures are currently located on the site. Semi-annual monitoring for isopropylbenzene is conducted to verify that the contaminant does not migrate offsite.

- SFF, which was used as a fuel storage facility for leaded and unleaded gasoline, fuel, and jet propellant, is located at the northern edge of the east-west runway. The site contained three ASTs, four USTs, and four earth-mounded tanks (EMTs) [Bechtel Environmental, Inc. (BEI), 1998]. By 1994, all tanks but one of the EMTs had been removed from the site, and investigations followed to determine the extent of contamination at the site. The fourth EMT was removed at a later date. A 1996 *Remedial Action Plan* (RAP) (ABB Environmental Services, Inc., 1996) recommended bioventing and biosparging combined with an oxygen barrier wall, which was selected for the northern portion of the site; soil excavation was recommended and selected for the southern portion. Beginning in October 1998, 28,953 tons of petroleum-impacted soil was excavated from the southern portion of the site (CH2M HILLConstructors, Inc., 2001). BEI completed installation of the approved bioventing and biosparging systems for the northern portion of the SFF site in March 1998, startup occurred in April 1998 (BEI, 1998), and the system was shut down in August 2007 (CH2M HILL Constructors, Inc., 2009). Post-active remediation monitoring results indicated that the soils in the northern portion of the site are clean, and that groundwater contains concentrations of VOCs, total recoverable petroleum hydrocarbons (TRPH) and naphthalene. A *Site Assessment Report* presented the wells that posed a concern during the site assessment, and specified all contaminants of concerns (TtNUS NUS, Inc., 2011), and recommended long-term monitoring at the site.

Groundwater will continue to be sampled semi-annually at six shallow monitoring wells for select VOCs, TRPH, and naphthalene.

- The Ocala F-18 Crash Site is located in the Ocala National Forest approximately 82 miles south of NAS Cecil Field and approximately 22 miles southeast of Ocala, Florida. A site assessment was conducted in February 1995 to investigate the area where a Navy F-18 jet, based at and flying from NAS Cecil Field, crashed in Ocala National Forest. In 2009, supplemental soil sampling attempted to identify a continuing source to the groundwater contamination. Recent groundwater sampling has been conducted, with contaminants of concerns being benzene, toluene, ethylbenzene, and xylenes; isopropylbenzene; 1,3,5-Trimethylbezene; 1,2,4-Trimethylbezene; naphthalene; 1-methylnaphthalene; and 2-methylnaphthalene. This SAP describes semi-annual sampling at two wells to verify that contamination is not migrating offsite, to confirm whether natural attenuation is occurring, and to allow for the monitoring of potential seasonal fluctuations.

This SAP was generated for, and complies with, applicable Navy, United States Environmental Protection Agency (USEPA) Region 4, and FDEP requirements, regulations, guidance, and technical standards, as appropriate. This includes the Department of Defense, Department of Energy, and USEPA Interagency Data Quality Task Force environmental requirements regarding federal facilities, as specified in the UFP-QAPP guidance (USEPA, 2005).

This SAP outlines the organization, project management, objectives, planned activities, measurement, data acquisition, assessment, oversight, and data review procedures associated with the LTM. Protocols for sample collection, handling, and storage, chain of custody, laboratory and field analyses, data validation, and reporting are also addressed. Field activities conducted under this SAP will be conducted in accordance with Resolution Consultants and FDEP Standard Operating Procedures and will meet the requirements of the *Site-Specific Health and Safety Plan*, prepared under separate cover.

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Appendices

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Acronyms and Abbreviations

%D	Percent difference/percent drift
%R	Percent recovery
%RSD	Percent relative standard deviation
ABB-ES	ABB Environmental Services, Inc.
AVS	Acid volatile sulfide
AVS/SEM	Acid volatile sulfide and simultaneously extracted metals
BCT	Base Cleanup Team
BEI	Bechtel Environmental, Inc.
bgs	Below ground surface
BP	British Petroleum
BRAC BCT	Base Realignment and Closure Base Cleanup Team
BS	Biosparging
CAR	Contamination Assessment Report
CAS No.	Chemical Abstract Services number
CCV	Continuing calibration verification
CLEAN	Comprehensive Long-term Environmental Action Navy
COC	Chemicals of concern
CSM	Conceptual site model
CV	Calibration verification
DDT	Dichlorodiphenyltrichloroethane
DFTPP	Decafluorotriphenylphosphine
DoD ELAP	DoD Environmental Laboratory Accreditation Program
DoD QSM	Department of Defense Quality Systems Manual
DoD	Department of Defense
DPT	Direct Push Technology
DQO	Data Quality Objective
EBS	Environmental Baseline Study
EICP	Extracted ion current profile
Empirical	Empirical Laboratories, LLC
EMT	Earth mounded tank
FDEP	Florida Department of Environmental Protection
FID	Flame ionization detector
FOL	Field Operation Leader
FS	Feasibility Study
FTL	Field team leader
FTMR	Field Task Modification Report
GC	Gas chromatography
GC/MS	Gas chromatograph/mass spectrometer
GCTL	Groundwater Cleanup Target Levels
GWMR	Groundwater Monitoring Report
HSO	Health and safety officer

ICAL	Initial calibration
ICV	Initial calibration verification
IDW	Investigative derived waste
JAA	Jacksonville Aviation Authority
JEDC	Jacksonville Economic Development Commission
LCS	Laboratory control sample
LCS/LCSD	Laboratory control sample/laboratory control sample duplicate
LOQ	Limit of quantitation
LTM	long-term groundwater monitoring
LUC	Land use controls
mg/l	Milligram per liter
MNA	Monitored Natural Attenuation
MS	Mass spectrometry
MS/MSD	Matrix spike/matrix spike duplicate
NA	Not applicable
NADC	Natural Attenuation Default Concentrations
NAMP	Natural Attenuation Monitoring Plan
NAMPAO	Natural Attenuation Monitoring Plan Approval Order
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
NIRIS	Naval Installation Restoration Information Solution
NSAP	North-South Apron Plume
NTU	Nephelometric Turbidity Unit
PAH	Polynuclear aromatic hydrocarbons
PAL	Project Action Limit
PARM	Post-active remediation monitoring
PCB	Polychlorinated biphenyl
PM	Project manager
QA	Quality assurance
QAO	Quality assurance officer
QC	Quality control
QSM	Quality Systems Manual
R	Rejection
RAP	Remedial Action Plan
RF	Response factor
RMO	Risk Management Option
RPD	Relative percent difference
RPM	Remedial project manager
RRT	Relative retention time
SAP	Sampling and analysis plan
SCTL	Soil Cleanup Target Level
SE	Southeast
SEM	Simultaneously extracted metals

SFF	South Fuel Farm
SIM	Selective ion monitoring
SIM-PAH	Selective ion monitoring polynuclear aromatic hydrocarbon
SOP	Standard operating procedure
SPCC	System Performance Check Compound
SSO	Site safety officer
SVOC	Semi-volatile organic compound
TtNUS	Tetra Tech NUS, Inc.
TFM	Transportation and Fuel Management
TMB	1, 2, 4-trimethylbenzene
TOM	Task order manager
TRPH	Total Recoverable Petroleum Hydrocarbons
UFP-QAPP	Uniform Federal Policy for Quality Assurance Plans
USEPA	United States Environmental Protection Agency
UST	Underground storage tank
VOC	Volatile organic compound

SAP WORKSHEET #2: SAMPLING AND ANALYSIS PLAN IDENTIFYING INFORMATION

(UFP-QAPP Manual Section 2.2.4)

Site Names/Numbers: North-South Apron Plume (NSAP); Building 82, Tank G82; British Petroleum (BP) Wells; Hangar 815 Wash Rack; Tanks 81 A, B, C; South Fuel Farm (SFF); and Ocala F-18 Crash site

Operable Units: Not applicable

Contractor Name: Resolution Consultants

Contract Number: N62470-08-D-1001

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

Work Assignment No: Contract Task Order JM34

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)* (USEPA 2005) and United States Environmental Protection Agency (USEPA) *Guidance for Quality Assurance Project Plans, USEPA QA/G-5* (EPA 2002).

2. Identify regulatory program: National Oil and Hazardous Substances Pollution Contingency Plan; Comprehensive Environmental Response, Compensation, and Liability Act of 1980; Florida DEP 62-777, Florida Administrative Code F.A.C.

3. This SAP is a project-specific SAP.

4. List organizational partners (stakeholders) and identify the connection with lead organization:

Organization Partners/Stakeholders	Connection
Navy Base Realignment and Closure (BRAC) Program Management Office (PMO) Southeast	Former Property Owner
Florida Department of Environmental Protection	Regulatory Stakeholder
USEPA Region 4	Regulatory Stakeholder
Jacksonville Aviation Authority (JAA)	Property Owner of BP Wells, 815 Wash Rack, Tanks G82, South Fuel Farm, and North-South Apron
City of Jacksonville	Property Owner of Tanks 81 ABC

5. Lead organization: BRAC PMO — Southeast

6. If any required SAP elements and 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: Not Applicable (NA), as there are no exclusions.

SAP WORKSHEET #3: DISTRIBUTION LIST

(UFP-QAPP Manual Section 2.3.2)

SAP Recipients	Title	Organization	Telephone Number (optional)	Email Address or Mailing Address
Art Sanford	Navy Remedial Project Manager	Navy Base Realignment and Closure Project Management Office, Southeast 4130 Faber Place Drive Suite 202 North Charleston, South Carolina 29405	843-743-2135	art.sanford.ctr@navy.mil
Deborah Vaughn-Wright	USEPA Remedial Project Manager	USEPA Region 4 Atlanta Federal Center 61 Forsyth St. S.W Atlanta GA 30303	404-562-8539	vaughn-wright.debbie@epa.gov
David Grabka	FDEP Remedial Project Manager	Florida Department of Environmental Protection MS 4535 2600 Blair Stone Road Tallahassee, Florida 32399-2400	850-245-8997	david.grabka@dep.state.fl.us
David Criswell	Navy BRAC Environmental Coordinator	Navy Base Realignment and Closure Project Management Office, Southeast 4130 Faber Place Drive Suite 202 North Charleston, South Carolina 29405	843-743-2130	David.criswell@navy.mil
Rusty Chandler	Jacksonville Airport Authority Point of Contact	13365 Aeronautical Circle Jacksonville, Florida 32221	904-573-1606	rchandler@jaa.aero
Bonnie Capito	Librarian and Records Manager	Naval Facilities Engineering Command Code 1832 5l0 Gilbert Street Norfolk, Virginia 23511-2699	757-322-4785	bonnie.capito@navy.mil
Kara Wimble	Task Order Manager	Resolution Consultants 7775 Baymeadows Way, Suite 104 Jacksonville, Florida 32256	904-367-4324	kwimble@ensafe.com

SAP Recipients	Title	Organization	Telephone Number (optional)	Email Address or Mailing Address
Robert Bailey	Field Team Leader/Site Safety Officer	Resolution Consultants 7775 Baymeadows Way, Suite 104 Jacksonville, Florida 32256	904-367-4324	rbailey@ensafe.com
Tina Cantwell	Project Chemist/Quality Assurance Officer/Data Manger	Resolution Consultants 5724 Summer Trees Drive Memphis, Tennessee 38134	901-937-4315	tcantwell@ensafe.com
Sonya Gordon	Project Manager	Empirical Laboratories, LLC (Empirical) 621 Mainstream Drive, Suite 270 Nashville, Tennessee 37228	615-345-1115	sgordon@empirlabs.com

Notes:

BRAC = Base Realignment and Closure
USEPA = United States Environmental Protection Agency
FDEP = Florida Department of Environmental Protection
SAP = Sampling and Analysis Plan
LLC = Limited Liability Corporation

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 or emails will constitute verification that applicable sections of the SAP have been reviewed. Copies of regulatory agency approval letters/emails will be retained in the project files and are listed in Worksheet #29 as project records.

2. Emails will be sent to the Navy, Resolution Consultants, and subcontractor project personnel who will be requested to verify by email that they have read the applicable SAP/sections and the date on which they were reviewed. Copies of the verification email will be included in the project files and is 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.

Project Personnel Sign-Off Sheet					
Name	**Organization/Title/Role**	**Telephone Number**	**Signature/Email Receipt**	**SAP Section Reviewed**	**Date SAP Read**
Navy and Regulator Partnering Team Personnel					
Art Sanford	Navy/Remedial Project Manager	843-743-2135		All	
David Criswell	Navy/BRAC Environmental Coordinator	843-743-2130		All	
David Grabka	FDEP/Remedial Project Manager	850-245-8997		All	
Deborah Vaughn-Wright	USEPA/Remedial Project Manager	404-562-8539		All	

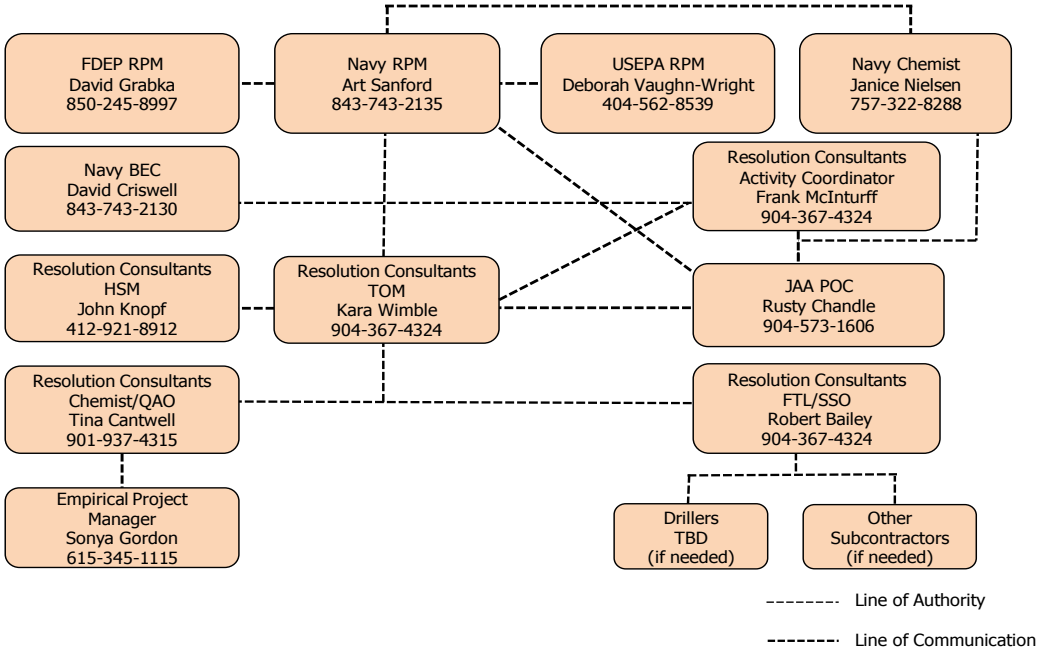
Project Personnel Sign-Off Sheet					
Name	**Organization/Title/Role**	**Telephone Number**	**Signature/Email Receipt**	**SAP Section Reviewed**	**Date SAP Read**
Resolution Consultants' Partnering Team Personnel					
Kara Wimble	Resolution Consultants/Task Order Manager	904-367-4324		All	
Robert Bailey	Resolution Consultants/Field Team Leader/ Site Safety Officer	904-367-4324		All	
Tina Cantwell	Resolution Consultants/Chemist/Quality Assurance Officer/Data Manager	901-937-4315		All	
Subcontractor Personnel					
Sonya Gordon	Empirical Laboratory Project Manager	615-345-1115		Worksheets #6, #12, #14, #15, #19, #20, #23-28, #30, and #34-36	

Notes:

USEPA = United States Environmental Protection Agency
Empirical = Empirical Laboratories LLC
FDEP = Florida Department of Environmental Protection
BRAC = Base Realignment and Closure
SAP = Sampling and Analysis Plan

SAP WORKSHEET #5: PROJECT ORGANIZATIONAL CHART

(UFP-QAPP Manual Section 2.4.1)



Notes:

RPM	=	Remedial Project Manager	BEC	=	Base Realignment and Closure Environmental Coordinator
HSM	=	Health & Safety Manager	FTL	=	Field Team Leader
SSO	=	Site Safety Officer	QAO	=	Quality Assurance Officer
TBD	=	To be determined	USEPA	=	U.S. Environmental Protection Agency
POC	=	Point of Contact	FDEP	=	Florida Department of Environmental Protection
JAA	=	Jacksonville Aviation Authority			
DVM	=	Data Validation Manager			

SAP WORKSHEET #6: COMMUNICATION PATHWAYS

(UFP-QAPP Manual Section 2.4.2)

The communication pathways for the SAP are shown below.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Regulatory Agency Interface	USEPA RPM FDEP RPM Navy RPM	Deborah Vaughn-Wright David Grabka Art Sanford	404-562-8539 850-245-8997 843-743-2135	The Navy RPM informs the regulatory agencies of work progress on a periodic basis.
Progress Reports	Resolution Consultants TOM Resolution Consultants FTL	Kara Wimble Robert Bailey	904-367-4324 904-367-4324	The Resolution Consultants FTL verbally informs the TOM on a daily basis. TOM provides weekly update to the RPM either by phone message and/or email each Friday afternoon field activities are taking place.
Gaining Site Access	Resolution Consultants FTL JAA POC	Robert Bailey Rusty Chandler	904-367-4324 904-573-1613	The Resolution Consultants FTL will contact the JAA point of contact verbally or via email at least three business 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 FTL JAA POC	Robert Bailey Rusty Chandler	904-367-4324 904-573-1613	The Resolution Consultants FTL will coordinate verbally or via email with JAA point of contact at least 14 calendar days in advance of site access to initiate the utility clearance process for all intrusive sampling locations.
Stop Work Due to Safety Issues	Resolution Consultants TOM Resolution Consultants FTL/SSO Resolution Consultants QAO Resolution Consultants HSO Navy RPM JAA POC	Kara Wimble Robert Bailey Tina Cantwell John Knopf Art Sanford Rusty Chandler	904-367-4324 904-367-4324 901-937-4315 901-937-4255 843-743-2135 904-573-1613	The responsible party verbally informs the FTL, TOM, and subcontractors within 1 hour on recommendation to stop work and within 24 hours of recommendation to restart work. Responsible party follows verbal notification with an email to the Project Team within 24 hours. If a subcontractor is the responsible party, the subcontractor PM must verbally inform Resolution Consultants SSO within 15 minutes, and the Resolution Consultants SSO will then follow the procedure listed above.
SAP Changes Prior to Field/ Laboratory Work	Resolution Consultants TOM Resolution Consultants FTL Navy RPM	Kara Wimble Robert Bailey Art Sanford	904-367-4324 904-367-4324 843-743-2135	Any change of the approved SAP will be made only upon authorization of the Navy RPM and regulatory agencies. The Resolution Consultants TOM is responsible for initiating any SAP change requests via the communication channels described for the Navy and regulatory agencies.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
SAP Changes in the Field	Resolution Consultants TOM Resolution Consultants FTL Navy RPM	Kara Wimble Robert Bailey Art Sanford	904-367-4324 904-367-4324 843-743-2135	FTL informs TOM verbally within the same day; TOM informs Navy RPM via email within 24 hours; TOM sends a field task modification form to RPM, if warranted, within seven calendar days and RPM signs the letter within five business days of receipt. Scope change is to be implemented before work is executed. Document the change on a field task modification request form (within two business days) or SAP amendment (within timeframe agreed to by Project Team).
Field Corrective Actions	Resolution Consultants TOM Resolution Consultants FTL Navy RPM	Kara Wimble Robert Bailey Art Sanford	904-367-4324 904-367-4324 843-743-2135	FTL informs TOM verbally within the same day; TOM informs Navy RPM via email within 24 hours that corrective actions have been implemented. Corrective actions will be documented in weekly progress reports. Navy RPM will notify EPA/FDEP of any significant corrective actions taken.
Recommendations to stop work and initiate work upon corrective action	Resolution Consultants FTL/SSO Resolution Consultants TOM Resolution Consultants QAO Navy RPM	Robert Bailey Kara Wimble Tina Cantwell Art Sanford	904-367-4324 904-367-4324 901-937-4315 843-743-2135	Responsible party verbally informs the TOM, FTL, and subcontractors within 1 hour of recommendation to stop work and within 24 hours of recommendation to restart work. Responsible party follows verbal notification with an email to the Project Team within 24 hours.
Sample Receipt and Laboratory Quality Variances	Resolution Consultants TOM Resolution Consultants FTL Empirical Laboratories PM	Kara Wimble Robert Bailey Sonya Gordon	904-367-4324 904-367-4324 877-345-1113 ext. 238	The Laboratory PM will notify (verbally or via email the Resolution Consultants FTL immediately upon receipt of any chain of custody/sample receipt variances for clarification or direction from the Resolution Consultants FTL. The Resolution Consultants FTL will notify (verbally or via email) the Resolution Consultants TOM within one business day, if corrective action is required. The Resolution Consultants TOM will notify (verbally or via email) the Laboratory PM and the Resolution Consultants FTL within one business day of any required corrective action.
Analytical Corrective Actions	Empirical Laboratory PM Resolution Consultants Project Chemist	Sonya Gordon Tina Cantwell	877-345-1113 ext. 238 901-937-4315	The laboratory shall notify the Resolution Consultants' chemist of any analytical data anomaly within one business day of discovery. After the laboratory receives guidance from the Resolution Consultants' chemist, the laboratory shall initiate any corrective action to prevent further anomalies.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Analytical Data Quality Issues	Empirical Laboratory PM Resolution Consultants Project Chemist Resolution Consultants TOM Navy RPM	Sonya Gordon Tina Cantwell Kara Wimble Art Sanford	877-345-1113 ext. 238 901-937-4315 904-367-4324 843-743-2135	The laboratory PM notifies (verbally or via email) the Resolution Consultants' chemist within one business day of when an issue related to laboratory data is discovered. Resolution Consultants' chemist notifies Resolution Consultants' TOM within one business day. Resolution Consultants' chemist notifies the Resolution Consultants' TOM verbally or via email 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. Resolution Consultants' TOM verbally advises the Navy RPM within 24 hours of notification from the chemist. The Navy RPM takes corrective action that is appropriate for the identified deficiency.
Reporting Data Validation Issues/Data Validation Corrective Actions	Resolution Consultants Project Chemist Resolution Consultants TOM	Tina Cantwell Kara Wimble	901-937-4315 904-367-4324	The Resolution Consultants project chemist or data validator will perform validation as specified in Worksheets #34, #35, and #36, and will contact the laboratory as soon as possible if issues are found that require corrective action. If the Resolution Consultants project chemist or data validator identifies non-usable data during the data validation process that requires corrective action, the Resolution Consultants TOM will coordinate with the project chemist to take corrective action appropriate for the identified deficiency to ensure the project objectives are met. Corrective action may include resampling and/or reanalyzing the affected sample, as determined by the Resolution Consultants TOM.

Communication Drivers	Responsible Entity	Name	Phone Number	Procedure (Timing, Pathway To/From, etc.)
Notification of Non-Usable Data	Empirical Laboratory PM Resolution Consultants Project Chemist Resolution Consultants TOM Navy RPM USEPA RPM FDEP RPM	Sonya Gordon Tina Cantwell Kara Wimble Art Sanford Deborah Vaughn-Wright David Grabka	877-345-1113 ext. 238 901-937-4315 904-367-4324 843-743-2135 404-562-8539 850-245-8997	If the laboratory determines that any data they have generated is non-usable, the Laboratory PM will notify (verbally or via email) the Resolution Consultants project chemist within one business day of when the issue is discovered. The Resolution Consultants project chemist will notify (verbally or via email) Resolution Consultants TOM within one 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 TOM will be notified verbally or via email within 48 hours of validation completion that a non-routine and significant laboratory quality deficiency has resulted in non-usable data. The Resolution Consultants TOM will take corrective action appropriate for the identified deficiency to ensure the project objectives are met. The Resolution Consultants TOM will notify (verbally or via email) the Navy 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. The Navy RPM, may at their discretion, contact the Navy project chemist for assistance in problem resolution. Such notification will be made within one business day of when the issue is discovered.

Notes:

RPM	=	Remedial project manager	SSO	=	Site safety officer
FTL	=	Field team leader	HSO	=	Health and safety officer
TOM	=	Task order manager	SAP	=	Sampling and analysis plan
QAO	=	Quality assurance officer	PM	=	Project manager
USEPA	=	United States Environmental Protection Agency	FDEP	=	Florida Department of Environmental Protection
NAVFAC	=	Naval Facilities Engineering Command	NAS	=	Naval Air Station
JAA	=	Jacksonville Airport Authority	POC	=	Point of Contact

SAP WORKSHEET #7: PERSONNEL RESPONSIBILITIES TABLE

(UFP-QAPP Manual Section 2.4.3)

Title/Role	Title/Role	Organizational Affiliation	Responsibilities
Art Sanford	Navy Remedial Project Manager	BRAC PMO SE	Oversees project implementation including scoping, data review, and evaluation.
Debbie Vaughn-Wright	Remedial Project Manager	USEPA	Participates in scoping, data review, evaluation, and approves the SAP. Oversees project execution for USEPA.
David Grabka	FDEP Remedial Project Manageer	FDEP	Participates in scoping, data review, evaluation, and approves the SAP. Oversees project execution for FDEP.
Frank McInturff	Senior Technical Advisor	Resolution Consultants	Oversees projects in Florida on behalf of Resolution Consultants
Kara Wimble	Task Order Manager	Resolution Consultants	Oversees project implementation, including scoping, data review, and evaluation. Oversees project and manages financial, schedule, and technical day-to-day activities of the project.
Robert Bailey	Field Team Leader/ Site Safety Officer	Resolution Consultants	As FTL, supervises, coordinates, and performs field sampling activities. As the SSO, is responsible for onsite project-specific health and safety training and monitoring site conditions.
Tina Cantwell	Project Chemist/QAO/Data Validation Manager	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	Health and Safety Manager	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
Sonya Gordon	Project Manager	Empirical Laboratories	Coordinates analyses with laboratory staff, ensures that scope of work is followed, provides quality review of data packages, and communicates with Resolution Consultant project staff.

Notes:

HASP = Health and Safety Plan
BRAC PMO SE = Base Realignment and Closure Program Management Office Southeast
USEPA = United States Environmental Protection Agency
FDEP = Florida Department of Environmental Protection
RPM = Remedial Project Manager
FTL = Field Team Leader
SSO = Site Safety Officer
QAO = Quality Assurance Officer

SAP WORKSHEET #8: SPECIAL PERSONNEL TRAINING REQUIREMENTS TABLE

(UFP-QAPP Manual Section 2.4.4)

Not Applicable

SAP WORKSHEET #9: PROJECT SCOPING SESSION PARTICIPANTS SHEET

(UFP-QAPP Manual Section 2.5.1)

Long-Term monitoring was scoped at a BCT partnering meeting on 13 August 2009. A summary of the attendees and the decisions made are detailed below.

Project Name: Former NAS Cecil Field **PM**: Rob Simcik	**Site Name**: Petroleum Sites **Site Location**: Jacksonville, Florida
Date of Session: 13 August 2009 **Scoping Session Purpose**: DQO meeting with TtNUS, Navy, and Regulatory Team	

Name	Title	Affiliation	Phone #	Email Address
David Grabka	RPM	FDEP	850-245-8997	David.Grabka@dep.state.fl.us
Art Sanford	RPM	Navy	843-743-2135	Art.sanford@navy.mil
Ronald Kotun, Ph.D.	Senior Toxicologist	TtNUS	412-921-8291	ronald.kotun@tetratech.com
Doyle Brittain	RPM	USEPA	404-562-8518	Brittain.doyle@epa.gov
Rob Simcik	Engineer	TtNUS	412-921-8163	Robert.simcik@tetratech.com
Mark Jonnet	GIS/Engineer	TtNUS	412-921-8622	Mark.jonnet@tetratech.com
Mike Halil	RAC PM	CH2M Hill	904-777-4812 ext. 233	Michael.Halil@CH2M.com
Kara Wimble	Scientist	TtNUS	904-730-4669 ext. 217	Kara.wimble@tetratech.com

Comments/Decisions:

Draft SAP Worksheets #10 and #11 were provided to the meeting participants on 13 August 2009. Revisions to Worksheets #10 and #11 and figures were made based on the meeting discussion. The meeting minutes are included in Appendix A.

Action Items:

Complete UFP-SAP for Petroleum Sites based on BCT agreement of the DQOs.

Consensus Decisions:

BCT decisions regarding DQOs are included in meeting minutes in Appendix A.

SAP WORKSHEET #10: CONCEPTUAL SITE MODEL

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

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES

SAP WORKSHEET #17: SAMPLING DESIGN AND RATIONALE

(UFP-QAPP Manual Sections 2.5.2, 2.61, 2.8.1, 3.1.1)

The sites discussed in this SAP are all located within the former Naval Air Station Cecil Field except the Ocala F-18 Crash site, which is located in the Ocala National Forest, Ocala, Florida. For organizational purposes, the components of Worksheets #10, #11, #15, and #17 will be combined by site. The majority of former NAS Cecil Field is located in southwestern Duval County, and the southernmost portion of NAS Cecil Field is located in Clay County. The base was operated by the Navy from approximately 1943 to 1999. This SAP governs work to be conducted at seven NAS Cecil Field sites where petroleum compounds are the primary contaminants of concern (COCs):

1) North-South Apron Plume
2) Building 82, Tank G82
3) BP Wells
4) 815 Wash Rack
5) Tanks 81 A, B, C
6) South Fuel Farm
7) Ocala F-18 Crash site

These seven sites are being investigated and acted upon under the FDEP Petroleum Program. Groundwater at all seven of the sites is currently being monitored, and this SAP is being used to identify and refine the Long Term Monitoring (LTM) Program for each site. Figure 10-1 provides a location map for all seven petroleum sites. Additional details concerning conceptual site models for each site, including historical site activities, past investigations, current site conditions, and potential unacceptable ecological and human exposures are provided in each section.

The LTM program at Former NAS Cecil Field will be optimized to ensure that remedial effectiveness is being adequately and accurately monitored. The optimization will include:

(a) A review of historical data, the Remedial Action Objectives (RAOs), and exit strategy
(b) A review of Data Quality Objectives (DQOs) for each site with the BCT.
(c) Addition and removal of sampling points (wells) as they become required or obsolete

(d) Adjustment in monitoring frequencies
(e) Suspension of monitoring as remedial goals are achieved
(f) Adjustments in the list of analytes included for monitoring

Each of these components of the optimization of the LTM will be discussed and approved by the BCT for each site covered in this UFP-SAP. Resolution Consultants will implement these aspects of optimization to each of the sites included in this report and document the results and recommendations in the first Long-Term Monitoring (LTM) report for each site. Resolution Consultants will also present these recommendations to the BCT and include decisions in an annual update of this UFP-SAP. A table of scheduled fieldwork for each of these sites and associated deliverable is detailed in Worksheet #16.

Information Inputs

The inputs needed to resolve the project problem identified in Section 11.1 include field observations and measurements, chemical data, site feature locations, and Project Action Limits (PALs) as described below. Observations made during site visits, historical information obtained through review of records and aerial photographs, and data collected during previous studies, as summarized in Worksheet #10, were used to develop the CSM and sampling plan. Specific informational inputs, to serve as the basis for decisions during the execution of this project, include the following:

- **Chemical Data:** Groundwater chemical data will be collected to determine if target analytes are present and assess potential threats to human health and the environmental at the Site. Concentrations of any detected target analytes will be compared to their respective PALs, as part of a screening level risk evaluation to support the decision making process.
- **Field investigation parameters:** Parameters, including pH, temperature, specific conductivity, oxidation reduction potential, dissolved oxygen, and turbidity, will be used to confirm groundwater samples are representative of the formation being investigated. Field parameters will also be used to assist with understanding of the nature of contamination.

- **Project Action Limits:** As an initial threshold value for choosing between alternative actions, chemical data will first be compared to PALs, as included on Worksheet #15. Human health risk screening will include groundwater data. Groundwater data will be compared to FDEP GCTLs.

- **Background Concentrations:** Background concentrations are generally considered to be the level or amount of a constituent found in common areas not associated with a particular contaminant release. If concentrations of constituents in soil samples from the site exceed background values, then the site may have residual contamination. Comparison to background concentrations of constituents also provides a relative idea of the degree of contamination. Such comparisons are helpful when addressing contamination in areas that may have been influenced by numerous anthropogenic (nearby roads) and natural activities (weathering, flooding, wind dispersion). To help address the principal study questions, the concentrations of metals (greatest and average) detected in soil will be compared to background concentrations. The 1998 Inorganic Background Data Sets at Cecil Field established background concentrations for groundwater, soil, sediment, and surface water. Before additional background values are cited, they will be clearly identified and their acceptability and approval for use shall be coordinated with the Navy, FDEP, and USEPA before incorporating these values into the screening process.

To conduct comparisons of site data to screening levels, the selected laboratory must be able to achieve limits of quantitation (LOQs) that are low enough to measure constituent concentrations less than the PALs. Analytical data reported by the laboratory will use the following reporting conventions: All results less than the detection limit (DL) will be considered non-detects; positive results reported at concentrations between the DL and LOQ will be reported with a "J" qualifier; and analytes not found (not detected) in a sample will be reported as the limit of detection (LOD) with a "U" qualifier. For risk screening purposes, in the event that an analyte concentration exceeds a PAL but is less than or equal to an established background concentration, the analyte will not be considered a contaminant of concern. For characterization purposes, if a background concentration for a particular analyte is greater than the PAL for that analyte, the background concentration will replace the PAL. Even though every effort has been made to obtain a laboratory/analytical method with LOQs that are low enough to measure constituent concentrations less than the screening values, several target analytes have a PAL that falls between the LOD and the project LOQ, as summarized on Worksheet #15. The Project Team will accept the results for

these particular analytes where the result falls below the LOQ, if the results are "J" qualified. Any J-flagged data will be accepted to achieve project goals; however, greater scrutiny will be applied in these cases. Additionally, the inability to quantify select chemicals to PAL levels with confidence will be addressed in the any LTM reports associated with the various petroleum sites. The Former NAS Cecil Field Partnering Team will be involved in rendering the final conclusion regarding adequacy of the data.

The usable data from previous investigations and LTM events was used in conjunction with the new LTM data to evaluate current site conditions, contaminant trends, and to determine the COCs for the media being monitored at all sites. The full list of analytes is listed by site in Worksheet #15. See Worksheets #20 and #23 for a list of the analytical methods applicable to each site. See Worksheet #21 for a list of sampling methods.

Site-Specific Sampling Design

The BCT has selected a biased sampling approach appropriate for LTM at each site. The numbers of selected sampling points for each site are based on the available wells and a need to obtain comprehensive spatial coverage over the area of interest. Upgradient and downgradient sampling locations at each site have been selected to monitor the source areas or contaminated groundwater plumes at each site and to execute the decision rules. The samples will be collected according to field sampling procedures presented in Worksheet #21.

NORTH-SOUTH APRON PLUME

SAP WORKSHEET #10: CONCEPTUAL SITE MODEL FOR NSAP

10.1.1 Site Description — NSAP

The North-South Apron Plume (NSAP) is located on the north-south flight line, east of Building 815, on the eastern edge of the apron (see Figure 10.1-1). The site has been in LTM since 2001. Aviation related activities were conducted in this area since NAS Cecil Field was established in 1941, including fueling operations, aircraft maintenance, and operational activities. Information regarding potential sources of contamination at this site is very limited.

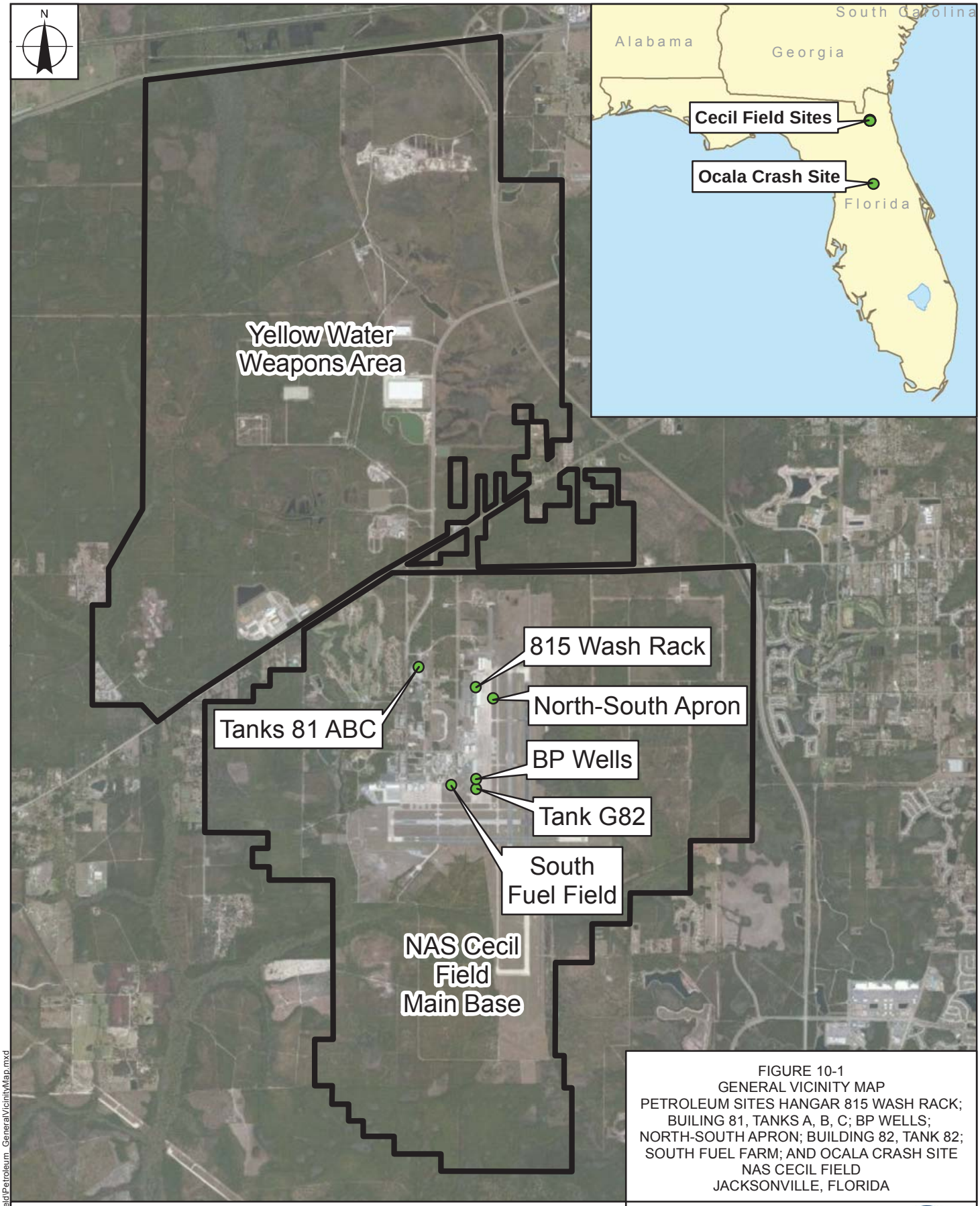


FIGURE 10-1
GENERAL VICINITY MAP
PETROLEUM SITES HANGAR 815 WASH RACK;
BUILING 81, TANKS A, B, C; BP WELLS;
NORTH-SOUTH APRON; BUILDING 82, TANK 82;
SOUTH FUEL FARM; AND OCALA CRASH SITE
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Petroleum Sites
Facility Boundary

1 inch = 1 miles

0 0.5 1 1.5 2 Miles

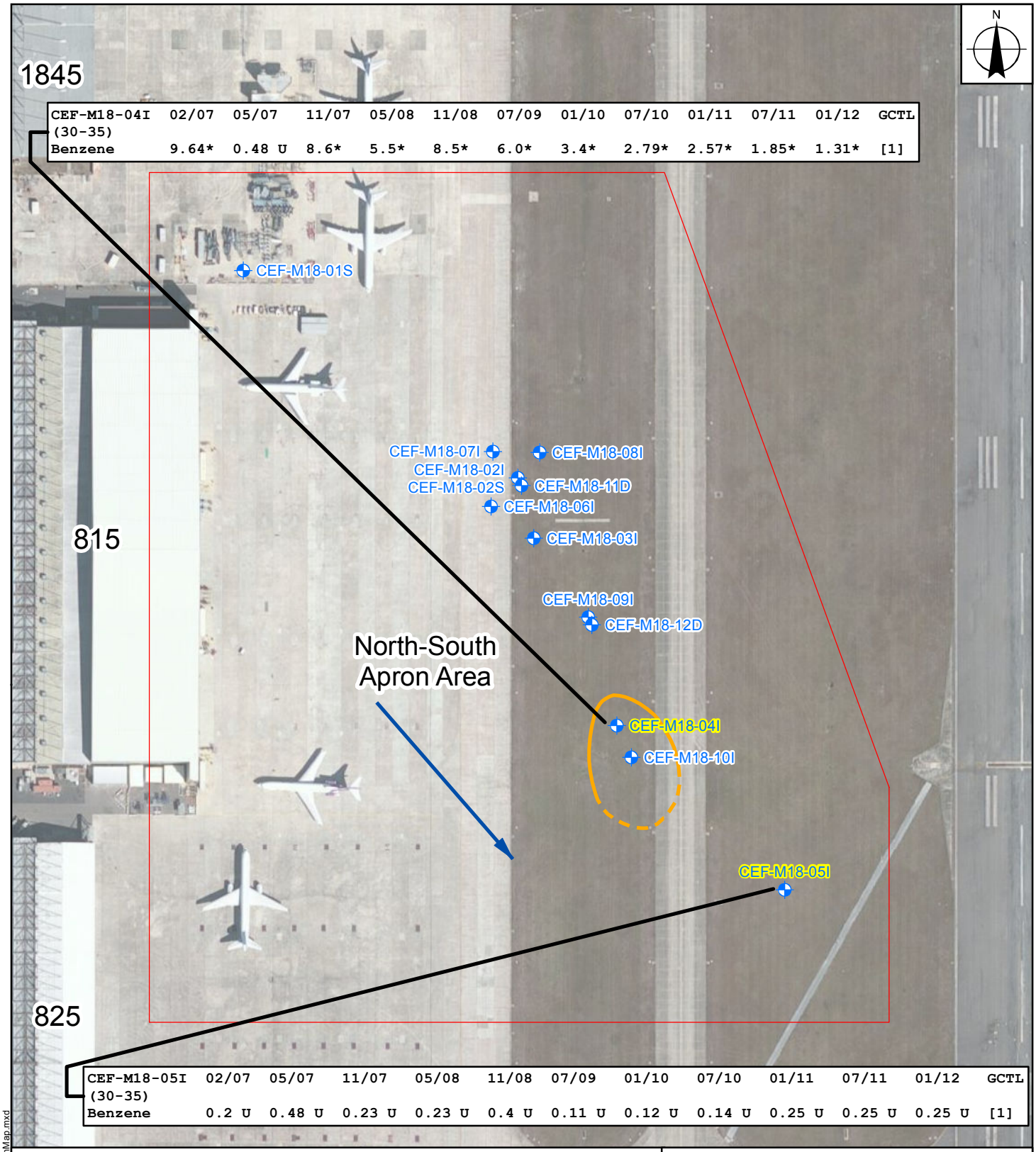
NAVFAC Naval Facilities Engineering Command

RESOLUTION CONSULTANTS

REQUESTED BY: K. Wimble	DATE: 11/19/2012
DRAWN BY: N. Rinehart	PROJECT NUMBER: 0888812660

X:\Navy\NAS_CecilField\Petroleum_GeneralVicinityMap.mxd

SOURCE: ARCGIS ONLINE BING AERIAL (c) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS



CEF-M18-04I (30-35)	02/07	05/07	11/07	05/08	11/08	07/09	01/10	07/10	01/11	07/11	01/12	GCTL
Benzene	9.64*	0.48 U	8.6*	5.5*	8.5*	6.0*	3.4*	2.79*	2.57*	1.85*	1.31*	[1]

CEF-M18-05I (30-35)	02/07	05/07	11/07	05/08	11/08	07/09	01/10	07/10	01/11	07/11	01/12	GCTL
Benzene	0.2 U	0.48 U	0.23 U	0.23 U	0.4 U	0.11 U	0.12 U	0.14 U	0.25 U	0.25 U	0.25 U	[1]

Monitoring Well
Groundwater Flow Direction
Benzene Plume (µg/L)
Inferred Benzene Plume
Site Boundary

1 inch = 200 feet

0 100 200 300 400 Feet

CEF-M18-05I = Sample ID
(30-35) = Well screen interval, feet below ground surface
9.64 = Detected concentration (µg/L)
* = GCTL value exceeded
U = Not detected at or above MDL (associated value)
[1] = Ground Cleanup Target Level (GCTL)

NOTE: Highlighted wells are currently in the LTM program

FIGURE 10.1-1
SITE LOCATION MAP AND HISTORICAL ANALYTICAL DATA IN GROUNDWATER
NORTH-SOUTH APRON
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUESTED BY: K. Wimble	DATE: 12/12/2012
DRAWN BY: N. Rinehart	PROJECT NUMBER: 0888812660

X:\Navy\NAS_CecilField\PetroSiteNorthSouthApronMap.mxd

SOURCE: ARCGIS ONLINE BING AERIAL (c) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS

10.1.2 History of Environmental Investigations and Actions — NSAP

A direct push technology (DPT) investigation by Harding Lawson and Associates in 1999 led to Tetra Tech Nuclear Utility Services (TtNUS) conducting a site assessment of Main Base Open Area 18 (in the area of current North-South Apron site. Two shallow wells (CEF-M18-01S and CEF-M18-02S) and five intermediate wells (CEF-M18-01I through CEF-M18-05I) were installed and confirmed the presence of benzene and xylenes in the intermediate zone of the aquifer only at concentrations greater than the FDEP Groundwater Cleanup Target Levels (GCTLs). According to the *Site Assessment Report* (SAR), all samples collected from the shallow monitoring wells analyzed for VOCs were either less than their respective GCTLs or were non-detect. The SAR stated that no upgradient shallow contaminant source could be identified that explained the presence of this groundwater contamination (TtNUS, 2001).

TtNUS conducted four quarterly groundwater monitoring events for the site on the following dates: 2 May 2001; 7 August 2001; 6 November 2001; and 14 February 2002. The data indicated that benzene concentrations had increased in monitoring wells CEF-M18-02I and CEF-M18-04I, and the Year 1 milestone objectives had not been achieved in those wells (TtNUS, 2002). The TtNUS 2002 report recommended the Navy suspend LTM and conduct a supplemental site assessment. FDEP concurred with this recommendation in May 2002.

Between August and December 2004, TtNUS conducted a DPT investigation and installed and sampled five intermediate monitoring wells (CEF-M18-06I through CEF-M18-10I) and two deep monitoring wells (CEF-M18-11D and CEF-M18-12D) (TtNUS, 2005a).

On 21 October 2005, the FDEP agreed with a SAR recommendation to resume LTM and submitted a Natural Attenuation Monitoring Plan Approval Order (NAMPAO) (FDEP, 2005). Since 2005, regular LTM has occurred at the site. Results from the most recent sampling event (January 2012) indicate that benzene continues to exceed its GCTL at monitoring well CEF-M18-04I but benzene was not detected in the downgradient well CEF-M18-05I (TtNUS, 2012).

Currently, two wells (CEF-M18-04I and CEF-M18-05I) are sampled annually for benzene only. Groundwater elevations are measured at nine intermediate wells at the site (CEF-M18-02I, CEF-M18-03I, CEF-M18-04I, CEF-M18-05I, CEF-M18-06I, CEF-M18-07I, CEF-M18-08I, CEF-M18-09I, CEF-M18-10I).

10.1.3 Conceptual Site Model — NSAP

A summary of the conceptual site model (CSM) based on site conditions at the NSAP are shown on Figure 10.1-2. The text below describes the CSM.

10.1.3.1 Sources of Contamination

Based on the 2001 SAR, no upgradient shallow source could be identified that would explain the presence of benzene, toluene, ethylbenzene, and xylenes (BTEX) in groundwater. Dioxins, semi-volatile organic compounds (SVOCs), pesticides, polychlorinated biphenyls (PCBs), and other metal analyses are not required during this investigation because data from previous investigations indicated that these analytes were not detected or were detected at concentrations less than FDEP Groundwater Cleanup Target Levels (GCTLs) on a consistent basis.

10.1.3.2 Potential Contaminant Migration Mechanisms

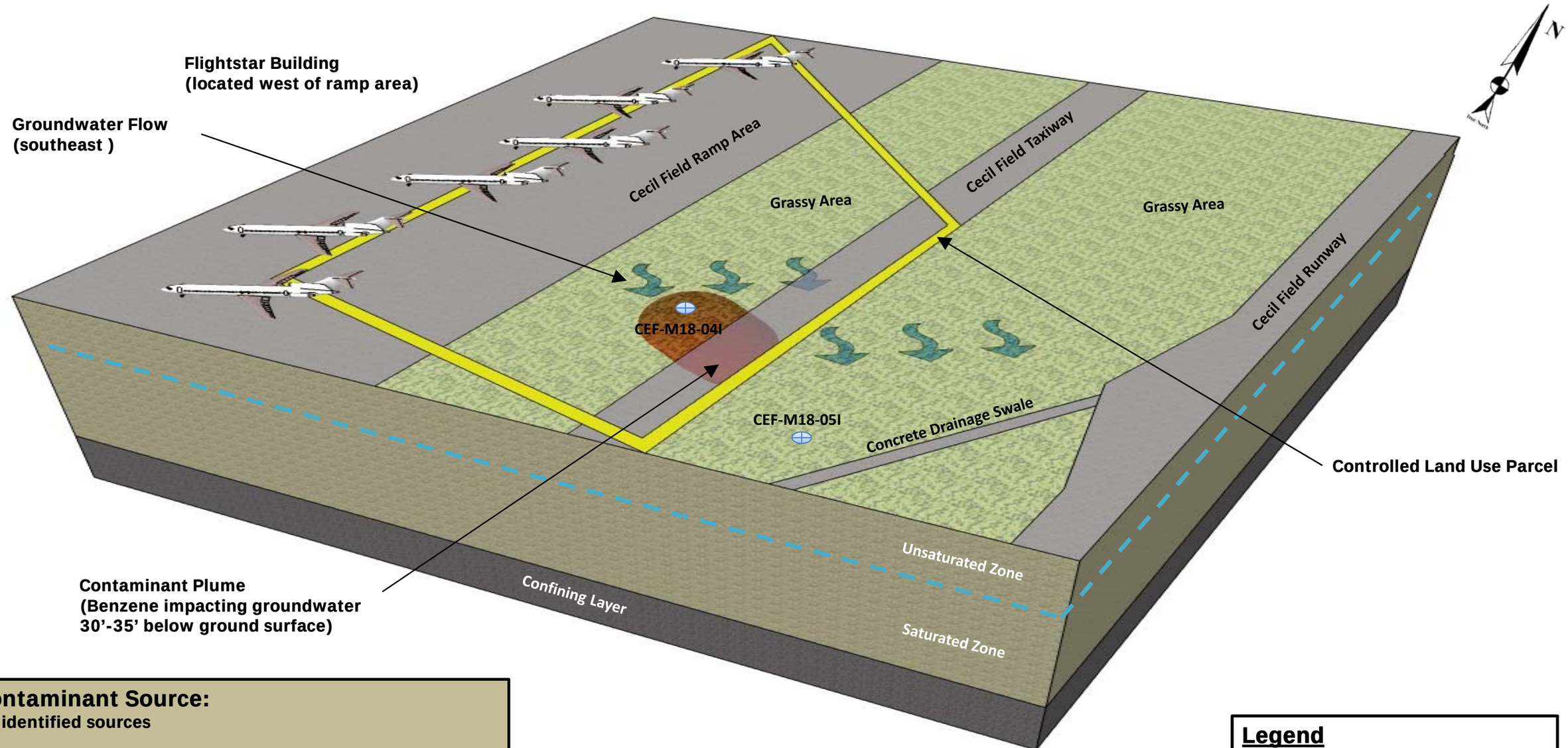
Because the benzene contamination is located between 30 feet to 35 feet below ground surface (bgs) in the groundwater only, the contamination could migrate to the southeast in the intermediate zones of the surficial aquifer based on the historical groundwater flow data. Soil leaching to groundwater under the influence of infiltrating precipitation is a potential contaminant migration mechanism. Surface water runoff in the NSAP area is collected by the storm sewer system, thus overland runoff does not affect the contamination, which is only present from 30-35 feet bgs.

10.1.3.3 Land Uses and Potential Exposure

The Jacksonville Economic Development Commission (JEDC) Reuse Plan provides for continued industrial and/or commercial uses of the site. Land use controls (LUCs) were developed for this site in January 2005 and identified the site has aromatics exceeding human health criteria in groundwater (TtNUS, 2007d). The LUCs are as follows:

- Groundwater may not be used for human consumption
- Groundwater may not be used for industrial purposes
- Tampering or damaging any Navy wells or remediation systems is prohibited

Former NAS Cecil Field is supplied with public water; therefore, human exposure to potentially contaminated site groundwater through ingestion, inhalation, or direct contact with potable water is not a consideration. Ecological receptors are not exposed to groundwater; however, contamination exceeding regulatory criteria remains.



Contaminant Source:
No identified sources

Receptors:
Human: None due current and future land use
Ecological: None due to lack of habitat

Land Use Controls:
- Groundwater may not be used for human consumption
- Groundwater may not be used for industrial purposes
- Tampering or damaging any Navy wells or remediation systems is prohibited

NOTES:
1. Conceptual Site Model not to scale. Horizontal dimensions based on recent aerial imaging, site visits, and historic knowledge. Vertical dimensions exaggerated for purpose of conveying pertinent site information.
2. Groundwater monitoring well locations are approximated based on geographic information system data.

Legend
⊕ - Groundwater Monitoring Well

Figure 10.1-2
Conceptual Site Model
North-South Apron Plume
Former NAS Cecil Field, Jacksonville, Florida

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUEST BY: Kara Wimble	DATE: 11/02/2012
DRAWN BY: David Myers	CTO NO. JM34

This site is located between the apron and active Runway Alpha, and does not allow for direct access for contact with groundwater. The resulting lack of ecological habitat and complete exposure pathways preclude potential unacceptable risks for ecological receptors. Direct exposure of potential human receptors to groundwater is restricted based upon the current and future land use.

SAP WORKSHEET #11: PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR NORTH-SOUTH APRON (NSAP)

11.1.1 Problem Definition

Benzene groundwater contamination remains in the area of the NSAP site. Concentrations exceed FDEP GCTLs. LTM continues to show that no contaminant migration is occurring. The source of contamination is unknown, and the plume appears to be contained. Groundwater is monitored annually. To confirm whether natural attenuation is occurring at the site, data regarding the benzene levels in the groundwater must be collected and evaluated. These data will be used to determine an appropriate path forward as described in Section 11.4.1.

11.1.2 Study Boundaries

The NSAP area covers approximately 25 acres, delineated from the northwest corner to the southeast corner by CEF-M18-01S and CEF-M18-05I, respectively. This area is shown in Figure 10.1-1. The vertical boundary for the groundwater plume is the water table. The groundwater benzene contaminant plume is the population of interest and constitutes the spatial decision unit. The temporal decision unit is each round of monitoring when determined whether an exceedance of GCTL has occurred and it is two consecutive monitoring rounds when determining whether parameters or wells may be eliminated from monitoring.

11.1.3 Analytic Approach

A direct comparison of measured concentrations within the groundwater will be made against the appropriate PAL. The PAL for benzene is detailed in Worksheet #15. Additionally, if none of the measured benzene concentrations within any groundwater sample exceed criteria after two consecutive rounds of monitoring, then the monitoring program will be discontinued after coordination with the BCT. The following decision rules govern data use for the monitoring programs at NSAP.

Decision Rule #1: If the measured benzene concentration from any non-compliance/source well groundwater sample is greater than the GCTL, then continue LTM until levels of benzene are below the GCTL for two consecutive sampling rounds.

Decision Rule #2: If the measured benzene concentration is greater than the GCTL in any compliance well sample, then additional delineation will be performed by Resolution Consultants at the direction and approval of the BRAC BCT Team and an FTMR will be issued to govern the delineation.

Decision Rule #3: If the measured benzene concentration in any well sample exceeds the GCTL in a given sampling round, but no migration is detected downgradient of the compliance wells for two consecutive events, then a permanent groundwater restriction will be evaluated for Risk Management Option (RMO) III (62-780.680, F.A.C.). This will indicate that contamination exists and the contaminated area is defined. RMO III would put a restriction on the use of the groundwater, but allow it to remain onsite.

Decision Rule #4: If all measured benzene concentrations in all groundwater samples collected from the targeted monitoring wells are less than action levels for two consecutive events, then recommend NFA.

Decision Rule #5: Throughout the groundwater monitoring, if any particular measured benzene concentration is less than its GCTL for two consecutive sampling rounds, then the BCT will discuss the elimination of the well from the monitoring program, in accordance with the Navy guidance on groundwater monitoring well optimization. The well will be eliminated unless it is a compliance well, or the BCT determines that the inclusion of the well provides useful information on evaluating the overall program and should not be removed.

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES FOR NSAP

Site:	North-South Apron						
Matrix:	Groundwater						
Analytical Group:	Volatile Organic Compounds						
Analyte	**CAS No.**	**Project Action Level (µg/L)**	**Project Action Level Source (µg/L)**	**Project Quantitation Limit Goal (µg/L)**	**Laboratory Limit of Quantitation[1] (µg/L)**	**Laboratory Limit of Detection[1] (µg/L)**	**Laboratory Method Detection Limit[1] (µg/L)**
Benzene	71-43-2	1	FDEP GCTL	0.3	1	0.5	0.25

Notes:
[1] Laboratory quantitation, detection, and method detection limits, provided by Empirical Laboratory, are targets that are achievable under optimal conditions and may vary during the course of the project. Physical characteristics, such as matrix interference, will affect the actual limits achieved.
CAS No. = Chemical Abstract Services number
µg/L = Micrograms per liter
FDEP GCTL = Florida Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005;
http://www.dep.state.fl.us/legal/Rules/waste/62-777/62-777_TableI_GroundwaterCTLs.pdf

SAP WORKSHEET #17: SAMPLING DESIGN AND RATIONALE FOR NSAP

Site-Specific Sampling Design

The NSAP sampling strategy consists of annual sampling of two intermediate monitoring wells: CEF-M18-04I and CEF-M18-05I. The wells were chosen based on historical groundwater flow data, detections of the benzene in the wells, and whether they are downgradient or upgradient from the contamination plume. The intent is to include wells that indicate whether contaminant concentrations are naturally attenuating. The sampling locations are detailed in Worksheet #18. Annual sampling will occur for an additional year per the MOP issued on 21 October 2005. A map of the monitoring wells is provided in Figure 10.1-1.

BUILDING 82, TANK G82

SAP WORKSHEET #10: CONCEPTUAL SITE MODEL FOR BUILDING 82, TANK G82

10.2.1 Site Description — BUILDING 82, TANK G82

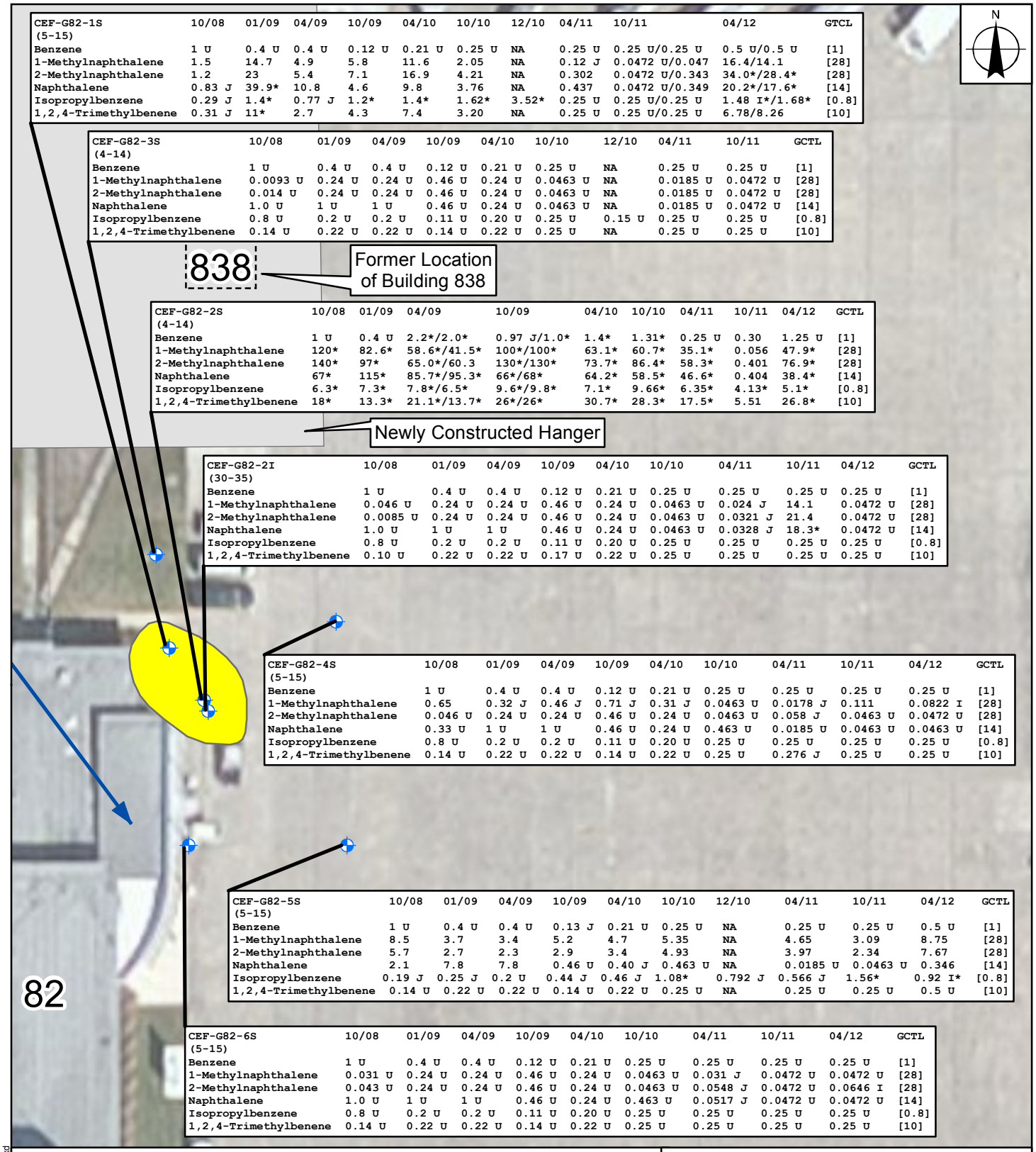
The Building 82, Tank G82 site comprises an air traffic control tower and underground storage tank (UST) G82, which used to store diesel fuel for emergency generators. Tank G82 was removed in June 1997. Soil and groundwater have been contaminated near the UST as a result of leaks originating from Tank G82. The leaking tank released an unknown volume of fuel to the environment. A detailed site plan is shown on Figure 10.2-1.

10.2.2 History of Environmental Investigations and Actions — Building 82, Tank G82

From 1997 to 2006, several environmental investigations were conducted to determine levels and extent of polynuclear aromatic hydrocarbons (PAH) and volatile organic compound (VOC) contaminants, which were identified to be related to site operations. Dioxins, pesticides, PCBs, and metals were not detected or were detected at concentrations less than FDEP GCTLs on a consistent basis (ABB Environmental Services, Inc. [ABB-ES], 1998). The investigations required installation of several groundwater monitoring wells, and soil and groundwater sampling and analyses. Synthetic Precipitation Leaching Procedure (SPLP) analyses and organic carbon chain speciation were conducted on select samples.

In 2001, CH2M HILL removed approximately 148 cubic yards of soil contaminated with PAHs and VOCs. Removal of contaminated soil in the northern and southern portions of this site was confirmed as complete in 2001. At the time of the excavation, the water table was at 5.98 feet bgs, so CH2M Hill over-excavated slightly too approximately 7 feet bgs (CH2M HILL, 2001). A 2001 *Site Assessment Report Addendum* (SARA) concluded that approximately 49 cubic yards of contaminated soil remained along Building G82 and the flight line eastern and western areas.

These soils could not be removed without potentially undermining the apron and Building 82 (CH2M Hill, 2001). In samples collected from the unexcavated soil, Total Recoverable Petroleum Hydrocarbons (TRPH) was reported present in soil at concentrations greater than the FDEP Soil Cleanup Target Level (SCTL). Xylenes, naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene also were present in SPLP samples at concentrations that exceeded their respective GCTLs (FDEP, 2001). One carbon chain fraction (C12-C16, aliphatic) exceeded its sub-classification SCTL (Broward, 2001).



CEF-G82-1S (5-15)	10/08	01/09	04/09	10/09	04/10	10/10	12/10	04/11	10/11	04/12	GTCL
Benzene	1 U	0.4 U	0.4 U	0.12 U	0.21 U	0.25 U	NA	0.25 U	0.25 U/0.25 U	0.5 U/0.5 U	[1]
1-Methylnaphthalene	1.5	14.7	4.9	5.8	11.6	2.05	NA	0.12 J	0.0472 U/0.047	16.4/14.1	[28]
2-Methylnaphthalene	1.2	23	5.4	7.1	16.9	4.21	NA	0.302	0.0472 U/0.343	34.0*/28.4*	[28]
Naphthalene	0.83 J	39.9*	10.8	4.6	9.8	3.76	NA	0.437	0.0472 U/0.349	20.2*/17.6*	[14]
Isopropylbenzene	0.29 J	1.4*	0.77 J	1.2*	1.4*	1.62*	3.52*	0.25 U	0.25 U/0.25 U	1.48 I*/1.68*	[0.8]
1,2,4-Trimethylbenene	0.31 J	11*	2.7	4.3	7.4	3.20	NA	0.25 U	0.25 U/0.25 U	6.78/8.26	[10]

CEF-G82-3S (4-14)	10/08	01/09	04/09	10/09	04/10	10/10	12/10	04/11	10/11	GCTL
Benzene	1 U	0.4 U	0.4 U	0.12 U	0.21 U	0.25 U	NA	0.25 U	0.25 U	[1]
1-Methylnaphthalene	0.0093 U	0.24 U	0.24 U	0.46 U	0.24 U	0.0463 U	NA	0.0185 U	0.0472 U	[28]
2-Methylnaphthalene	0.014 U	0.24 U	0.24 U	0.46 U	0.24 U	0.0463 U	NA	0.0185 U	0.0472 U	[28]
Naphthalene	1.0 U	1 U	1 U	0.46 U	0.24 U	0.0463 U	NA	0.0185 U	0.0472 U	[14]
Isopropylbenzene	0.8 U	0.2 U	0.2 U	0.11 U	0.20 U	0.25 U	0.15 U	0.25 U	0.25 U	[0.8]
1,2,4-Trimethylbenene	0.14 U	0.22 U	0.22 U	0.14 U	0.22 U	0.25 U	NA	0.25 U	0.25 U	[10]

CEF-G82-2S (4-14)	10/08	01/09	04/09	10/09	04/10	10/10	04/11	10/11	04/12	GCTL
Benzene	1 U	0.4 U	2.2*/2.0*	0.97 J/1.0*	1.4*	1.31*	0.25 U	0.30	1.25 U	[1]
1-Methylnaphthalene	120*	82.6*	58.6*/41.5*	100*/100*	63.1*	60.7*	35.1*	0.056	47.9*	[28]
2-Methylnaphthalene	140*	97*	65.0*/60.3	130*/130*	73.7*	86.4*	58.3*	0.401	76.9*	[28]
Naphthalene	67*	115*	85.7*/95.3*	66*/68*	64.2*	58.5*	46.6*	0.404	38.4*	[14]
Isopropylbenzene	6.3*	7.3*	7.8*/6.5*	9.6*/9.8*	7.1*	9.66*	6.35*	4.13*	5.1*	[0.8]
1,2,4-Trimethylbenene	18*	13.3*	21.1*/13.7*	26*/26*	30.7*	28.3*	17.5*	5.51	26.8*	[10]

CEF-G82-2I (30-35)	10/08	01/09	04/09	10/09	04/10	10/10	04/11	10/11	04/12	GCTL
Benzene	1 U	0.4 U	0.4 U	0.12 U	0.21 U	0.25 U	0.25 U	0.25 U	0.25 U	[1]
1-Methylnaphthalene	0.046 U	0.24 U	0.24 U	0.46 U	0.24 U	0.0463 U	0.024 J	14.1	0.0472 U	[28]
2-Methylnaphthalene	0.0085 U	0.24 U	0.24 U	0.46 U	0.24 U	0.0463 U	0.0321 J	21.4	0.0472 U	[28]
Naphthalene	1.0 U	1 U	1 U	0.46 U	0.24 U	0.0463 U	0.0328 J	18.3*	0.0472 U	[14]
Isopropylbenzene	0.8 U	0.2 U	0.2 U	0.11 U	0.20 U	0.25 U	0.25 U	0.25 U	0.25 U	[0.8]
1,2,4-Trimethylbenene	0.10 U	0.22 U	0.22 U	0.17 U	0.22 U	0.25 U	0.25 U	0.25 U	0.25 U	[10]

CEF-G82-4S (5-15)	10/08	01/09	04/09	10/09	04/10	10/10	04/11	10/11	04/12	GCTL
Benzene	1 U	0.4 U	0.4 U	0.12 U	0.21 U	0.25 U	0.25 U	0.25 U	0.25 U	[1]
1-Methylnaphthalene	0.65	0.32 J	0.46 J	0.71 J	0.31 J	0.0463 U	0.0178 J	0.111	0.0822 I	[28]
2-Methylnaphthalene	0.046 U	0.24 U	0.24 U	0.46 U	0.24 U	0.0463 U	0.058 J	0.0463 U	0.0472 U	[28]
Naphthalene	0.33 U	1 U	1 U	0.46 U	0.24 U	0.463 U	0.0185 U	0.0463 U	0.0463 U	[14]
Isopropylbenzene	0.8 U	0.2 U	0.2 U	0.11 U	0.20 U	0.25 U	0.25 U	0.25 U	0.25 U	[0.8]
1,2,4-Trimethylbenene	0.14 U	0.22 U	0.22 U	0.14 U	0.22 U	0.25 U	0.276 J	0.25 U	0.25 U	[10]

CEF-G82-5S (5-15)	10/08	01/09	04/09	10/09	04/10	10/10	12/10	04/11	10/11	04/12	GCTL
Benzene	1 U	0.4 U	0.4 U	0.13 J	0.21 U	0.25 U	NA	0.25 U	0.25 U	0.5 U	[1]
1-Methylnaphthalene	8.5	3.7	3.4	5.2	4.7	5.35	NA	4.65	3.09	8.75	[28]
2-Methylnaphthalene	5.7	2.7	2.3	2.9	3.4	4.93	NA	3.97	2.34	7.67	[28]
Naphthalene	2.1	7.8	7.8	0.46 U	0.40 J	0.463 U	NA	0.0185 U	0.0463 U	0.346	[14]
Isopropylbenzene	0.19 J	0.25 J	0.2 U	0.44 J	0.46 J	1.08*	0.792 J	0.566 J	1.56*	0.92 I*	[0.8]
1,2,4-Trimethylbenene	0.14 U	0.22 U	0.22 U	0.14 U	0.22 U	0.25 U	NA	0.25 U	0.25 U	0.5 U	[10]

CEF-G82-6S (5-15)	10/08	01/09	04/09	10/09	04/10	10/10	04/11	10/11	04/12	GCTL
Benzene	1 U	0.4 U	0.4 U	0.12 U	0.21 U	0.25 U	0.25 U	0.25 U	0.25 U	[1]
1-Methylnaphthalene	0.031 U	0.24 U	0.24 U	0.46 U	0.24 U	0.0463 U	0.031 J	0.0472 U	0.0472 U	[28]
2-Methylnaphthalene	0.043 U	0.24 U	0.24 U	0.46 U	0.24 U	0.0463 U	0.0548 J	0.0472 U	0.0646 I	[28]
Naphthalene	1.0 U	1 U	1 U	0.46 U	0.24 U	0.463 U	0.0517 J	0.0472 U	0.0472 U	[14]
Isopropylbenzene	0.8 U	0.2 U	0.2 U	0.11 U	0.20 U	0.25 U	0.25 U	0.25 U	0.25 U	[0.8]
1,2,4-Trimethylbenene	0.14 U	0.22 U	0.22 U	0.14 U	0.22 U	0.25 U	0.25 U	0.25 U	0.25 U	[10]

Monitoring Well

GW Flow Direction

Groundwater Plume-VOCs and SVOCs

1 inch = 40 feet

0 10 20 30 40 Feet

CEF-G82-5S = Sample ID
(5-15) = Well screen interval, feet below ground surface
8.5 = Detected concentration (Sample/Duplicate in µg/L)
NA = Not analyzed
* = GCTL value exceeded
I = Reported value is between MDL and PQL
J = Estimated concentration
U = Not detected at or above MDL (associated value)
[1] = Ground Cleanup Target Level (GCTL)

FIGURE 10.2-1
SITE LOCATION MAP AND HISTORICAL ANALYTICAL DATA IN GROUNDWATER
BUILDING 82, TANK G82
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

NAVFAC Naval Facilities Engineering Command

RESOLUTION CONSULTANTS

REQUESTED BY: K. Wimble	DATE: 12/12/2012
DRAWN BY: N. Rinehart	PROJECT NUMBER: 0888812660

X:\Navy\NAS_CecilField\PetroSiteTankG82Map.mxd

SOURCE: ARCGIS ONLINE BING AERIAL (c) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS

In November 2006, monitoring wells in the shallow aquifer [5 to 15 feet feet below ground surface (bgs)] were sampled and analyzed as a baseline for a treatability study by CH2M HILL. Only groundwater from wells CEF-G82-1S and CEF-G82-2S had constituents at levels exceeding GCTLs (isopropylbenzene, naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, benzo[a]anthracene, 1,2,4-trimethylbenzene, 1,3,5-trimethlbenzene, and dibenz[a,h]anthracene). During the September 2007 Base Realignment and Closure Base Cleanup Team (BRAC BCT) meeting, FDEP agreed that based on 2006 site-wide groundwater sampling results, monitoring only with LUCs was appropriate and that no active remediation, such as air sparging, was needed at the Tank G82 site. This decision was based on the likelihood that natural attenuation was occurring because the concentrations of the COC had been decreasing in the absence of active remediation. On 29 May 2008, CH2M HILL submitted an updated *Natural Attenuation Monitoring Plan* (NAMP) for both Building 82 and the adjacent BP Wells site based on the results of the November 2006 sampling event. (CH2M HILL, 2008) The NAMP recommended that Tank G82 be sampled for chemical parameters (VOCs, naphthalene, PAHs, TRPH) and natural attenuation parameters (alkalinity, nitrate, nitrite, sulfate, sulfide, and methane) on a quarterly basis for the first two years. The second semi-annual Year 2 event (April 2010) was revised in accordance with the 2 February 2010 BCT meeting Decision No. 777: analysis for natural attenuation parameters was eliminated because of a lack of background concentration data.

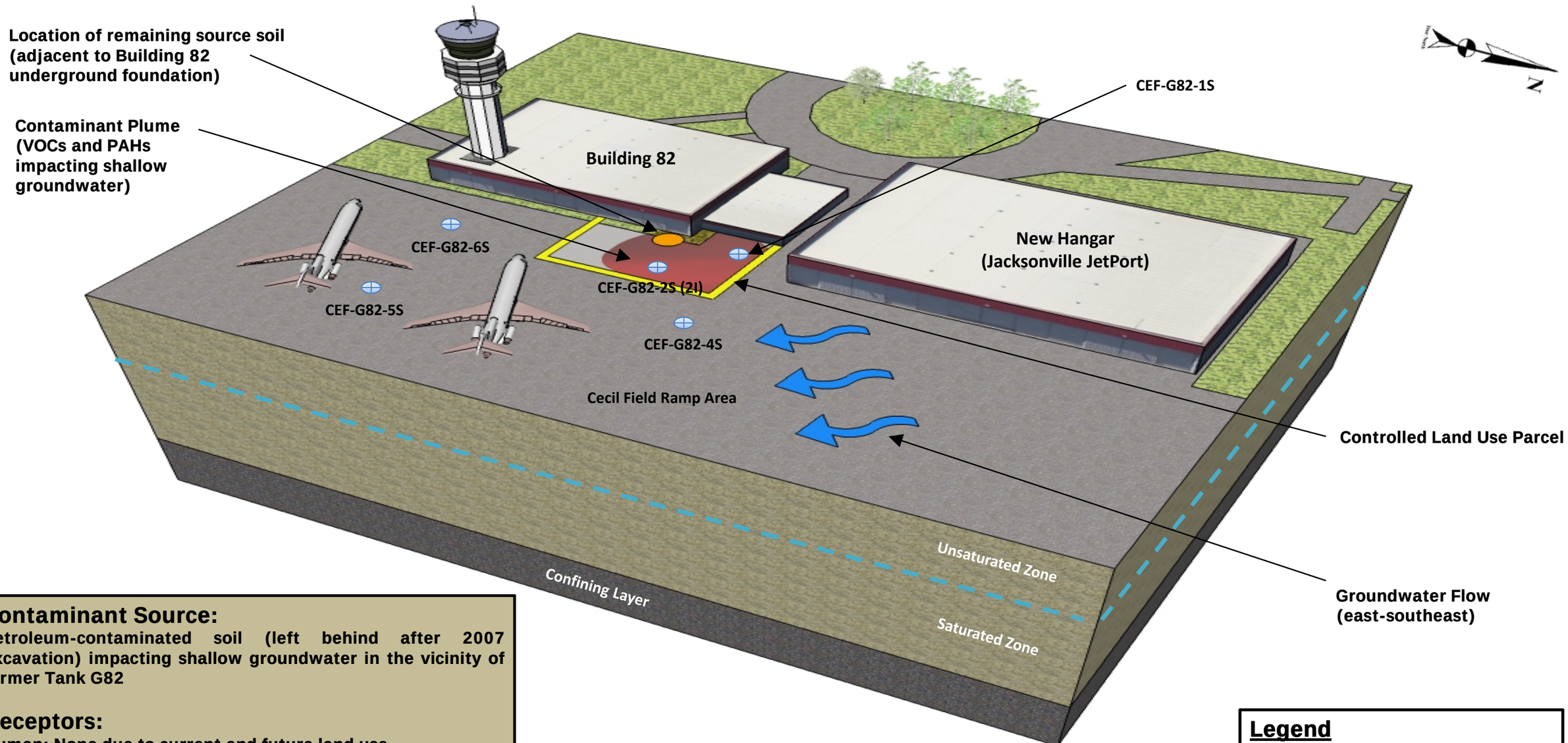
Currently, seven wells are sampled semi-annually for benzene, isopropylbenzene, 1,2,4-trimethylbenzene, naphthalene, 1-methylnapthalene, 2-methylnaphthalene, and TRPH. Groundwater elevations are measured at seven wells (CEF-82-1S, CEF-82-2S, CEF-82-2I, CEF-82-3S, CEF-82-4S, CEF-82-5S, CEF-82-6S) at the site.

10.2.3 Conceptual Site Model — Building 82, Tank G82

A summary of the CSM based on post-removal action site conditions at Building 82, Tank G82 is shown on Figure 10.2-2. The text below describes the CSM.

10.2.3.1 Sources of Contamination — Building 82, Tank G82

Soil and shallow groundwater (near the top of the water table) are contaminated near the former UST as a result of leaks originating from Tank G82. Soil excavation in this area was terminated to prevent potential damage to infrastructure, leaving approximately 49 cubic yards of contaminated soil in place along Building 82 and the flight line apron.



Contaminant Source:

Petroleum-contaminated soil (left behind after 2007 excavation) impacting shallow groundwater in the vicinity of former Tank G82

Receptors:

Human: None due to current and future land use
Ecological: None due to lack of habitat

Land Use Controls:

- Land may not be used for residential use
- Surface soils may not be disturbed
- Subsurface soils may not be disturbed
- Groundwater may not be used for human consumption
- Groundwater may not be used for industrial purposes
- Tampering or damaging any Navy wells or remediation systems is prohibited

NOTES:

1. Conceptual Site Model not to scale. Horizontal dimensions based on recent aerial imaging, site visits, and historic knowledge. Vertical dimensions exaggerated for purpose of conveying pertinent site information.
2. Groundwater monitoring well locations are approximated based on geographic information system data.

Legend

⊕ - Groundwater Monitoring Well

Figure 10.2-2
Conceptual Site Model
Building 82, Tank G82
Former NAS Cecil Field, Jacksonville, Florida

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUEST BY: Kara Wimble	DATE: 11/02/2012
DRAWN BY: David Myers	CTO NO. JM34

Benzene, naphthalene, isopropylbenzene, 1,2,4-trimethylbenzene (TMB), 1-methylnaphthalene, and 2-methylnaphthalene have been detected at the site downgradient from the unexcavated soil at concentrations exceeding their respective GCTLs.

10.2.3.2 Potential Contaminant Migration Mechanisms — Building 82, Tank G82

Soil contaminants may migrate to groundwater due to leaching under the influence of infiltrating precipitation. Upon entering the water column, a chemical may be carried with the flow of groundwater to downgradient locations. Groundwater contaminants may ultimately be deposited in sediment or surface water. The Building 82, Tank G82 shallow groundwater VOC contamination is migrating from the former location of the UST to the southeast in the shallow zones of the surficial aquifer. Surface water runoff in the Building 82, Tank G82 is also a possible migration mechanism.

The most recent data indicate that contamination is located under the apron at flight line (approximately 10 feet bgs in the groundwater only) and is migrating in the shallow zone of the surficial aquifer. In addition, the site is located on the apron and is covered with concrete. The groundwater flow at the site is to the east-southeast.

10.2.3.3 Land Uses and Potential Exposure — Building 82, Tank G82

The JEDC Reuse Plan provides for continued industrial and/or commercial uses of the site.

Land use controls (LUCs) were developed for this site in January 2005 and identified the site has aromatics, naphthalenes, and TRPH exceeding human health criteria in groundwater. The LUCs are as follows (TtNUS, 2007):

- Land may not be used for residential use
- Surface soils may not be disturbed
- Subsurface soils may not be disturbed
- Groundwater may not be used for human consumption
- Groundwater may not be used for industrial purposes
- Tampering or damaging any Navy wells or remediation systems is prohibited

Former NAS Cecil Field is supplied with public water; therefore, human exposure to potentially contaminated site groundwater as a result of potable water use is not a consideration. Ecological receptors are not exposed to groundwater; however, contamination exceeding regulatory criteria remains.

This site is in a highly developed paved area with buildings, and does not allow for direct access for contact with groundwater. The resulting lack of ecological habitat and complete exposure pathways preclude potential unacceptable risks for ecological receptors. Direct exposure of potential human receptors to soil and groundwater is prevented based upon the current and future land use.

SAP WORKSHEET #11: PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR BUILDING 82, TANKS G82

11.2 Problem Definition

Contaminant concentrations in wells CEF-G82-1S, CEF-G82-2S, and CEF-G82-5S exceed benzene, isopropylbenzene, 1,2,4-trimethylbenzene, naphthalene, 1-methylnaphthalene, 2-methylnaphthalene, and TRPH GCTLs. Soil contamination that exceeds leachability SCTLs remains at this site. Approximately 49 square yards of impacted soil were not accessible for removal due to the proximity to Building 82 and is now capped with a concrete handicap ramp, thus groundwater is the medium of concern. MNA is the selected remedy for groundwater at the site, so groundwater monitoring is required to determine whether natural attenuation is occurring at the site or whether a different remedy should be considered.

11.2.1 Study Boundaries

The Building 82, Tank G82 area covers approximately 100 feet by 75 feet, or 7,500 square feet. This is delineated from the northwest corner to the southeast corner by CEF-G82-3S and CEF-G82-5S, respectively, as shown on Figure 10.2-1. The vertical boundary for the groundwater plume is from 5 feet to no deeper than 15 feet bgs. The contaminated groundwater plume is the population of interest and constitutes the spatial decision unit. The temporal decision unit is each round of monitoring when determined whether an exceedance of GCTL has occurred and it is two consecutive monitoring rounds when determining whether parameters or wells may be eliminated from monitoring.

11.2.2 Analytical Approach

A direct comparison of measured concentrations within the groundwater will be made against the appropriate PAL. PALs are detailed for each COC in Worksheet #15. Additionally, if none of the measured COC concentrations within any groundwater sample exceed criteria after two consecutive rounds of monitoring, then the monitoring program will be discontinued after coordination with the BCT. The following decision rules govern data use for the monitoring programs at Building 82, Tank G82.

Decision Rule #1: If any measured concentration of any COC from any sample is greater than or equal to the GCTL in non-compliance/source wells, then continue LTM until levels of COCs in a particular well are less than the GCTL for two consecutive sampling rounds.

Decision Rule #2: If any sample taken from a compliance well has a measured COC concentration that is greater than or equal to the GCTL, then conduct additional delineation of groundwater contamination. The additional delineation will be performed by Resolution Consultants at the direction and approval of the BRAC BCT Team and an FTMR will be issued to govern the delineation.

Decision Rule #3*:* If any measured COC concentration is greater than or equal to the GCTL in any sample but no migration is detected outside of the compliance wells for two consecutive semi-annual events, then a permanent groundwater restriction will be evaluated for RMO III (62-780.680, F.A.C). This will indicate that contamination exists and the contaminated area is defined. RMO III will put a restriction on the use of the groundwater, but allow it to remain onsite.

Decision Rule #4*:* If all measured concentrations of COCs in all groundwater samples are less than action levels for two consecutive quarters in all wells at the site, then recommend NFA.

Decision Rule #5: Throughout the groundwater monitoring, if any particular measured COC concentration is less than its GCTL for two consecutive sampling rounds or all measured COC concentrations in any particular well are less than GCTLs for at least two consecutive sampling rounds, then the BCT will discuss the elimination of the well or COC from the monitoring program, in accordance with the Navy guidance on groundwater monitoring well optimization. The well (or COC) will be eliminated unless the well is a compliance well, or the BCT determines that the inclusion of the well (or COC) provides useful information on evaluating the overall program and should not be removed.

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES FOR BUILDING 82, TANKS G82

Site:	Building 82, Tank G82						
Matrix:	Groundwater						
Analytical Group:	Volatile Organic Compounds						
Analyte	**CAS No.**	**Project Action Level (µg/L)**	**Project Action Level Source (µg/L)**	**Project Quantitation Limit Goal (µg/L)**	**Laboratory Limit of Quantitation[1] (µg/L)**	**Laboratory Limit of Detection[1] (µg/L)**	**Laboratory Method Detection Limit[1] (µg/L)**
Benzene	71-43-2	1	FDEP GCTL	0.3	1	0.5	0.25
Isopropylbenzene	98-82-8	0.8	FDEP GCTL	0.26	**1**	0.5	0.25
1,2,4-Trimethylbenzene	95-63-6	10	FDEP GCTL	3.3	1	0.5	0.25

Notes:
[1] Laboratory quantitation, detection, and method detection limits, provided by Empirical Laboratory, are targets that are achievable under optimal conditions and may vary during the course of the project. Physical characteristics, such as matrix interference, will affect the actual limits achieved.

CAS No. = Chemical Abstract Services number
µg/L = Micrograms per liter
FDEP GCTL = Florida Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005; http://www.dep.state.fl.us/legal/Rules/waste/62-777/62-777_TableI_GroundwaterCTLs.pdf
Bold = Project action level is less than the laboratory limit of quantitation but the limit of detection is sufficiently low to meet the intended data use

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES FOR BUILDING 82, TANKS G82

Site:	Building 82, Tank G82						
Matrix:	Groundwater						
Analytical Group:	Polynuclear Aromatic Hydrocarbons						
Analyte	**CAS No.**	**Project Action Level (µg/L)**	**Project Action Level Source (µg/L)**	**Project Quantitation Limit Goal (µg/L)**	**Laboratory Limit of Quantitation[1] (µg/L)**	**Laboratory Limit of Detection[1] (µg/L)**	**Laboratory Method Detection Limit[1] (µg/L)**
Naphthalene	91-20-3	14	FDEP GCTL	4.6	0.2	0.1	0.05
1-Methylnaphthalene	90-12-0	28	FDEP GCTL	9.3	0.2	0.1	0.05
2-Methylnaphthalene	91-57-6	28	FDEP GCTL	9.3	0.2	0.1	0.05

Site:	Building 82, Tank G82						
Matrix:	Groundwater						
Analytical Group:	Total Recoverable Petroleum Hydrocarbons						
Analyte	**CAS No.**	**Project Action Level (mg/L)**	**Project Action Level Source (mg/L)**	**Project Quantitation Limit Goal (mg/L)**	**Laboratory Limit of Quantitation[1] (mg/L)**	**Laboratory Limit of Detection[1] (mg/L)**	**Laboratory Method Detection Limit[1] (mg/L)**
TRPH (C8-C40)	-3558	5	FDEP GCTL	1.67	0.68	0.34	0.17

Notes:
[1] Laboratory quantitation, detection, and method detection limits, provided by Empirical Laboratory, are targets that are achievable under optimal conditions and may vary during the course of the project. Physical characteristics, such as matrix interference, will affect the actual limits achieved.

CAS No. = Chemical Abstract Services number
µg/L = Micrograms per liter
mg/L = Milligrams per liter
TRPH = Total Recoverable Petroleum Hydrocarbons
FDEP GCTL = Florida Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005; http://www.dep.state.fl.us/legal/Rules/waste/62-777/62-777_TableI_GroundwaterCTLs.pdf

SAP WORKSHEET #17: SAMPLING DESIGN AND RATIONALE FOR BUILDING 82, TANKS G82

Site-Specific Sampling Design

The sampling design and rationale are based on the NAMP submitted by CH2M Hill on 29 May 2008. The seven shallow wells (CEF-G82-1S, CEF-G82-2S, CEF-G82-3S, CEF-G82-4S, CEF-G82-5S, CEF-G82-6S, and CEF-G82-2I) were chosen based on historical groundwater flow data, detections of COCs in the wells, and whether they are downgradient or upgradient from the contamination plume. The intent is to include wells that indicate whether contaminant concentrations are naturally attenuating. Semi-annual sampling will occur for two years based on the NAMP. The sampling locations are detailed in Worksheet #18. A map of the monitoring wells is provided in Figure 10.2-1.

BP WELLS

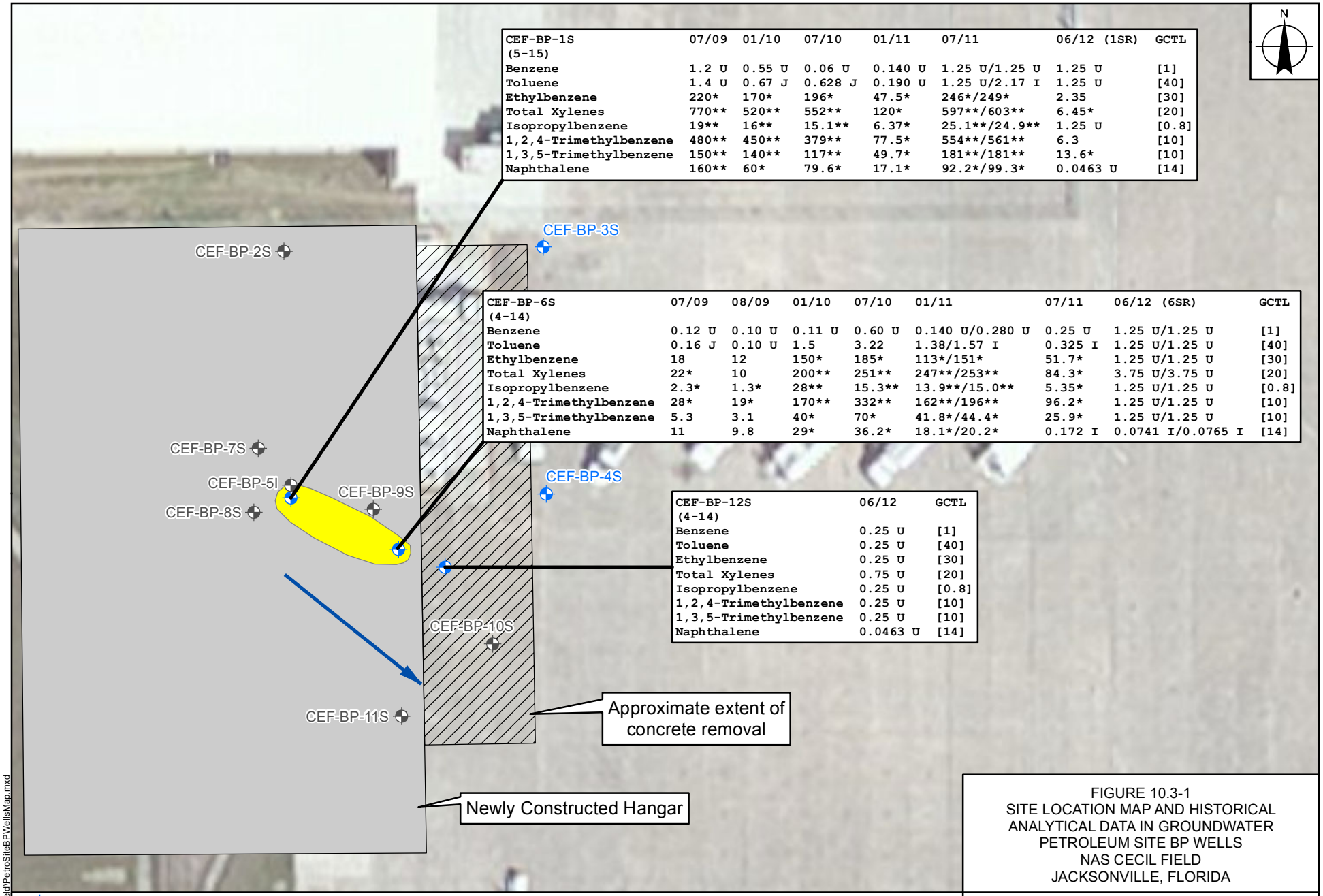
SAP WORKSHEET #10: CONCEPTUAL SITE MODEL FOR BP WELLS

10.3.1 Site Description — BP Wells

The area where the British Petroleum (BP) Wells are located is on the north-south flight line, southeast of Building 880, on the western edge of the apron. The BP Wells area is associated with an area formerly consisting of secondary containment for several large above ground storage tanks (ASTs) that served to refuel planes and other vehicles. The ASTs and secondary containment have been removed and a newly constructed hangar is located on top of the current plume. A detailed site plan is shown on Figure 10.3-1. Post remediation monitoring is currently being conducted at the site.

10.3.2 History of Environmental Investigations and Actions — BP Wells

In October 1999, Golder Associates, Inc. performed a due diligence investigation of the area for construction of a proposed aircraft fueling station on behalf of BP Kaman. The history of the BP Wells area prior to the due diligence investigation is not documented. As part of the due diligence investigation, four shallow monitoring wells (CEF-BP-1 through CEF-BP-4) were installed and sampled for organic compounds. TRPH, toluene; ethylbenzene, xylenes, naphthalene, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene were detected in one well at concentrations greater than FDEP GCTLs. Based on the initial results, the Navy directed TtNUS to further investigate the nature and extent of the groundwater contamination. A SAR was initiated by TtNUS in February 2000 based on the results of the due diligence investigation. Xylenes, 1,2,4-trimethylbenzene-, and 1,3,5-trimethylbenzne were detected in monitoring well CEF-BP-1S at concentrations above the FDEP GCTLs. The SAR recommended a groundwater MOP for xylenes, 1,2,4-trimethylbenzene, and 1,3,5-trimethylbenzene, which was subsequently approved on August 31, 2000 (FDEP, 2000a).



CEF-BP-1S (5-15)	07/09	01/10	07/10	01/11	07/11	06/12 (1SR)	GCTL
Benzene	1.2 U	0.55 U	0.06 U	0.140 U	1.25 U/1.25 U	1.25 U	[1]
Toluene	1.4 U	0.67 J	0.628 J	0.190 U	1.25 U/2.17 I	1.25 U	[40]
Ethylbenzene	220*	170*	196*	47.5*	246*/249*	2.35	[30]
Total Xylenes	770**	520**	552**	120*	597**/603**	6.45*	[20]
Isopropylbenzene	19**	16**	15.1**	6.37*	25.1**/24.9**	1.25 U	[0.8]
1,2,4-Trimethylbenzene	480**	450**	379**	77.5*	554**/561**	6.3	[10]
1,3,5-Trimethylbenzene	150**	140**	117**	49.7*	181**/181**	13.6*	[10]
Naphthalene	160**	60*	79.6*	17.1*	92.2*/99.3*	0.0463 U	[14]

CEF-BP-6S (4-14)	07/09	08/09	01/10	07/10	01/11	07/11	06/12 (6SR)	GCTL
Benzene	0.12 U	0.10 U	0.11 U	0.60 U	0.140 U/0.280 U	0.25 U	1.25 U/1.25 U	[1]
Toluene	0.16 J	0.10 U	1.5	3.22	1.38/1.57 I	0.325 I	1.25 U/1.25 U	[40]
Ethylbenzene	18	12	150*	185*	113*/151*	51.7*	1.25 U/1.25 U	[30]
Total Xylenes	22*	10	200**	251**	247**/253**	84.3*	3.75 U/3.75 U	[20]
Isopropylbenzene	2.3*	1.3*	28**	15.3**	13.9**/15.0**	5.35*	1.25 U/1.25 U	[0.8]
1,2,4-Trimethylbenzene	28*	19*	170**	332**	162**/196**	96.2*	1.25 U/1.25 U	[10]
1,3,5-Trimethylbenzene	5.3	3.1	40*	70*	41.8*/44.4*	25.9*	1.25 U/1.25 U	[10]
Naphthalene	11	9.8	29*	36.2*	18.1*/20.2*	0.172 I	0.0741 I/0.0765 I	[14]

CEF-BP-12S (4-14)	06/12	GCTL
Benzene	0.25 U	[1]
Toluene	0.25 U	[40]
Ethylbenzene	0.25 U	[30]
Total Xylenes	0.75 U	[20]
Isopropylbenzene	0.25 U	[0.8]
1,2,4-Trimethylbenzene	0.25 U	[10]
1,3,5-Trimethylbenzene	0.25 U	[10]
Naphthalene	0.0463 U	[14]

FIGURE 10.3-1
SITE LOCATION MAP AND HISTORICAL ANALYTICAL DATA IN GROUNDWATER
PETROLEUM SITE BP WELLS
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Monitoring Well
Abandoned Well
Groundwater Flow Direction
VOC Plume

CEF-BP-12S = Sample ID
(4-14) = Well screen interval, feet below ground surface
220 = Detected concentration (Sample/Duplicate in µg/L)
* = GCTL value exceeded

** = NADC value exceeded
I = Reported value is between MDL and PQL
J = Estimated concentration
U = Not detected at or above MDL (associated value)
[1] = Ground Cleanup Target Level (GCTL)

1 inch = 40 feet
0 10 20 30 40 Feet

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUESTED BY: K. Wimble	DATE: 12/12/2012
DRAWN BY: N. Rinehart	PROJECT NUMBER: 0888812660

X:\Navy\NAS_CecilField\PetroSite8PWellsMap.mxd

SOURCE: ARCGIS ONLINE BING AERIAL (c) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS

During MOP implementation, the direction of groundwater flow continued to be to the southeast. The analytical results indicated that the action levels for 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, and xylenes were exceeded in the groundwater sample from monitoring well CEF-BP-1S. The concentrations of 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, and xylenes in groundwater samples from CEF-BP-1S also exceeded the Natural Attenuation Default Concentrations (NADCs). The concentrations in monitoring well CEF-BP-1S were also significantly greater than those observed in the previous sampling event (April 2001).

The monitoring report recommended that the semi-annual monitoring program be suspended and that a Remedial Action Plan (RAP) be prepared for the site because the contaminant concentrations at the source well were greater than the NADCs and because there was a significant increase in contaminant concentrations. On 20 February 2002, the FDEP agreed that a RAP was warranted. Subsequently, TtNUS recommended that a Treatability Study be conducted for this small petroleum plume. The Treatability Study was completed in five installments from October 2002 through October 2003, and tested the effectiveness of an iSOC gas infusion system in reducing hydrocarbon concentrations in groundwater at the BP Wells site. The Treatability Study Report (TtNUS, 2004), stated that the iSOC system was not effective and it was recommended that an air sparging pilot study be conducted. At the March 2004 BCT meeting, it was agreed that the Treatability Study approach would be discontinued and an additional site assessment would occur.

No action was taken until a site-wide groundwater monitoring event was performed by CH2M Hill in November 2006. Isopropylbenzene, ethylbenzene, total xylenes, 1,3,5-trimethylbenzene, and 1,2,4-trimethylbenzene were detected in monitoring well CEF-BP-1S at concentrations exceeding their respective GCTLs (CH2M HILL, 2007). CH2M Hill submitted a NAMP for the BP Wells, in conjunction with the adjacent Building 82, Tank G82 site, identifying that LTM of natural attenuation in groundwater for three years was needed (CH2M HILL, 2008).

Semi-annual sampling in accordance with the updated NAMP began in July 2008. GCTLs and NADCs for various COCs continued to be exceeded in the source well, CEF-BP-1S, and levels of COCs increased from July 2008 to January 2010 in downgradient well CEF-BP-6S. *Field Task Modification Report* No. 1(FTMR No. 01) (TtNUS in May 2010) recommended the installation of two shallow groundwater wells downgradient of CEF-BP-6S, and the collection of four soil samples in the vicinity of CEF-BP-1S. The purpose of these proposed actions was to establish a new downgradient groundwater monitoring point for the shallow zone of the surficial aquifer and to ensure that a continuing soil source was not contributing to the groundwater contamination. The groundwater monitoring well and soil sample locations were confirmed at the May 2010 BCT meeting (Minute 2621).

On 19 July 2010, in accordance with FTMR No. 01, four soil samples were collected from four soil borings: CEF-BP-SS01 (located adjacent to CEF-BP-1S); and CEF-BP-SS02, CEF-BP-SS03, CEF-BP-SS04 (located approximately 10 feet west, northwest, and north, respectively, from CEF-BP-1S). No borings were installed to the south or east of CEF-BP-1S because of Building 838 and the flight line. Soil samples were collected at 1-foot intervals until the water table was encountered (approximately 4.5 feet bgs) and tested with an organic vapor analyzer (flame ionization detector).

Concentrations reported by the laboratory for soil samples collected during this sampling event were compared to FDEP SCTLs. Concentrations of benzo(a)pyrene equivalents exceeded the residential SCTL of 0.1 milligrams per kilogram in soil sample CEF-BP-SS01. TRPH concentrations exceed residential and leachability SCTLs in both CEF-BP-SS01 and CEF-BP-SS04. No other analytes were detected in excess of SCTLs in any of the other soil samples, as reported in the *Groundwater Monitoring and Supplemental Soil Sampling Report, First Semi-Annual, Third Year — July 2010 report*. TRPH was not detected at levels greater than GCTLs in groundwater.

During the November 2010 BCT meeting, it was decided that wells CEF-BP-7S and CEF-BP-8S did not need to be monitored any longer, other than the measurement of water levels, and also that no further action with regards to soil was required at this time. (Meeting Minute No. 2651, Decisions 794 and 795). A Field Task Modification Report (FTMR) was prepared to reflect this change to the monitoring program.

In January 2011, samples were collected from wells CEF-BP-1S, CEF-BP-4S, CEF-BP-5I, CEF-BP-6S, CEF-BP-9S, CEF-BP-10S, and CEF-BP-11S. No concentrations exceeded NADCs in the CEF-BP-1S after concentrations of several COCs were greater than their respective NADCs for the previous four semi-annual events. Several COCs exceeded GCTLs in CEF-BP-1S and CEF-BP-6S; and concentrations of 1,2,4-trimethylbenzene, total xylenes, and isopropylbenzene exceeded NADCs in CEF-BP-6S. Based on the results of the January 2011 sampling event, it was recommended that a pilot study be conducted or RAP be prepared to address the NADC exceedances at the site. A *Work Plan for Chemical Injection using DPT, BP Wells Site* (TtNUS, 2011) was prepared based on BCT discussions and decisions at the May 2011 BTC Meeting (Decision No. 813, Minute No. 2682) to inject Oxygen Release Compound Advanced (ORC Advanced).

Prior to ORC Advanced chemical injection, monitoring wells CEF-BP-1S, CEF-BP-2S, CEF-BP-5I, and CEF-BP-6S through CEF-BP-11S were abandoned using in-situ grouting methods because of upcoming hangar construction activities planned at the site. The injection of the ORC Advanced was conducted immediately after the demolition of the building and adjacent concrete taxiway apron and during the final site preparation activities. The chemical injection was conducted from 15 November 2011 through 18 November 2011. The twenty-four ORC Advanced injection points were used to treat a 1,200 square-foot area with the injection points spaced 7 feet apart and the rows spaced 8 feet apart, located around the area with the highest exceedances of COCs. Two additional injection points were added west of the former oil/water separator (OWS) for a total of twenty-six points. They were positioned mid-point between the southernmost row and the middle row.

Upon completion of the hangar, JAA installed three new monitoring wells in May 2012. These monitoring wells are distinguished as CEF-BP-1SR, CEF-BP-6SR, and CEF-BP-12S. Based on the FTMR submitted in 8 June 2012 and BCT decisions, groundwater samples were collected at these newly installed wells on 25 June 2012.

In the source well CEF-BP-1SR, the concentration of 1,3,5-trimethylbenzene exceeded the GCTL. During the previous event, a total of five VOCS (xylenes, isopropylbenzene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, and ethylbenzene) and naphthalene exceeded GCTLs in well CEF-BP-1S. In downgradient well CEF-BP-6SR, concentrations decreased to non-detect or to less than the GCTLs. In the previous event, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, total xylenes, isopropylbenzene, and ethylbenzene exceeded GCTLs in well CEF-BP-6S. No COC concentrations were detected in groundwater from the farther downgradient well CEF-BP-12S. The concentrations detected during the June 2012 groundwater sampling event were significantly lower, apparently as a result of the effectiveness of the injection of ORC Advanced.

Currently, three wells (CEF-BP-1SR, CEF-BP-6SR, and CEF-BP-12) are sampled semi-annually for BTEX, isopropylbenzene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, naphthalene, 1-methylnapthalene, 2-methylnaphthalene, and TRPH. Monitoring wells CEF-BP-1S and CEF-BP-6S have been replaced with CEF-BP-1SR and CEF-BP-6SR. Groundwater elevations are measured at five wells (CEF-BP-1SR, CEF-BP-3S, CEF-BP-4S, CEF-BP-6SR, and CEF-BP-12S) at the site.

10.3.3 Conceptual Site Model — BP Wells

A summary of the CSM based on post-removal action site conditions at the BP Wells site is shown on Figure 10.3-2. The text below describes the CSM.

10.3.3.1 Sources of Contamination — BP Wells

The contaminant source area well (CEF-BP-1S) was located at the southeastern corner of the secondary containment for several large ASTs that actively serve to refuel planes and other vehicles at the former NAS Cecil Field. The pipe used to direct accumulated water inside the secondary containment empties adjacent to source well CEF-BP-1S. This pipe leads to the OWS located directly to the west of source cell CEF-BP-1S, and according to a representative of the JAA in July 2009 the OWS has overflowed repeatedly, possibly contributing to the source of the contamination.

Ethylbenzene, 2-methylnaphthalene, isopropylbenzene, naphthalene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, and total xylenes were previously detected at the BP Wells at concentrations greater than their respective GCTLs prior to remedial efforts.

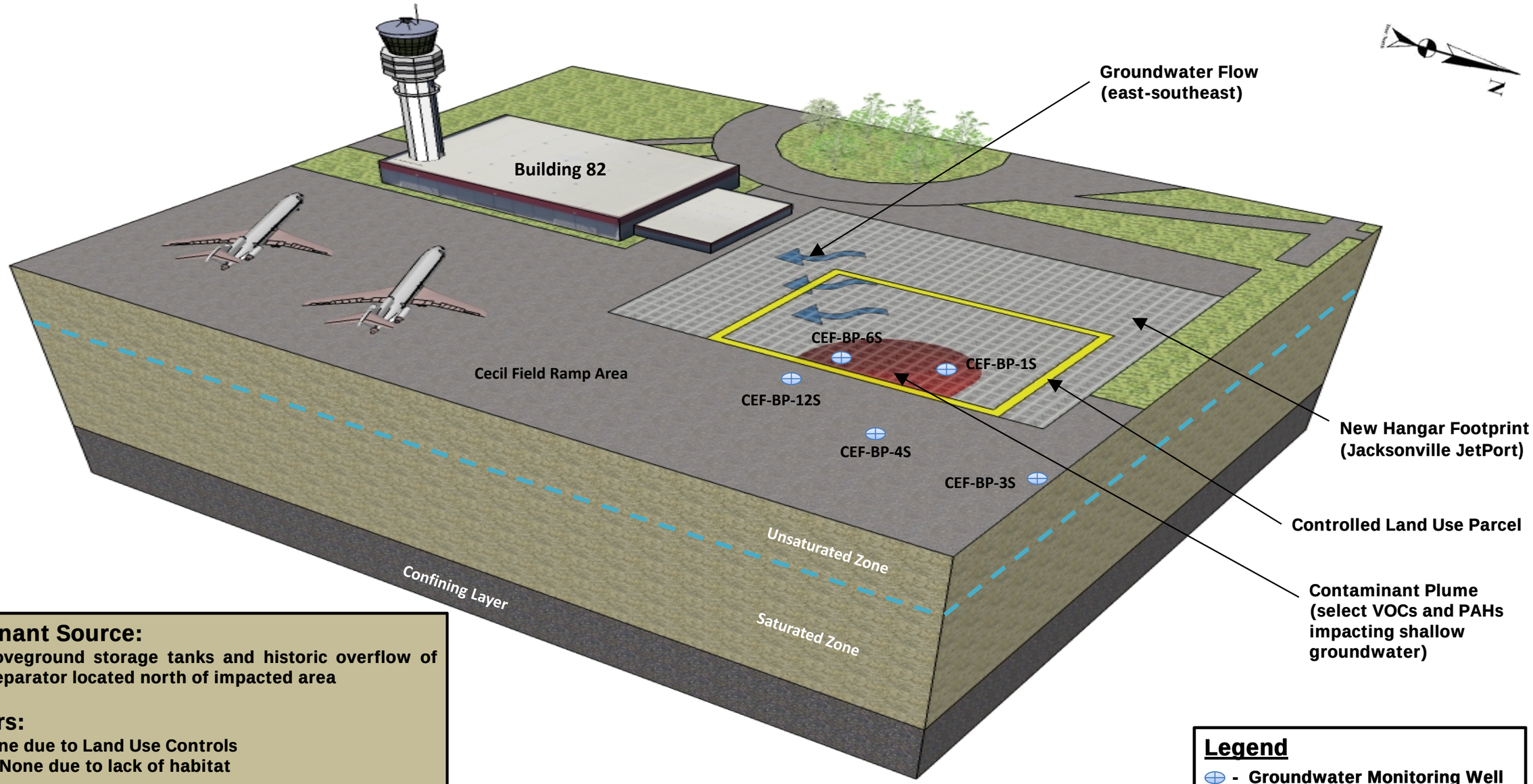
10.3.3.2 Potential Contaminant Migration Mechanisms — BP Wells

VOC and PAH contamination is located in the shallow zone of the surficial groundwater aquifer only (no deeper than 15 feet bgs), and the contamination is migrating from the source area to the southeast in the shallow zone of the aquifer. Soil contaminants may continue to migrate to groundwater under the influence of infiltrating precipitation. Upon entering the water column, a chemical may be carried with the flow of groundwater to downgradient locations.

The most recent data indicate that the contamination is located under the flight line apron at the top of the water table in groundwater only, and the contamination is migrating in the shallow zone of the surficial aquifer. In addition, the site is located on the apron and is covered with concrete and a hangar. The contamination groundwater flow is to the southeast.

10.3.3.3 Land Uses and Potential Exposure

The JEDC Reuse Plan provides for continued industrial and/or commercial uses of the site.



Contaminant Source:

Former aboveground storage tanks and historic overflow of oil-water separator located north of impacted area

Receptors:

Human: None due to Land Use Controls
Ecological: None due to lack of habitat

Land Use Controls:

- Land may not be used for residential, recreational, or agricultural use
- Surface soils may not be disturbed
- Subsurface soils may not be disturbed
- Groundwater may not be used for human consumption
- Groundwater may not be used for industrial purposes
- Tampering or damaging any Navy wells or remediation systems is prohibited

Legend

- Groundwater Monitoring Well

NOTES:

1. Conceptual Site Model not to scale. Horizontal dimensions based on recent aerial imaging, site visits, and historic knowledge. Vertical dimensions exaggerated for purpose of conveying pertinent site information.
2. Groundwater monitoring well locations are approximated based on geographic information system data.

Figure 10.3-2
Conceptual Site Model
BP Wells
Former NAS Cecil Field, Jacksonville, Florida

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUEST BY: Kara Wimble	DATE: 11/02/2012
DRAWN BY: David Myers	CTO NO. JM34

LUCs were developed for this site in January 2005, revised in June 2005, and identified the site has aromatics and naphthalenes exceeding human health criteria in groundwater (TtNUS, 2007). The LUCs are as follows:

- Land may not be used for residential, recreational, or agricultural use
- Surface soils may not be disturbed
- Subsurface soils may not be disturbed
- Groundwater may not be used for human consumption
- Groundwater may not be used for industrial purposes
- Tampering or damaging any Navy wells or remediation systems is prohibited

Former NAS Cecil Field is supplied with public water; therefore, human exposure to potentially contaminated site groundwater through ingestion, inhalation, or direct contact is not a consideration. Ecological receptors are not exposed to groundwater; however contamination exceeding regulatory criteria remains.

This petroleum site is located in a highly developed area, consists largely of paved areas and buildings, and does not allow for direct access for contact with groundwater. The resulting lack of ecological habitat and complete exposure pathways preclude potential unacceptable risks for ecological receptors. Direct exposure of potential human receptors to soil and groundwater is restricted based upon the current and future land use.

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

11.3 Problem Definition

The COCs exceeded their action levels (GCTLs and NADCs) in groundwater increasing contaminant concentrations appeared to be increasing and migrating downgradient, therefore active remediation in the form of ORC injections occurred at the site. The first quarter of post-ORC injection sampling (June 2012) still showed minor GCTL exceedances at the site. Groundwater monitoring is still required to determine whether the ORC injections will reduce the COCs below their respective GCTLs or other actions should be taken.

11.3.1 Study Boundaries

The BP Wells area covers approximately 9,375 square feet to the north of Building 82. The former plume area is delineated from the northwest corner by CEF-BP-2S to the southeast corner by CEF-BP-6S and CEF-BP-4S, as shown on Figure 10.3-1. The vertical boundary for the groundwater contaminant plume is the water table. The contaminated groundwater is the population of interest and constitutes the spatial decision unit. The temporal decision unit is each round of monitoring when determined whether an exceedance of GCTL has occurred and it is two consecutive monitoring rounds when determining whether parameters or wells may be eliminated from monitoring.

11.3.2 Analytical Approach

A direct comparison of measured concentrations within the groundwater will be made against the appropriate PAL. PALs are detailed for each COC in Worksheet #15. Additionally, if none of the measured COC concentrations within any groundwater sample exceed criteria after two consecutive rounds of monitoring, then the monitoring program will be discontinued after coordination with the BCT. The following decision rules govern data use for the monitoring programs at BP Wells.

Decision Rule #1: If any measured source well groundwater COC concentration in any sample is greater than its GCTL, then continue LTM until measured COC concentrations are less than their GCTL for two consecutive sampling rounds.

Decision Rule #2: If any measured COC concentration in any sample is greater than its GCTL in the compliance well, then conduct additional delineation of contamination in groundwater. The additional delineation will be performed by Resolution Consultants at the direction and approval of the BRAC BCT Team and an FTMR will be issued to govern the delineation.

Decision Rule #3: If the measured COC concentration exceeds the GCTL in any sample but no migration is detected outside of the compliance wells for four consecutive quarters, then a permanent groundwater restriction will be evaluated for RMO III (62-780.680, F.A.C.). This will indicate that contamination exists and the contaminated area is defined. RMO III will put a restriction on the use of the groundwater, but allow it to remain onsite.

Decision Rule #4: If all measured COC concentrations in all groundwater samples are less than action levels for two consecutive quarters in all wells within the BP Wells area, then recommend NFA.

Decision Rule #5: If measured COC concentrations are between GCTLs and NADCs in the source wells, then a MNA Plan will be developed by Resolution Consultants once it is deemed necessary by the BCT Team.

Decision Rule #6: Throughout the groundwater monitoring, if any particular measured COC concentration is less than its GCTL for two consecutive sampling rounds or all measured COC concentrations in any particular well are less than GCTLs for at least two consecutive sampling rounds, then the BCT will discuss the elimination of the well or COC from the monitoring program, in accordance with the Navy guidance on groundwater monitoring well optimization. The well (or COC) will be eliminated unless the well is a compliance well, or the BCT determines that the inclusion of the well (or COC) provides useful information on evaluating the overall program and should not be removed.

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES FOR BP WELLS

Site:	BP Wells
Matrix:	Groundwater
Analytical Group:	Volatile Organic Compounds

Analyte	CAS No.	Project Action Level (µg/L)	Project Action Level Source (µg/L)	Project Quantitation Limit Goal (µg/L)	Laboratory Limit of Quantitation[1] (µg/L)	Laboratory Limit of Detection[1] (µg/L)	Laboratory Method Detection Limit[1] (µg/L)
Ethylbenzene	100-14-4	30	FDEP GCTL	10	1	0.5	0.25
Isopropylbenzene	98-82-8	0.8	FDEP GCTL	0.26	**1**	0.5	0.25
1,2,4-Trimethylbenzene	95-63-6	10	FDEP GCTL	3.3	1	0.5	0.25
1,3,5-Trimethylbenzene	108-67-8	10	FDEP GCTL	3.3	1	0.5	0.25
Total Xylenes	1330-20-7	20	FDEP GCTL	6.7	3	1.5	0.75

Notes:
[1] Laboratory quantitation, detection, and method detection limits, provided by Empirical Laboratory, are targets that are achievable under optimal conditions and may vary during the course of the project. Physical characteristics, such as matrix interference, will affect the actual limits achieved.

CAS No. = Chemical Abstract Services number
µg/L = Micrograms per liter
FDEP GCTL = Florida Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005; http://www.dep.state.fl.us/legal/Rules/waste/62-777/62-777_TableI_GroundwaterCTLs.pdf
Bold = Project action level is less than the laboratory limit of quantitation but the limit of detection is sufficiently low to meet the intended data use

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES FOR BP WELLS

Site:	BP Wells						
Matrix:	Groundwater						
Analytical Group:	Polynuclear Aromatic Hydrocarbons						
Analyte	**CAS No.**	**Project Action Level (µg/L)**	**Project Action Level Source (µg/L)**	**Project Quantitation Limit Goal (µg/L)**	**Laboratory Limit of Quantitation[1] (µg/L)**	**Laboratory Limit of Detection[1] (µg/L)**	**Laboratory Method Detection Limit[1] (µg/L)**
Naphthalene	91-20-3	14	FDEP GCTL	4.6	0.2	0.1	0.05
2-Methylnaphthalene	91-57-6	28	FDEP GCTL	9.3	0.2	0.1	0.05

Site:	BP Wells						
Matrix:	Groundwater						
Analytical Group:	Total Recoverable Petroleum Hydrocarbons						
Analyte	**CAS No.**	**Project Action Level (mg/L)**	**Project Action Level Source (mg/L)**	**Project Quantitation Limit Goal (mg/L)**	**Laboratory Limit of Quantitation[1] (mg/L)**	**Laboratory Limit of Detection[1] (mg/L)**	**Laboratory Method Detection Limit[1] (mg/L)**
TRPH (C8-C40)	-3558	5	FDEP GCTL	1.67	0.68	0.34	0.17

Notes:

[1] Laboratory quantitation, detection, and method detection limits, provided by Empirical Laboratory, are targets that are achievable under optimal conditions and may vary during the course of the project. Physical characteristics, such as matrix interference, will affect the actual limits achieved.

CAS No. = Chemical Abstract Services number
µg/L = Micrograms per liter
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TRPH = Total Recoverable Petroleum Hydrocarbons
FDEP GCTL = Florida Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005; http://www.dep.state.fl.us/legal/Rules/waste/62-777/62-777_TableI_GroundwaterCTLs.pdf

SAP WORKSHEET #17: SAMPLING DESIGN AND RATIONALE FOR BP WELLS

Site-Specific Sampling Design

The sampling design and rationale is based on the NAMP submitted by CH2M Hill on 29 May 2008. Chemical injection (ORC Advanced) was used to address the NADC exceedances in November 2011. Post-injection monitoring is being conducted on a semi-annual basis. The third post-ORC injection sampling event is scheduled for June 2013, sampling monitoring wells CEF-BP-1SR, CEF-BP-6SR, CEF-BP-12SR to gauge concentrations and the effectiveness of the injectant. The sampling locations are detailed in Worksheet #18. A map of the monitoring wells is provided in Figure 10.3-1.

HANGAR 815 WASH RACK

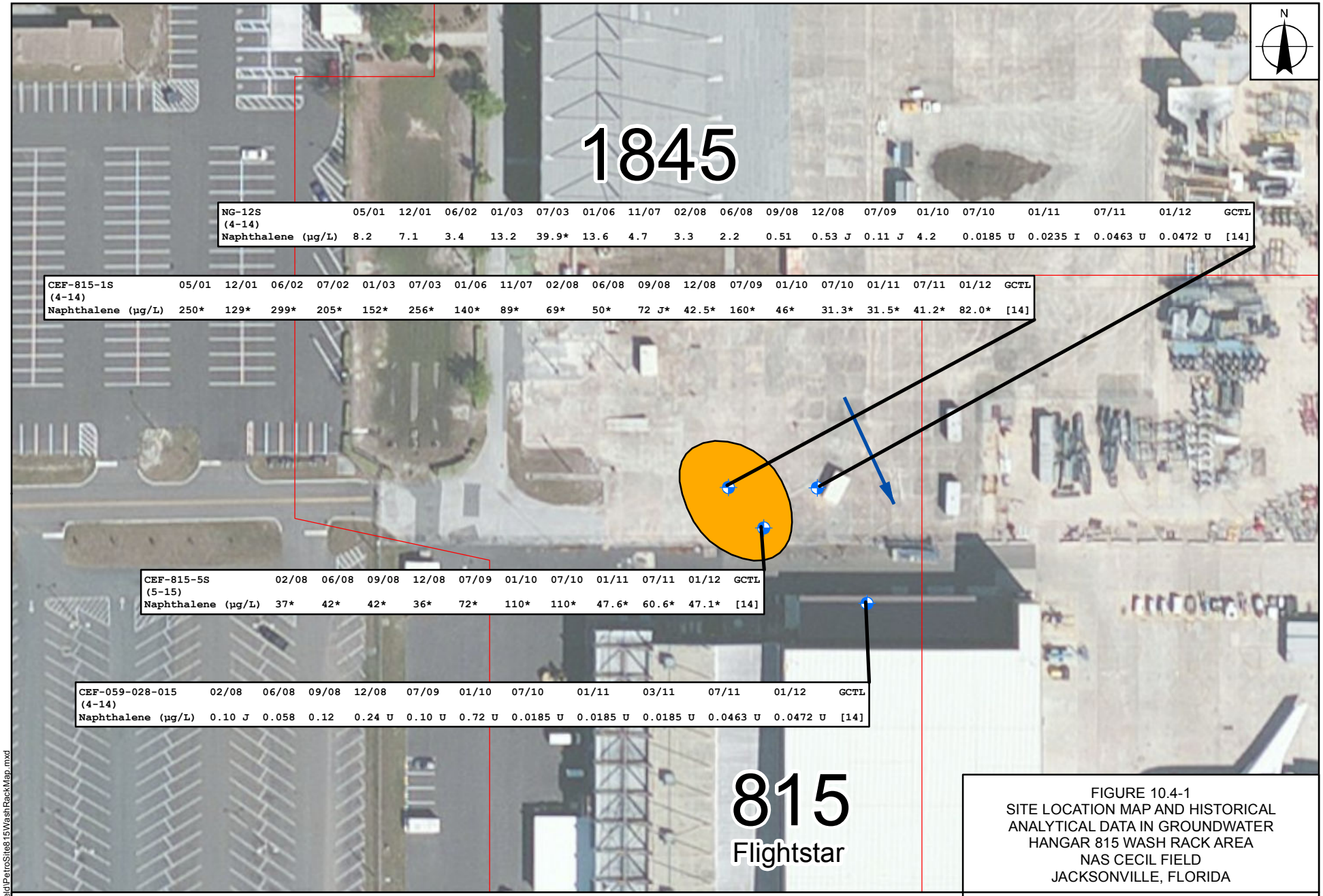
SAP WORKSHEET #10: CONCEPTUAL SITE MODEL FOR HANGAR 815 WASH RACK

10.4.1 Site Description — Hangar 815 Wash Rack

Hangar 815 is a maintenance hangar and is located at the northern end of the flight line, at the eastern end of Lake Newman Street (formerly 6th Street). There was a wash rack north of the hangar. A site plan is included as Figure 10.4-1.

10.4.2 History of Environmental Investigations and Actions — Hangar 815 Wash Rack

Naphthalene contamination was identified in groundwater. There are no tanks associated with this particular area of contamination. For the 1999 SAR, two shallow monitoring wells were installed at the wash rack. Under the FDEP Petroleum Program (FDEP, 2000b), the extent of contamination was delineated, and semi-annual monitoring was proposed and approved.



NG-12S (4-14)	05/01	12/01	06/02	01/03	07/03	01/06	11/07	02/08	06/08	09/08	12/08	07/09	01/10	07/10	01/11	07/11	01/12	GCTL
Naphthalene (µg/L)	8.2	7.1	3.4	13.2	39.9*	13.6	4.7	3.3	2.2	0.51	0.53 J	0.11 J	4.2	0.0185 U	0.0235 I	0.0463 U	0.0472 U	[14]

CEF-815-1S (4-14)	05/01	12/01	06/02	07/02	01/03	07/03	01/06	11/07	02/08	06/08	09/08	12/08	07/09	01/10	07/10	01/11	07/11	01/12	GCTL
Naphthalene (µg/L)	250*	129*	299*	205*	152*	256*	140*	89*	69*	50*	72 J*	42.5*	160*	46*	31.3*	31.5*	41.2*	82.0*	[14]

CEF-815-5S (5-15)	02/08	06/08	09/08	12/08	07/09	01/10	07/10	01/11	07/11	01/12	GCTL
Naphthalene (µg/L)	37*	42*	42*	36*	72*	110*	110*	47.6*	60.6*	47.1*	[14]

CEF-059-028-015 (4-14)	02/08	06/08	09/08	12/08	07/09	01/10	07/10	01/11	03/11	07/11	01/12	GCTL
Naphthalene (µg/L)	0.10 J	0.058	0.12	0.24 U	0.10 U	0.72 U	0.0185 U	0.0185 U	0.0185 U	0.0463 U	0.0472 U	[14]

FIGURE 10.4-1
SITE LOCATION MAP AND HISTORICAL ANALYTICAL DATA IN GROUNDWATER
HANGAR 815 WASH RACK AREA
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Monitoring Well
Groundwater Flow Direction
Approximate Plume (January 2012)
SiteBoundaries

CEF-815-5S = Sample ID
(5-15) = Well screen interval, feet below ground surface
37 = Detected concentration (Sample/Duplicate in µg/L)
* = GCTL value exceeded

I = Reported value is between MDL and PQL
J = Estimated concentration
U = Not detected at or above MDL (associated value)
[14] = Ground Cleanup Target Level (GCTL)

1 inch = 80 feet
0 20 40 60 80 Feet

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUESTED BY: K. Wimble	DATE: 12/12/2012
DRAWN BY: N. Rinehart	PROJECT NUMBER: 0888812660

X:\Navy\NAS_CecilField\PetroSite815WashRackMap.mxd

SOURCE: ARCGIS ONLINE BING AERIAL (c) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS

LTM occurred at the site per FDEP approval of the recommended sampling. Following the results from the July 2003 groundwater sampling event, TtNUS concluded that naphthalene concentrations in the well CEF-815-1S were continuously exceeding the annual milestone cleanup objectives (TtNUS, 2004b). TtNUS recommended that the monitoring program be discontinued and a RAP developed for the site. The FDEP concurred with discontinuing the monitoring program, but recommended conducting a soil assessment prior to preparation of a RAP. The results from the soil assessment indicated that the FDEP SCTL for TRPH was not exceeded where TRPH was detected. Site COCs (benzene, toluene, ethyl benzene, total xylenes, methyl tert-butyl ether, and PAHs) were not detected and all reporting limits were less than SCTLs (TtNUS, 2005b).

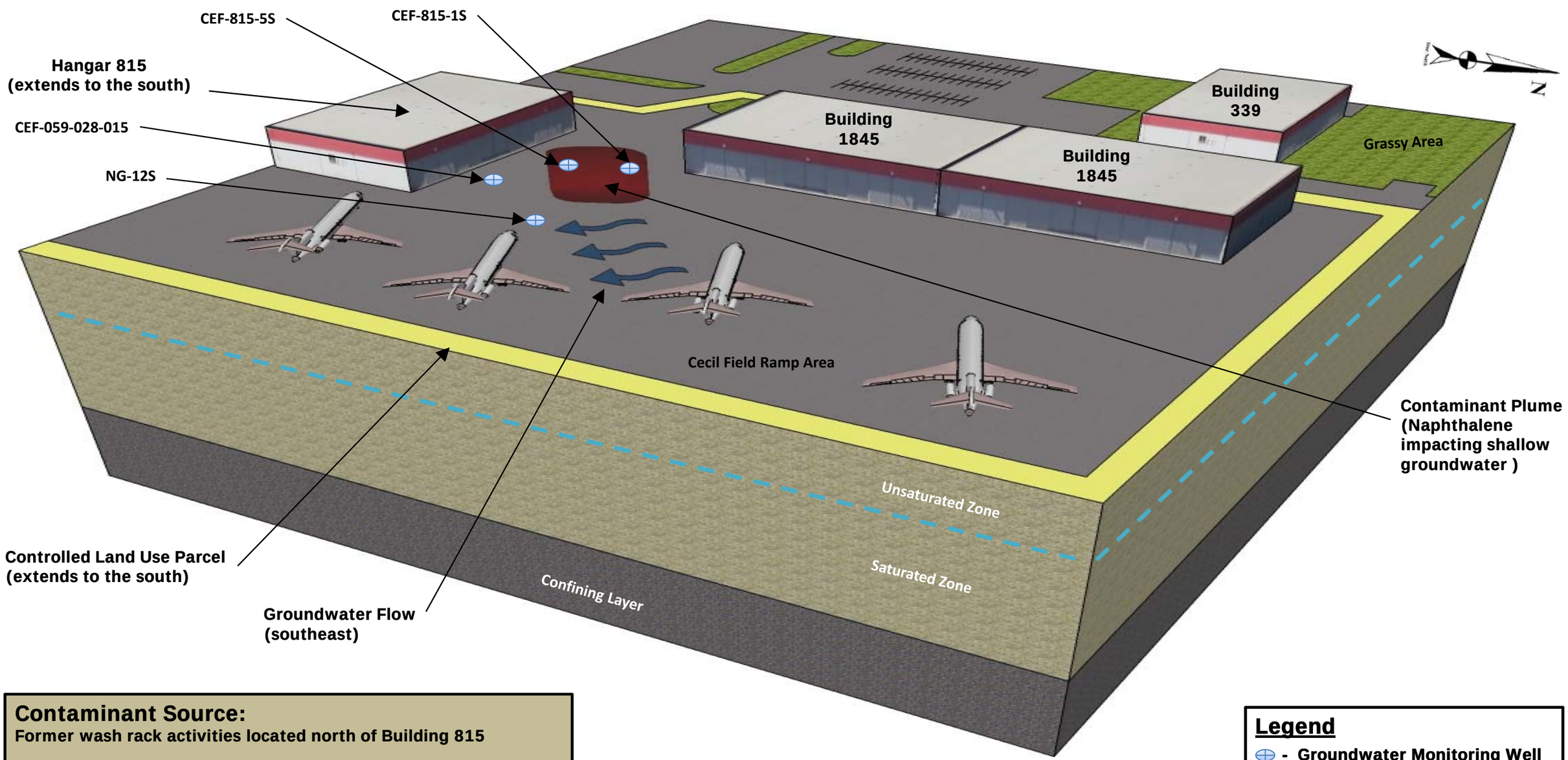
Based on results from the January 2005 supplemental soil sampling results, during the February 2005 partnering meeting, the BCT agreed to transfer the site from the UST program to the Installation Restoration (IR) Program so site remediation could occur concurrently with Site 59. Therefore, the remedial action was scheduled to be conducted under the IR Program.

However, during the September 2007 BCT meeting, it was decided that groundwater at the Hangar 815 Wash Rack area would be investigated under the Petroleum Program. In November 2007, TtNUS collected groundwater samples from monitoring wells CEF-815-1S and NG-12S and sampled for naphthalene and TRPH. Elevated levels of naphthalene were detected in CEF-815-1S; therefore, monitoring well CEF-815-5S was installed downgradient from the site to further delineate the contamination plume in February 2008. Because nearly two years had passed since the most recent groundwater sampling event had occurred at the site and a RAP had not been prepared pending the site's transfer to the IR Program, a SARA was completed in May 2008 (TtNUS, 2008c). Based on the recommendation of the SARA, FDEP approved LTM of the site (FDEP, 2008).

Currently, four wells (CEF-815-1S, CEF-815-5S, CEF-059-028-015, and NG-12S) are sampled annually for naphthalene only. Groundwater elevations are measured at the same four wells at the site.

10.4.3 Conceptual Site Model — Hangar 815 Wash Rack

A summary of the CSM based on site conditions at the 815 Wash Rack area is shown on Figure 10.4-2. The text below describes the CSM.



Contaminant Source:

Former wash rack activities located north of Building 815

Receptors:

Human: None due to Land Use Controls
Ecological: None due to lack of habitat

Land Use Controls:

- Groundwater may not be used for human consumption
- Groundwater may not be used for industrial purposes
- Tampering or damaging any Navy wells or remediation systems is prohibited

NOTES:

1. Conceptual Site Model not to scale. Horizontal dimensions based on recent aerial imaging, site visits, and historic knowledge. Vertical dimensions exaggerated for purpose of conveying pertinent site information.
2. Groundwater monitoring well locations are approximated based on geographic information system data.

Legend

- Groundwater Monitoring Well

Figure 10.4-2
Conceptual Site Model
Hangar 815 Wash Rack
Former NAS Cecil Field, Jacksonville, Florida

Naval Facilities Engineering Command

RESOLUTION CONSULTANTS

REQUEST BY: Kara Wimble	DATE: 11/02/2012
DRAWN BY: David Myers	CTO NO. JM34

10.4.3.1 Sources of Contamination — Hangar 815 Wash Rack

The source of Hangar 815 Wash Rack groundwater contamination is from former activities in the area of the wash rack located to the north of Hangar 815. Dioxins, SVOCs, pesticides, PCBs, and other metal analyses were conducted at this site but naphthalene is the only contaminant of concern, as no other chemicals have been detected at concentrations exceeding GCTLs.

10.4.3.2 Potential Contaminant Migration Mechanisms — Hangar 815 Wash Rack

Naphthalene contamination is limited to the shallow zone of the surficial groundwater aquifer and the contamination is migrating to the southeast from the Hangar 815 Wash Rack area. Surface water runoff from the Hangar 815 Wash Rack area is collected by below-ground storm sewer pipes that discharge to a flight line outfall on the eastern side of the north-south runways. A storm water retention pond located west of the 815 Wash Rack was investigated as PSC 56. The pond received discharges from floor drains in Hangar 1845 and from a nearby OWS. No further action was recommended based on the results of the PSC investigation of the storm water pond (TtNUS, 2001e).

Soil contaminants may migrate to groundwater under the influence of infiltrating precipitation. Upon entering the water column, a chemical may be carried with the flow of groundwater to downgradient locations. Groundwater contaminants may be ultimately deposited in sediment or surface water.

10.4.3.3 Land Uses and Potential Exposure — Hangar 815 Wash Rack

The JEDC Reuse Plan provides for continued industrial and/or commercial uses of the site.

LUCs were developed for IR Site 59, and Hangar 815 Wash Rack is contained within this area. The LUC RD identified that Site 59 has chlorinated volatiles exceeding human health criteria in groundwater; however, the COC for Hangar 815 Wash Rack is naphthalene (TtNUS, 2007). The LUCs are as follows:

- Groundwater may not be used for human consumption
- Groundwater may not be used for industrial purposes
- Tampering or damaging any Navy wells or remediation systems is prohibited

Former NAS Cecil Field is supplied with public water; therefore, human exposure to potentially contaminated site groundwater as a result of potable use is not a consideration. Ecological receptors are not exposed to groundwater; however, contamination exceeding regulatory

criteria remains. This petroleum site is located in a highly developed areas, consists largely of paved areas and buildings, and does not allow for direct access for contact with groundwater. The resulting lack of ecological habitat and complete exposure pathways preclude potential unacceptable risks for ecological receptors. Direct exposure of potential human receptors to soil and groundwater is prevented based upon the current and future land use.

SAP WORKSHEET #11: PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR HANGAR 815 WASH RACK

11.4 Problem Definition

Naphthalene exceeded the action levels (GCTL and NADC) in groundwater in the area of the former wash rack north of Hangar 815. LTM indicates that contaminant concentrations are generally within range of previous concentrations; however, contaminant migration currently does not appear to be occurring. MNA was the selected remedy for the site, so groundwater monitoring is required to determine whether natural attenuation is occurring at the site or other actions should be taken.

11.4.1 Study Boundaries

The Hangar 815 Wash Rack area covers approximately 0.5 acre between Buildings 1845 and Hangar 815, as shown on Figure 10.4-1. The vertical boundary for the groundwater plume is between 5 feet and 15 feet bgs. The contaminated groundwater is the population of interest and constitutes the spatial decision unit. The temporal decision unit is each round of monitoring when determined whether an exceedance of GCTL has occurred and it is two consecutive monitoring rounds when determining whether parameters or wells may be eliminated from monitoring.

11.4.2 Analytical Approach

A direct comparison of measured concentrations within the groundwater will be made against the appropriate PAL. The PAL for naphthalene is detailed in Worksheet #15. Additionally, if none of the measured naphthalene concentrations within any groundwater sample exceed criteria after two consecutive rounds of monitoring, then the monitoring program will be discontinued after coordination with the BCT. The following decision rules govern data use for the monitoring programs at Hangar 815 Wash Rack.

Decision Rule #1: If the measured naphthalene concentration is greater than its GCTL in any non-compliance/source well sample, then continue long-term monitoring until levels of naphthalene are below the GCTL for two consecutive sampling rounds.

Decision Rule #2: If any sample taken from the compliance wells has a measured naphthalene concentration greater than the GCTL, then conduct additional delineation of groundwater contamination. The additional delineation will be performed by Resolution Consultants at the direction and approval of the BRAC BCT Team and an FTMR will be issued to govern the delineation.

Decision Rule #3: If any measured naphthalene concentration in any sample exceeds the GCTL but no migration is detected outside of the compliance wells for four consecutive monitoring events, then a permanent groundwater restriction will be evaluated for RMO III (62-780.680, F.A.C.). This will indicate that contamination exists and the contaminated area is defined. RMO III will put a restriction on the use of the groundwater, but allow it to remain onsite.

Decision Rule #4: If measured naphthalene concentrations in all groundwater samples are less than action levels for two consecutive quarters in all wells at the site, then recommend NFA.

Decision Rule #5: Throughout the groundwater monitoring, if any particular naphthalene concentration is less than its GCTL for two consecutive sampling rounds, then the BCT will discuss the elimination of the well or COC from the monitoring program, in accordance with the Navy guidance on groundwater monitoring well optimization. The well (or COC) will be eliminated unless the well is a compliance well, or the BCT determines that the inclusion of the well (or COC) provides useful information on evaluating the overall program and should not be removed.

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES FOR HANGAR 815 WASH RACK

Site:	Hangar 815 Wash Rack
Matrix:	Groundwater
Analytical Group:	Polynuclear Aromatic Hydrocarbons

Analyte	CAS No.	Project Action Level (µg/L)	Project Action Level Source (µg/L)	Project Quantitation Limit Goal (µg/L)	Laboratory Limit of Quantitation[1] (µg/L)	Laboratory Limit of Detection[1] (µg/L)	Laboratory Method Detection Limit[1] (µg/L)
Naphthalene	91-20-3	14	FDEP GCTL	4.6	0.2	0.1	0.05

Notes:
[1] Laboratory quantitation, detection, and method detection limits, provided by Empirical Laboratory, are targets that are achievable under optimal conditions and may vary during the course of the project. Physical characteristics, such as matrix interference, will affect the actual limits achieved.
CAS No. = Chemical Abstract Services number
µg/L = Micrograms per liter
FDEP GCTL = Florida Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005; http://www.dep.state.fl.us/legal/Rules/waste/62-777/62-777_TableI_GroundwaterCTLs.pdf

SAP WORKSHEET #17: SAMPLING DESIGN AND RATIONALE FOR HANGAR 815 WASH RACK

The sampling strategy at the Hangar 815 Wash Rack area consists of semi-annual sampling of four shallow monitoring wells: CEF-815-01S, CEF-815-05S, NG-12S, and CEF-059-028-015. The wells were chosen based on historical groundwater flow data, detections of naphthalene in the wells, and whether they are downgradient or upgradient from the contamination plume. The intent is to include wells that indicate whether contaminant concentrations are naturally attenuating. The sampling locations are detailed in Worksheet #18. A map of the monitoring wells is provided in Figure 10.4-1.

BUILDING 81, TANKS 81 A, B, AND C

SAP WORKSHEET #10: CONCEPTUAL SITE MODEL FOR TANKS 81 A, B, AND C

10.5.1 Site Description — Tanks 81 A, B, and C

The site known as Building 81, Tanks 81 A, B, and C (Tanks 81 A, B, and C) has groundwater contamination in the form of isopropylbenzene in excess of the FDEP GCTL. A site plan is included as Figure 10.5-1.

An Environmental Baseline Study (EBS) performed by ABB ES in 1994 indicates that the buildings associated with the site were constructed approximately in 1952 and 1953. According to the EBS, this site was on the eastern edge of an area called the Transportation and Fuel Management (TFM) compound. The TFM compound consisted of seven buildings (Buildings 49, 80, 80C, 178, 180, 384, and 584), also known as Site 25. Automotive maintenance for the base was managed from the TFM compound. Immediately east of the TFM compound and separated from the TFM compound by a north-south fence, was the Public Works Maintenance Area, used by a Navy subcontractor for plumbing, carpentry, general painting, welding, electrical, and light machine work related to general maintenance on base. The central building of the Public Works Maintenance Area was Building 81. Support buildings were located to the north and east of Building 81, including Buildings 78, 98, 100, 101, 201, 247, and 929. Currently no buildings are present at the site.

The actual construction date of the tanks is unknown. Former Tanks 81 A, B, and C consisted of three ASTs located northwest of Building 81. Tanks 81 A, B, and C were contained in a secondary concrete containment pit that was approximately 2 feet deep. According to the SAR, there is limited available information about the construction of the three ASTs kept in this pit. The location of the former Tanks 81 A, B, and C is a relatively flat area with both an asphalt parking lot and a grassy vacant lot. Currently, no buildings are present at the site.

10.5.2 History of Environmental Investigations and Actions — Tanks 81 A, B, C

Beginning with the 1994 EBS in which petroleum contamination was detected at the Tanks 81 A, B, and C site, a series of environmental investigations were conducted to characterize the nature and extent of contamination. These investigations spanned from 1999 to the present and were conducted under the oversight of FDEP. During these investigations and associated remediation activities consisting of contaminated soil removal, the list of COCs was reduced to include only isopropylbenzene in groundwater; however, the investigations have not completely delineated the extent of isopropylbenzene contamination. No free petroleum product has ever been detected at this site.

According to the most recent groundwater sampling event (April 2012), isopropylbenzene continues to be detected above the GCTLs, but is showing general decreases site wide (excluding CEF-081-26I). The groundwater isopropylbenzene contamination is limited to the intermediate and deep depths bgs, and is shown in Figure 10.5-1. Currently, seven wells (CEF-081-04I, CEF-081-22I, CEF-081-24I, CEF-081-25I, CEF-081-26I, CEF-081-27D, and CEF-081-28D) are sampled semi-annually for isopropylbenzene only. Groundwater elevations are measured at thirteen wells (the seven wells sampled plus CEF-081-1I, CEF-081-2I, CEF-081-03I, CEF-081-04I, CEF-081-05I, CEF-081-18I, CEF-081-19I, CEF-081-20I, and CEF-081-21I) at the site.

10.5.3 Conceptual Site Model — Tanks 81 A, B, C

A summary of the CSM based on site conditions at Tanks 81 A, B, and C, is shown on Figure 10.5-2. The text below describes the CSM.

10.5.3.1 Sources of Contamination — Tanks 81 A, B, C

Based on the environmental investigations and actions to date at Tanks 81 A, B, and C, the potential sources of contamination could be from the petroleum-based products stored in Tanks 81 A, B, and C or from the former petroleum related operations in the area of Building 81. Contaminants are likely to have been released to surface or subsurface soil in the form of liquid petroleum products containing isopropylbenzene.

Dioxins, TRPH, SVOCs, Pesticides, PCBs, and metal analyses are not required during this investigation because data from previous investigations indicated that these analytes were not detected at concentrations greater than FDEP GCTLs on a consistent basis.

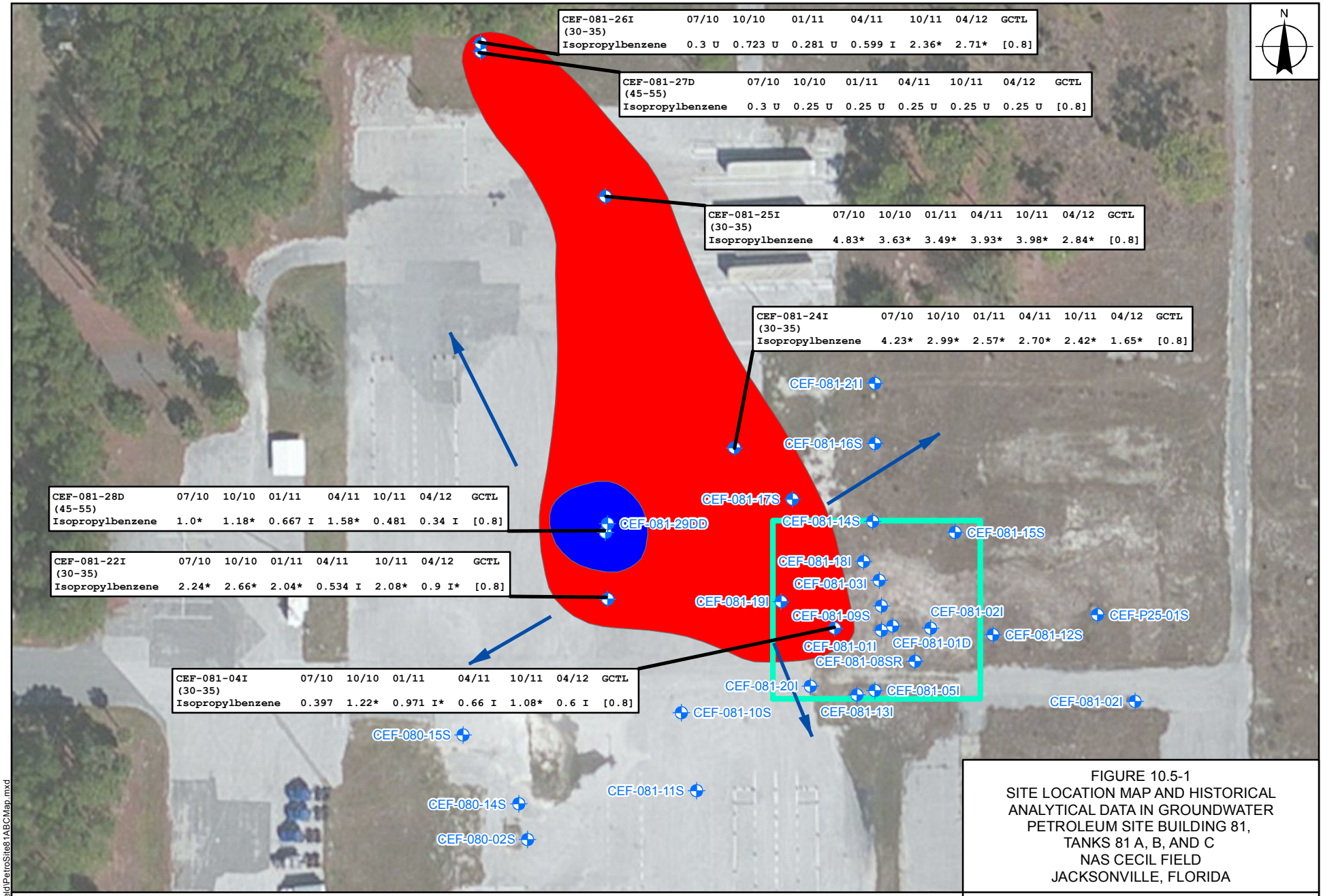


FIGURE 10.5-1
SITE LOCATION MAP AND HISTORICAL ANALYTICAL DATA IN GROUNDWATER
PETROLEUM SITE BUILDING 81,
TANKS 81 A, B, AND C
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Monitoring Well
LUC Area
Site81ABC_FlowDirection
Deep Plume as of April 2012
Intermediate Plume as of April 2012

CEF-081-04I = Sample ID
(30-35) = Well screen interval, feet below ground surface
1.2 = Detected concentration (Sample/Duplicate in µg/L)
* = GCTL value exceeded
I = Reported value is between MDL and PQL
J = Estimated concentration

U = Not detected at or above MDL (associated value)
[0.8] = Ground Cleanup Target Level (GCTL)

1 inch = 80 feet

0 20 40 60 80 Feet

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUESTED BY: K. Wimble	DATE: 12/12/2012
DRAWN BY: N. Rinehart	PROJECT NUMBER: 0888812660

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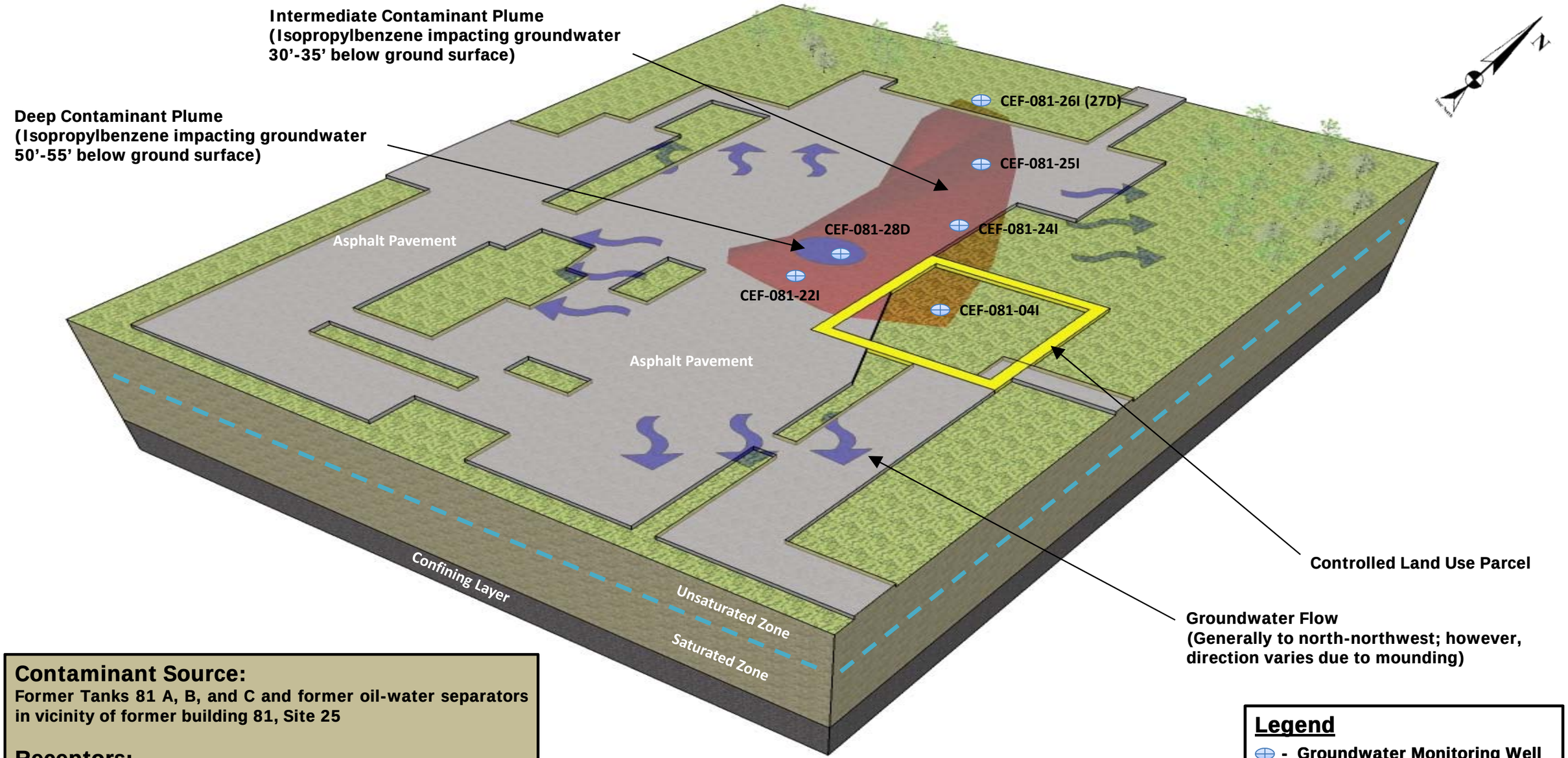
SOURCE: ARCGIS ONLINE BING AERIAL (c) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS



Contaminant Source:

Former Tanks 81 A, B, and C and former oil-water separators in vicinity of former building 81, Site 25

Receptors:

Human: None due to Land Use Controls
Ecological: None due to lack of habitat

Land Use Controls:

- Groundwater may not be used for human consumption
- Groundwater may not be used for industrial purposes
- Tampering or damaging any Navy wells or remediation systems is prohibited

NOTES:

1. Conceptual Site Model not to scale. Horizontal dimensions based on recent aerial imaging, site visits, and historic knowledge. Vertical dimensions exaggerated for purpose of conveying pertinent site information.
2. Groundwater monitoring well locations are approximated based on geographic information system data.

Legend

⊕ - Groundwater Monitoring Well

Figure 10.5-2
Conceptual Site Model
Building 81, Tanks 81 A, B, and C
Former NAS Cecil Field, Jacksonville, Florida

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUEST BY: Kara Wimble	DATE: 11/02/2012
DRAWN BY: David Myers	CTO NO. JM34

10.5.3.2 Potential Contaminant Migration Mechanisms — Tanks 81 A, B, C

The latest data indicate that isopropylbenzene contamination is located between 35 feet to 55 feet bgs.Intermediate groundwater flow has a relatively flat gradient that flows radially from wells CEF-081-24I and CEF-081-25I, with groundwater flowing northwest in the northern area of the site and flowing south in the southern area of the site. Based on this information, the contamination could migrate in the intermediate and deep zones of the surficial aquifer. Soil leaching to groundwater under the influence of infiltrating precipitation does not seem to be occurring at the site because there is a clean intermediate well, but this is a possible potential contaminant migration mechanism. Upon entering the water column, dissolved isopropylbenzene may be carried with the flow of the groundwater to downgradient locations. Groundwater flow varies from event to event, but generally flows toward the north-northwest.

10.5.3.3 Land Uses and Potential Exposure — Tanks 81 A, B, C

The JEDC Reuse Plan provides for continued industrial and/or commercial uses of the site.

LUCs were developed for this site in January 2005 and identified that the site has isopropylbenzene concentrations exceeding human health criteria in groundwater. Since the LUCs were developed for the site, the groundwater plume has migrated in a northerly direction. Because it appears that the plume is migrating, as of the most recent April 2012 sampling event, LUCs will not be re-adjusted until the plume is stable. The LUCs are as follows (TtNUS, 2007e):

- Groundwater may not be used for human consumption
- Groundwater may not be used for industrial purposes
- Tampering or damaging any Navy wells or remediation systems is prohibited

Former NAS Cecil Field is supplied with public water; therefore, human exposure to potentially contaminated site groundwater as a result of potable water use is not a consideration. Ecological receptors are not exposed to groundwater; however, contamination remains onsite which exceeds FDEP criteria, which are based on organoleptic considerations.

The site is located in a highly developed area consisting largely of paved areas and does not allow for direct access for contact with groundwater. The resulting lack of ecological habitat and complete exposure pathways preclude potential unacceptable risks for ecological receptors. Direct exposure of potential human receptors to soil and groundwater is prevented based upon the current and future land use.

SAP WORKSHEET #11: PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR TANKS 81 A, B, AND C

11.5 Problem Definition

Isopropylbenzene remains in groundwater of the Tanks 81 A, B, and C area at concentrations that exceed FDEP GCTLs. The project team must determine the extent of the isopropylbenzene contamination in groundwater so an appropriate response can be formulated to mitigate the potential risk associated with this site.

11.5.1 Study Boundaries

The Tanks 81 A, B, and C area covers approximately 2.16 acres. The area is shown in Figure 10.5-1. The vertical boundary extends from 35 to 55 feet bgs. The groundwater isopropylbenzene contaminant plume is the population of interest and constitutes the spatial decision unit. The temporal decision unit is each round of monitoring when determining whether an exceedance of GCTL has occurred and it is two consecutive monitoring rounds when determining whether parameters or wells may be eliminated from monitoring. The groundwater sampling frequency must be semi-annual to satisfy project objectives.

11.5.2 Analytical Approach

The following decision rules govern data use for the monitoring programs at Tanks 81 A, B, and C. Each decision rule must be applied to each well in each round of sampling. If the decision rules lead to a change in the list of wells that are to be sampled, the PM will review the change in the list of wells with the BCT and gain the approval of the team prior to using the new list in a sampling event. Concentration trends will be represented by the best fit line through the data points.

Decision Rule #1: If the measured isopropylbenzene concentrations in groundwater samples from any monitoring well within the plume are less than the GCTL for the two most recent sampling events, then recommend the well for removal from the monitoring program; but if the last two rounds of measured isopropylbenzene concentrations in groundwater samples from a well are not less than the GCTL, then continue long-term monitoring in that well until levels of isopropylbenzene are below the GCTL for two consecutive sampling rounds. At this point, the BCT will recommend removal of the well from the sampling program.

***Decision Rule #2**:* If the measured isopropylbenzene concentrations in a groundwater sample from all upgradient and downgradient wells are less than the GCTL, then continue with the scheduled monitoring program; otherwise resample any well in which concentrations exceed GCTL for verification prior to the next scheduled sampling event. If the exceedance is not confirmed, then continue with the scheduled monitoring program. If the exceedance is confirmed, the BCT will convene to determine appropriate actions to address the exceedance such as 1) verify groundwater flow direction, 2) further delineation of the plume, and 3) modification of the sampling plan.

***Decision Rule #3**:* If all measured isopropylbenzene concentrations in all groundwater samples collected from the targeted monitoring wells are less than the GCTL for two consecutive sampling events, then recommend the site for NFA.

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES FOR TANKS 81 A, B, AND C

Site:	Tanks A, B, and C						
Matrix:	Groundwater						
Analytical Group:	Volatile Organic Compounds						
Analyte	**CAS No.**	**Project Action Level (µg/L)**	**Project Action Level Source (µg/L)**	**Project Quantitation Limit Goal (µg/L)**	**Laboratory Limit of Quantitation[1] (µg/L)**	**Laboratory Limit of Detection[1] (µg/L)**	**Laboratory Method Detection Limit[1] (µg/L)**
Isopropylbenzene	98-82-8	0.8	FDEP GCTL	0.27	**1**	0.5	0.25

Notes:

[1] Laboratory quantitation, detection, and method detection limits, provided by Empirical Laboratory, are targets that are achievable under optimal conditions and may vary during the course of the project. Physical characteristics, such as matrix interference, will affect the actual limits achieved.

CAS No. = Chemical Abstract Services number
µg/L = Micrograms per liter
FDEP GCTL = Florida Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005; http://www.dep.state.fl.us/legal/Rules/waste/62-777/62-777_TableI_GroundwaterCTLs.pdf

SAP WORKSHEET #17: SAMPLING DESIGN AND RATIONALE FOR TANKS 81 A, B, AND C

Site-Specific Sampling Design

The sampling design and rationale for Tanks 81 A, B, and C are presented below. The BCT has selected a biased sampling approach appropriate for LTM at Tanks 81 A, B, and C. The wells to be sampled were chosen based on consideration of historical groundwater flow data, detections of the isopropylbenzene in each well, and whether they are downgradient or upgradient from the contamination plume. The seven wells that will be sampled are all intermediate or deep wells, because the extent of contamination is well-defined in the shallow depth. One of the well clusters to be sampled will be located within the isopropylbenzene plume. A sidegradient well, an upgradient well, a well downgradient of the isopropylbenzene plume, and a well downgradient of all former locations will also be sampled in order to delineate the groundwater plume. The sampling locations are detailed in Worksheet #18. A map is provided on Figure 10.5-1.

SOUTH FUEL FARM

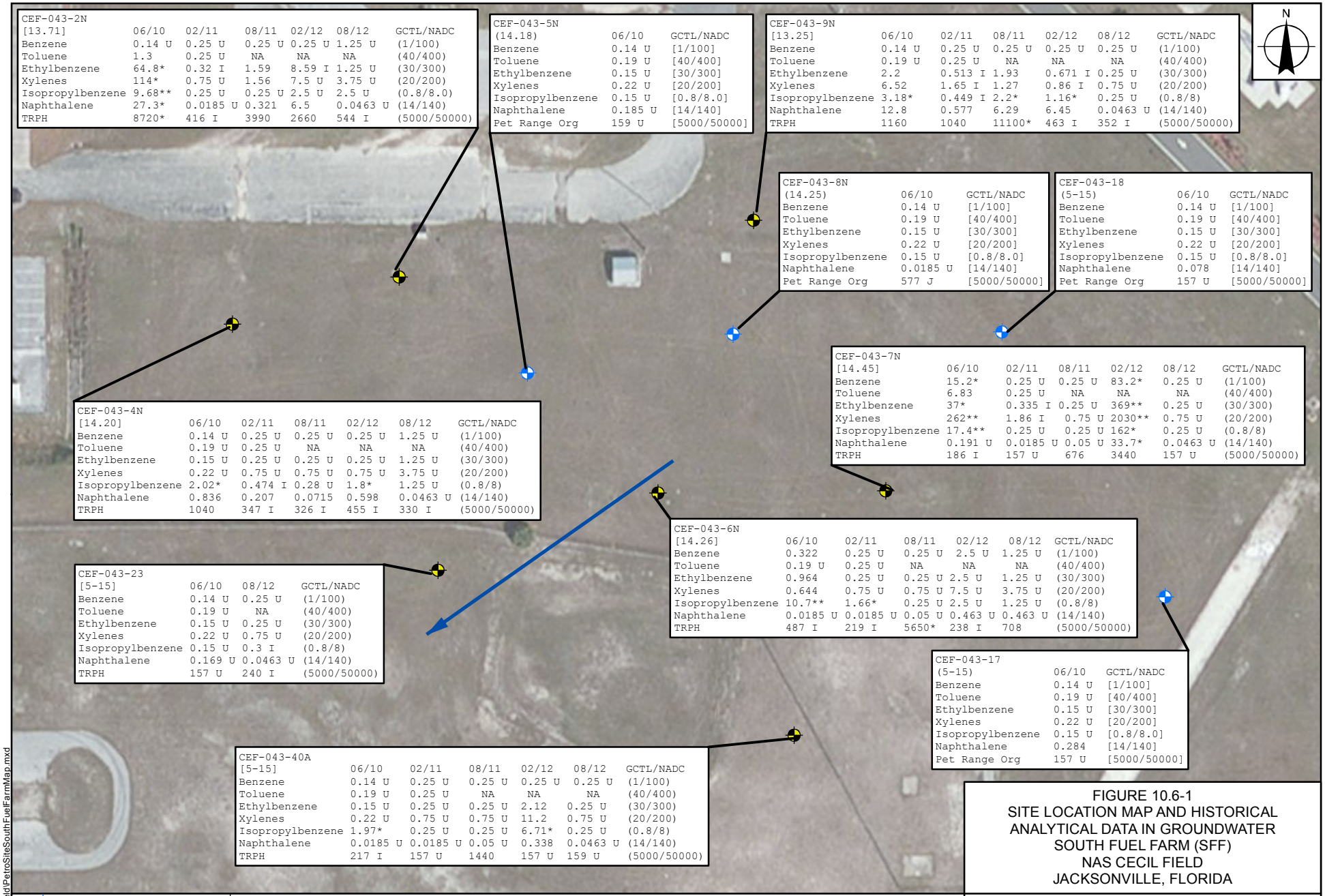
SAP WORKSHEET #10: CONCEPTUAL SITE MODEL FOR SOUTH FUEL FARM

10.6.1 Site Description — South Fuel Farm

South Fuel Farm (SFF), which was used as a fuel storage facility for leaded and unleaded gasoline, fuel, and jet propellant, is located at the northern edge of the east-west runway. When fully operational, the facility contained three ASTs, four USTs, and four earth-mounded tanks (EMTs) (Bechtel Environmental, Inc. [BEI], 1998). A site plan is included as Figure 10.6-1.

10.6.2 History of Environmental Investigations and Actions — South Fuel Farm

In 1983, the three ASTs were removed. In July 1994, the four USTs and three of the four EMTs were excavated. The fourth EMT was removed at a later date. Excessively contaminated soil that was excavated during the tank removals was returned to the excavations. A contamination assessment was conducted by ABB-ES and was completed in December 1991. A *Contamination Assessment Report* (CAR) was submitted in July 1992. Upon review of the CAR, the FDEP requested further investigation at this site. A supplemental investigation was completed in July 1995, and a *Contamination Assessment Report Addendum* was submitted in January 1996. The Contamination Assessment Report Addendum was approved in April 1996, and recommended that a RAP be prepared.



CEF-043-2N

[13.71]	06/10	02/11	08/11	02/12	08/12	GCTL/NADC
Benzene	0.14 U	0.25 U	0.25 U	0.25 U	1.25 U	(1/100)
Toluene	1.3	0.25 U	NA	NA	NA	(40/400)
Ethylbenzene	64.8*	0.32 I	1.59	8.59 I	1.25 U	(30/300)
Xylenes	114*	0.75 U	1.56	7.5 U	3.75 U	(20/200)
Isopropylbenzene	9.68**	0.25 U	0.25 U	2.5 U	2.5 U	(0.8/8.0)
Naphthalene	27.3*	0.0185 U	0.321	6.5	0.0463 U	(14/140)
TRPH	8720*	416 I	3990	2660	544 I	(5000/50000)

CEF-043-5N

(14.18)	06/10	GCTL/NADC
Benzene	0.14 U	[1/100]
Toluene	0.19 U	[40/400]
Ethylbenzene	0.15 U	[30/300]
Xylenes	0.22 U	[20/200]
Isopropylbenzene	0.15 U	[0.8/8.0]
Naphthalene	0.185 U	[14/140]
Pet Range Org	159 U	[5000/50000]

CEF-043-9N

[13.25]	06/10	02/11	08/11	02/12	08/12	GCTL/NADC
Benzene	0.14 U	0.25 U	0.25 U	0.25 U	0.25 U	(1/100)
Toluene	0.19 U	0.25 U	NA	NA	NA	(40/400)
Ethylbenzene	2.2	0.513 I	1.93	0.671 I	0.25 U	(30/300)
Xylenes	6.52	1.65 I	1.27	0.86 I	0.75 U	(20/200)
Isopropylbenzene	3.18*	0.449 I	2.2*	1.16*	0.25 U	(0.8/8)
Naphthalene	12.8	0.577	6.29	6.45	0.0463 U	(14/140)
TRPH	1160	1040	11100*	463 I	352 I	(5000/50000)

CEF-043-8N

(14.25)	06/10	GCTL/NADC
Benzene	0.14 U	[1/100]
Toluene	0.19 U	[40/400]
Ethylbenzene	0.15 U	[30/300]
Xylenes	0.22 U	[20/200]
Isopropylbenzene	0.15 U	[0.8/8.0]
Naphthalene	0.0185 U	[14/140]
Pet Range Org	577 J	[5000/50000]

CEF-043-18

(5-15)	06/10	GCTL/NADC
Benzene	0.14 U	[1/100]
Toluene	0.19 U	[40/400]
Ethylbenzene	0.15 U	[30/300]
Xylenes	0.22 U	[20/200]
Isopropylbenzene	0.15 U	[0.8/8.0]
Naphthalene	0.078	[14/140]
Pet Range Org	157 U	[5000/50000]

CEF-043-7N

[14.45]	06/10	02/11	08/11	02/12	08/12	GCTL/NADC
Benzene	15.2*	0.25 U	0.25 U	83.2*	0.25 U	(1/100)
Toluene	6.83	0.25 U	NA	NA	NA	(40/400)
Ethylbenzene	37*	0.335 I	0.25 U	369**	0.25 U	(30/300)
Xylenes	262**	1.86 I	0.75 U	2030**	0.75 U	(20/200)
Isopropylbenzene	17.4**	0.25 U	0.25 U	162*	0.25 U	(0.8/8)
Naphthalene	0.191 U	0.0185 U	0.05 U	33.7*	0.0463 U	(14/140)
TRPH	186 I	157 U	676	3440	157 U	(5000/50000)

CEF-043-4N

[14.20]	06/10	02/11	08/11	02/12	08/12	GCTL/NADC
Benzene	0.14 U	0.25 U	0.25 U	0.25 U	1.25 U	(1/100)
Toluene	0.19 U	0.25 U	NA	NA	NA	(40/400)
Ethylbenzene	0.15 U	0.25 U	0.25 U	0.25 U	1.25 U	(30/300)
Xylenes	0.22 U	0.75 U	0.75 U	0.75 U	3.75 U	(20/200)
Isopropylbenzene	2.02*	0.474 I	0.28 U	1.8*	1.25 U	(0.8/8)
Naphthalene	0.836	0.207	0.0715	0.598	0.0463 U	(14/140)
TRPH	1040	347 I	326 I	455 I	330 I	(5000/50000)

CEF-043-6N

[14.26]	06/10	02/11	08/11	02/12	08/12	GCTL/NADC
Benzene	0.322	0.25 U	0.25 U	2.5 U	1.25 U	(1/100)
Toluene	0.19 U	0.25 U	NA	NA	NA	(40/400)
Ethylbenzene	0.964	0.25 U	0.25 U	2.5 U	1.25 U	(30/300)
Xylenes	0.644	0.75 U	0.75 U	7.5 U	3.75 U	(20/200)
Isopropylbenzene	10.7**	1.66*	0.25 U	2.5 U	1.25 U	(0.8/8)
Naphthalene	0.0185 U	0.0185 U	0.05 U	0.463 U	0.463 U	(14/140)
TRPH	487 I	219 I	5650*	238 I	708	(5000/50000)

CEF-043-23

[5-15]	06/10	08/12	GCTL/NADC
Benzene	0.14 U	0.25 U	(1/100)
Toluene	0.19 U	NA	(40/400)
Ethylbenzene	0.15 U	0.25 U	(30/300)
Xylenes	0.22 U	0.75 U	(20/200)
Isopropylbenzene	0.15 U	0.3 I	(0.8/8)
Naphthalene	0.169 U	0.0463 U	(14/140)
TRPH	157 U	240 I	(5000/50000)

CEF-043-17

(5-15)	06/10	GCTL/NADC
Benzene	0.14 U	[1/100]
Toluene	0.19 U	[40/400]
Ethylbenzene	0.15 U	[30/300]
Xylenes	0.22 U	[20/200]
Isopropylbenzene	0.15 U	[0.8/8.0]
Naphthalene	0.284	[14/140]
Pet Range Org	157 U	[5000/50000]

CEF-043-40A

[5-15]	06/10	02/11	08/11	02/12	08/12	GCTL/NADC
Benzene	0.14 U	0.25 U	0.25 U	0.25 U	0.25 U	(1/100)
Toluene	0.19 U	0.25 U	NA	NA	NA	(40/400)
Ethylbenzene	0.15 U	0.25 U	0.25 U	2.12	0.25 U	(30/300)
Xylenes	0.22 U	0.75 U	0.75 U	11.2	0.75 U	(20/200)
Isopropylbenzene	1.97*	0.25 U	0.25 U	6.71*	0.25 U	(0.8/8)
Naphthalene	0.0185 U	0.0185 U	0.05 U	0.338	0.0463 U	(14/140)
TRPH	217 I	157 U	1440	157 U	159 U	(5000/50000)

FIGURE 10.6-1
SITE LOCATION MAP AND HISTORICAL ANALYTICAL DATA IN GROUNDWATER
SOUTH FUEL FARM (SFF)
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Monitoring Well
CEF-043-6N = Sample ID
0.19 U = Results (µg/L)
* = GCTL value exceeded
** = NADC value exceeded

Proposed NA Monitoring Well
J = Estimated concentration
NA = Not analyzed
U = Not detected at or above MDL (associated value)
(5-15) = Well screen interval, feet below ground surface
[40/400] = Ground Cleanup Target Level (GCTL)/NADC

Groundwater Flow Direction

1 inch = 80 feet
0 40 80 120 160 Feet

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUESTED BY: K. Wimble
DATE: 1/17/2013
DRAWN BY: N. Rinehart, S. Swan
PROJECT NUMBER: 0888812660

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SOURCE: ARCGIS ONLINE BING AERIAL (c) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS

A RAP was submitted by ABB-ES in 1996 specifying the recommended remedial action as enhanced intrinsic remediation through bioventing and biosparging (BS) (ABB-ES, 1996). Subsequent to RAP submittal, the BCT agreed to implement these remedial action activities for only the northern portion of the SFF site; the BCT agreed not to implement these activities in the southern portion of the site (BEI, 1998). Instead, soil excavation was chosen as the remedial alternative for the southern portion of the SFF site. CH2M HILL excavated 28,953 tons of petroleum-impacted soil from October 1998 to February 1999 (CH2M HILL, 2001).

BEI installed the approved bioventing and BS systems for the northern portion of the SFF site from December 1997 to March 1998. Startup of the bioventing/BS systems occurred on 6 April 1998 (BEI, 1998). CH2M Hill conducted supplemental soil and groundwater sampling during 2007 and performed an evaluation of the bioventing/BS systems at the site during 2006 and 2007 to provide recommendations for a path forward for remedial activities at the site. The findings of this evaluation were presented in two Technical Memoranda, dated 6 June 2006, and 12 January 2007. Both Technical Memoranda concluded that concentrations of contaminants historically detected at levels greater than industrial SCTLs and GCTLs had been reduced to levels less than the respective soil and groundwater criteria as a result of both operation of the bioventing/BS systems and natural attenuation (NA). Subsequently, the Navy proposed that the operation of the bioventing/BS systems be discontinued. The FDEP concurred with the Navy's proposed recommendation, with the stipulation that 1 year of post-active remediation monitoring (PARM) of groundwater be conducted. The BS and bioventing systems were run intermittently during 2007, and were taken off-line during August 2007 after FDEP concurred with the decision to shut them down.

There have been several PARM sampling events during which groundwater and soil were analyzed for various parameters at various frequencies. Quarterly post-active remediation groundwater sampling events were conducted on 8 February, 9 July and 10 July, 6 November 2008, and 3 February and 4 February 2009. Groundwater samples were collected from five monitoring wells (CEF-043-02N, -04N, -06N, -07N, and -09N), and analyzed for the following parameters: VOC, SVOCs, lead, and TRPH. Groundwater results indicated that groundwater monitoring should continue at the site, but that restarting the bioventing/BS system was unnecessary.

Surface soil samples were collected between 12 February and 14 February 2008 from 11 locations and subsurface soil samples were collected from 15 locations. The soil samples were analyzed for several VOCs and SVOCs including BTEX, and methyl tertiary butyl ether, and TRPH. Soil results did not warrant a restart of the bioventing system, and thus no further action (NFA) was recommended for soil.

Three semi-annual supplemental events followed the Post-active remediation monitoring (PARM) events as part of a Site Assessment.

- The June 2010 event included eleven wells for VOCs, naphthalene, and TRPH. Concentrations of benzene, isopropylbenzene, and xylenes exceeded the NADCs at one well, and isopropylbenzene exceeded its NADC at one other location. Four other wells contained at least one COC having a concentration exceeding its respective GCTL.

- The February 2011 event included the six wells which had GCTL or NADC exceedances during the June 2010 event. Groundwater samples were analyzed for VOCs, naphthalene, and TRPH. The only exceedance detected during the February 2011 event was a concentration exceeding the isopropylbenzene GCTL at one well.

- The August 2011 event included the same wells and analytes as the February 2011 event. Isopropylbenzene concentrations in well CEF-043-9N exceededed the isopropylbenzene GCTL, but were less than the NADC. Exceedances of the TRPH GCTL were also detected during the August 2011 sampling event, from wells CEF-043-6N and CEF-043-9N.

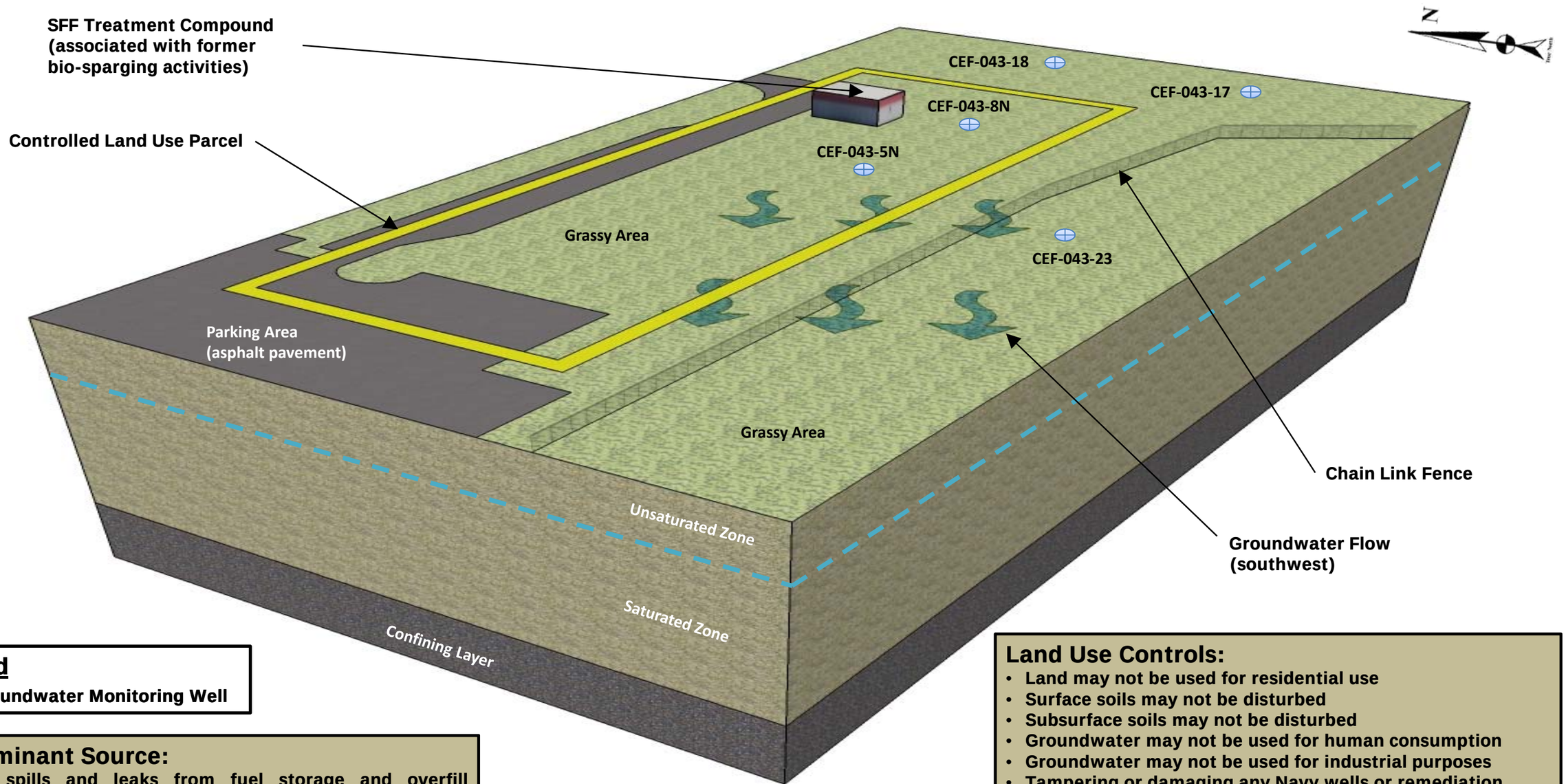
It was recommended in the SAR that sampling be conducted at SFF semi-annually at seven wells (CEF-043-2N, CEF-043-4N, CEF-043-6N, CEF-043-07N, CEF-043-09N, CEF-043-23, and CEF-043-40A) for benzene, ethylbenzene, isopropylbenzene, xylenes, naphthalene, and TRPH, and that groundwater elevation be measured at eleven wells (the seven wells sampled plus CEF-043-5N, CEF-043-08N, CEF-043-17, and CEF-043-18) at the site.

10.6.3 Conceptual Site Model — South Fuel Farm

A summary of the CSM based on site conditions at the SFF is shown on Figure 10.6-2. The text below describes the CSM.

10.6.3.1 Sources of Contamination — South Fuel Farm

The sources of SFF soil and groundwater contamination are the historic spills and leaks from fuel storage and overfill containment tanks on site. The three ASTs on site were removed in 1983, and the four USTs and three of the four EMTs were removed in 1994. No documentation of leaks, spills, or overflow is available.



Legend

- Groundwater Monitoring Well

Contaminant Source:

Historic spills and leaks from fuel storage and overfill containment tanks on site

Contaminants of Concern:

VOCs, PAHs, TRPH (shallow groundwater plume at approx. 10 feet below ground surface not yet defined)

Receptors:

Human: None due to Land Use Controls
Ecological: None due to lack of exposure

Land Use Controls:

- Land may not be used for residential use
- Surface soils may not be disturbed
- Subsurface soils may not be disturbed
- Groundwater may not be used for human consumption
- Groundwater may not be used for industrial purposes
- Tampering or damaging any Navy wells or remediation systems is prohibited

NOTES:

1. Conceptual Site Model not to scale. Horizontal dimensions based on recent aerial imaging, site visits, and historic knowledge. Vertical dimensions exaggerated for purpose of conveying pertinent site information.
2. Groundwater monitoring well locations are approximated based on geographic information system data.

Figure 10.6-2
Conceptual Site Model
South Fuel Farm
Former NAS Cecil Field, Jacksonville, Florida

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUEST BY: Kara Wimble	DATE: 11/02/2012
DRAWN BY: David Myers	CTO NO. JM34

10.6.3.2 Potential Contaminant Migration Mechanisms — South Fuel Farm

The potential contaminant migration pathways from SFF include overland runoff and infiltration. Vegetation and areas of pavement at the site serve to minimize the release of fugitive particulates from the surface; therefore, the airborne contaminant transport pathway is not a concern at the site.

Infiltrating precipitation can cause contamination to leach from surface soil to subsurface soil to groundwater. Upon entering the water column, chemicals, particularly VOCs, are carried with the flow of groundwater downgradient in a southwesterly direction. Any contaminant migration would occur in the shallow zone of the surficial aquifer.

10.6.3.3 Land Uses and Potential Exposure — South Fuel Farm

LUCs were developed for this site in January 2005 and identified that the site has napthalenes exceeding human health criteria in soil and aromatics and naphthalenes exceeding human health criteria in groundwater. The LUCs are as follows (TtNUS, 2007e):

- Land may not be used for residential use
- Surface soils may not be disturbed.
- Subsurface soils may not be disturbed.
- Groundwater may not be used for human consumption.
- Groundwater may not be used for industrial consumption.
- Tampering or damaging any Navy wells or remediation systems is prohibited.

Former NAS Cecil Field is supplied with public water; therefore, human exposure to contaminated site groundwater through ingestion, inhalation, or direct contact with potable water is not a consideration. Ecological receptors are not exposed to groundwater; however, contamination exceeding regulatory criteria remains.

SFF is located in a highly developed area consisting largely of paved areas and buildings, and does not allow for direct access for contact with groundwater. The only portion of the site that is currently being used consists of a parking area and roads in the northwest section. The resulting lack of ecological habitat and complete exposure pathways preclude potential unacceptable risks for ecological receptors. Direct exposure of potential human receptors to soil and groundwater is restricted based upon the current and likely future land uses.

Because potential contaminant sources no longer exist at the site and because the levels of contamination are low, additional contributions to the contaminant plume are unlikely to occur.

SAP WORKSHEET #11: PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR SOUTH FUEL FARM

11.6 Problem Definition

Several VOCs, TRPH, and naphthalene have been identified as the COCs at the SFF for the site after detected concentrations exceeded GCTLs or NADCs in several wells during PARM sampling. To confirm whether natural attenuation is occurring at the site, concentrations of select VOCs, SVOCs, and TRPH in the groundwater must be evaluated. The bioventing/BS system is still present at the site but has been inactive since 2007.

11.6.1 Study Boundaries

The SFF area covers approximately 40,000 square feet. This is delineated from the northeast corner to the southwest corner by upgradient well CEF-043-19 and downgradient well CEF-037-45, as shown on Figure 10.6-1. The vertical boundary for the groundwater plume is approximately from 5 feet to 15 feet bgs. The temporal decision unit is each round of monitoring when determining whether an exceedance of GCTL has occurred and it is two consecutive monitoring rounds when determining whether parameters or wells may be eliminated from monitoring. The groundwater sampling frequency must be semi-annual to satisfy project objectives.

11.6.2 Analytical Approach

At both of the sites, a direct comparison of measured concentrations within the groundwater will be made against the appropriate PAL. PALs are detailed for each COC in Worksheet #15. Additionally, if none of the measured COC concentrations within any groundwater sample exceed criteria after two consecutive rounds of monitoring, then the monitoring program will be discontinued after coordination with the BCT.

Decision Rule #1: If all measured concentrations of COCs in all wells are less than action levels for two consecutive sampling rounds, then no further monitoring will be recommended; otherwise, proceed to Decision Rule #2.

Decision Rule #2: If any measured source well COC concentration is greater than or equal to the GCTL, then continue monitoring until source well COC concentrations are less than the GCTL for two consecutive monitoring rounds. The BCT may also consider taking additional action.

***Decision Rule #3**:* If any compliance well COC concentration is greater than or equal to the GCTL, then confirm the exceedance. If the exceedance is confirmed, conduct additional delineation of groundwater contamination via additional groundwater sampling and installation of new monitoring wells. The additional delineation will be performed by Resolution Consultants at the direction and approval of the BRAC BCT Team and an FTMR will be issued to govern the delineation.

***Decision Rule #4**:* Throughout the groundwater monitoring, if any particular measured COC concentration is less than GCTL for two consecutive sampling rounds, or all measured COC concentrations in any particular well are less than GCTLs for at least two consecutive sampling rounds, then the BCT will discuss the elimination of the well or COC from the monitoring program, in accordance with the Navy guidance on groundwater monitoring well optimization. The well (or COC) will be eliminated unless the well is a compliance well, or if the BCT determines that the inclusion of the well (or COC) provides useful information on evaluating the overall program and should not be removed.

Decision Rule #5: If post-active remediation monitoring concentrations are greater than NADCs, confirm exceedances. If exceedances are confirmed, then convene the BCT to discuss restarting the BS and bioventing remedial systems. If post-active remediation monitoring concentrations are less than or equal to NADCs, monitor for NA. The BCT may discuss restarting the BS and bioventing systems if concentrations exceed GCTLs only for several events.

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES FOR SOUTH FUEL FARM

Site:	South Fuel Farm
Matrix:	Groundwater
Analytical Group:	Volatile Organic Compounds

Analyte	CAS No.	Project Action Level (µg/L)	Project Action Level Source (µg/L)	Project Quantitation Limit Goal (µg/L)	Laboratory Limit of Quantitation[1] (µg/L)	Laboratory Limit of Detection[1] (µg/L)	Laboratory Method Detection Limit[1] (µg/L)
Benzene	71-43-2	1	FDEP GCTL	0.3	1	0.5	0.25
Ethylbenzene	100-41-4	30	FDEP GCTL	10	1	0.5	0.25
Isopropylbenzene	98-82-8	0.8	FDEP GCTL	0.27	**1**	0.5	0.25
Total Xylenes	1330-20-7	20	FDEP GCTL	6.7	3	1.5	0.75

Notes:

[1] Laboratory quantitation, detection, and method detection limits, provided by Empirical Laboratory, are targets that are achievable under optimal conditions and may vary during the course of the project. Physical characteristics, such as matrix interference, will affect the actual limits achieved.

CAS No. = Chemical Abstract Services number
µg/L = Micrograms per liter
FDEP GCTL = Florida Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005; http://www.dep.state.fl.us/legal/Rules/waste/62-777/62-777_TableI_GroundwaterCTLs.pdf

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES FOR SOUTH FUEL FARM

Site:	South Fuel Farm						
Matrix:	Groundwater						
Analytical Group:	Polynuclear Aromatic Hydrocarbons						
Analyte	**CAS No.**	**Project Action Level (µg/L)**	**Project Action Level Source (µg/L)**	**Project Quantitation Limit Goal (µg/L)**	**Laboratory Limit of Quantitation[1] (µg/L)**	**Laboratory Limit of Detection[1] (µg/L)**	**Laboratory Method Detection Limit[1] (µg/L)**
Naphthalene	91-20-3	14	FDEP GCTL	4.6	0.2	0.1	0.05

Site:	South Fuel Farm						
Matrix:	Groundwater						
Analytical Group:	Total Recoverable Petroleum Hydrocarbons						
Analyte	**CAS No.**	**Project Action Level (mg/L)**	**Project Action Level Source (mg/L)**	**Project Quantitation Limit Goal (mg/L)**	**Laboratory Limit of Quantitation[1] (mg/L)**	**Laboratory Limit of Detection[1] (mg/L)**	**Laboratory Method Detection Limit[1] (mg/L)**
TRPH (C8-C40)	-3558	5	FDEP GCTL	1.67	0.68	0.34	0.17

Notes:
[1] Laboratory quantitation, detection, and method detection limits, provided by Empirical Laboratory, are targets that are achievable under optimal conditions and may vary during the course of the project. Physical characteristics, such as matrix interference, will affect the actual limits achieved.

CAS No. = Chemical Abstract Services number
µg/L = Micrograms per liter
mg/L = Milligrams per liter
TRPH = Total Recoverable Petroleum Hydrocarbons
FDEP GCTL = Florida Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005;
http://www.dep.state.fl.us/legal/Rules/waste/62-777/62-777_TableI_GroundwaterCTLs.pdf

SAP WORKSHEET #17: SAMPLING DESIGN AND RATIONALE FOR SOUTH FUEL FARM

Site-Specific Sampling Design

Six wells of intermediate depths were chosen based on historical groundwater flow data, detections of the COCs in the wells, and whether they are downgradient or upgradient from the contaminant plume. Monitoring wells CEF-043-06N and CEF-043-07N are the source area wells, and wells CEF-043-02N, CEF-043-04N, CEF-043-40A, and CEF-043-09N are being monitored as perimeter wells. The sampling objective is to determine whether contaminant concentrations are naturally attenuating, and to verify that contamination is not migrating offsite. The sampling locations are detailed in Worksheet #18. A map of the monitoring wells is provided on Figure 10.6-1.

OCALA F-18 CRASH SITE

SAP WORKSHEET #10: CONCEPTUAL SITE MODEL FOR OCALA F-18 CRASH SITE

10.7.1 Site Description

The Ocala F-18 Crash Site is located in the Ocala National Forest approximately 82 miles south of NAS Cecil Field and approximately 22 miles from Ocala, Florida. The site is devoid of buildings or pavement or any surface features other than vegetation, and it was not used prior to the June 1994 crash of a Navy F-18 jet. Soil and groundwater were contaminated near the crash site, as determined by the February 1995 Site Assessment conducted by BEI. A monitoring well location map is shown on Figure 10.7-1.

10.7.2 History of Environmental Investigations and Actions — Ocala Crash Site

The Navy F-18 crashed in the Ocala National Forest on June 21, 1994. Navy personnel determined that approximately 1,285 gallons of JP-5 jet fuel was on board at the time of the crash. Between September and November 1994, BEI conducted an initial remedial action consisting of the excavation of 2,650 cubic yards of excessively contaminated soil from the crash site. The contaminated soil was removed and disposed offsite at a FDEP-approved thermal treatment facility.

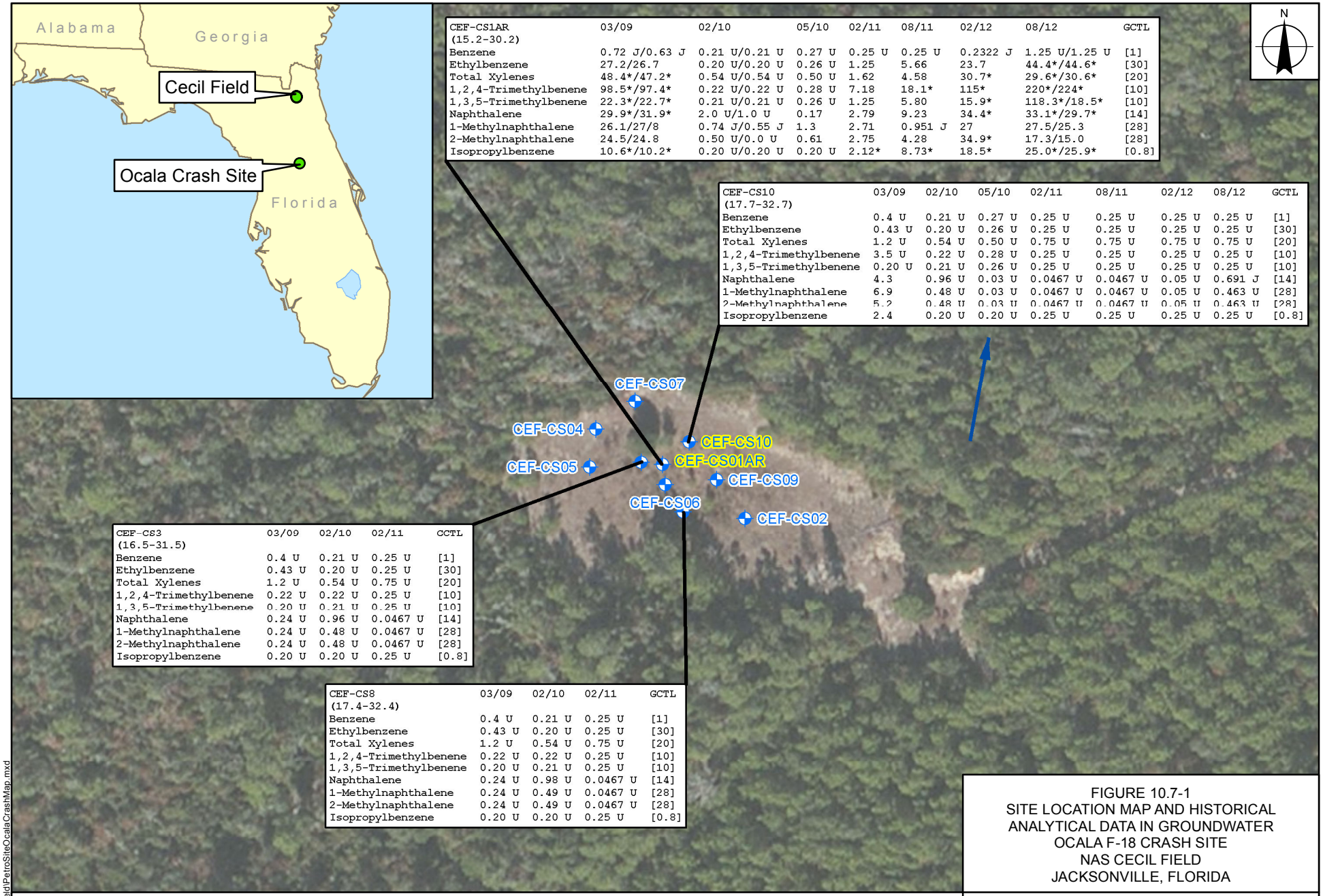
In February 1995, a site assessment was completed by BEI. Sixty soil borings were advanced, and three piezometers and one monitoring well (CEF-CS1) were installed. In January 1996, an additional 576 tons of excessively contaminated soil were removed. During the course of the soil excavation, monitoring well CEF-CS1 and the three piezometers were abandoned. Upon completion of the soil excavation activities, six monitoring wells (CEF-CS1A through CEF-CS06) were installed to evaluate groundwater quality and assess the groundwater flow direction. In June 1996, a remedial action closure report was prepared by BEI and submitted to the FDEP.

In May 1997, ABB-ES conducted site reconnaissance and conducted a water level elevation survey using the existing monitoring wells. The purpose of this event was to confirm the groundwater flow direction and determine if additional monitoring wells were necessary to evaluate and monitor groundwater quality. May 1997 measurements correlated with the March 1996 measurements, which indicated a northeasterly flow. Based on groundwater flow direction, an additional monitoring well was required to assess downgradient groundwater quality.

In September and November 1997, ABB-ES sampled various monitoring wells onsite to establish groundwater quality conditions. Their report concluded that the site was eligible for Monitoring Natural Attenuation and the FDEP subsequently agreed in their *Monitoring Only Plan Approval Order* dated 3 April 1998.

During the third year of monitoring in October 2002, TtNUS recommended preparation of a treatability study to assess the use of innovative technology to remediate the site since the COCs had not decreased in concentration (TtNUS, 2002). Monitoring continued in April 2003 (TtNUS, 2003b), and the COCs appeared to be within milestones in the *Monitoring Only Plan Approval Order*; therefore, continued monitoring was recommended. However, after reviewing the *Monitoring Only Plan Report*, FDEP determined that because five years had transpired without a decrease in COC concentrations below GCTLs, an additional well was required directly downgradient of the source well in accordance with plan recommendations. Considering the remoteness of the site and the need for tighter delineation of the plume that is centered on well CEF-CS1A, TtNUS mobilized to the site to install three perimeter wells (one upgradient, one sidegradient, and one downgradient). A *Supplementary SAR* recommended a NAMP be prepared based on the results of the investigation (TtNUS, 2005b).

A RAP was not prepared for the Ocala F-18 Crash Site, because Monitored Natural Attenuation (MNA) was determined to be the only remedial action necessary. Therefore, a NAMP was prepared and a Natural Attenuation Monitoring Plan Approval Order (NAMPAO) was issued, specifying the LTM plan to be followed at the site (FDEP, 2005a).



CEF-CS1AR (15.2-30.2)	03/09	02/10	05/10	02/11	08/11	02/12	08/12	GCTL
Benzene	0.72 J/0.63 J	0.21 U/0.21 U	0.27 U	0.25 U	0.25 U	0.2322 J	1.25 U/1.25 U	[1]
Ethylbenzene	27.2/26.7	0.20 U/0.20 U	0.26 U	1.25	5.66	23.7	44.4*/44.6*	[30]
Total Xylenes	48.4*/47.2*	0.54 U/0.54 U	0.50 U	1.62	4.58	30.7*	29.6*/30.6*	[20]
1,2,4-Trimethylbenene	98.5*/97.4*	0.22 U/0.22 U	0.28 U	7.18	18.1*	115*	220*/224*	[10]
1,3,5-Trimethylbenene	22.3*/22.7*	0.21 U/0.21 U	0.26 U	1.25	5.80	15.9*	118.3*/18.5*	[10]
Naphthalene	29.9*/31.9*	2.0 U/1.0 U	0.17	2.79	9.23	34.4*	33.1*/29.7*	[14]
1-Methylnaphthalene	26.1/27/8	0.74 J/0.55 J	1.3	2.71	0.951 J	27	27.5/25.3	[28]
2-Methylnaphthalene	24.5/24.8	0.50 U/0.0 U	0.61	2.75	4.28	34.9*	17.3/15.0	[28]
Isopropylbenzene	10.6*/10.2*	0.20 U/0.20 U	0.20 U	2.12*	8.73*	18.5*	25.0*/25.9*	[0.8]

CEF-CS10 (17.7-32.7)	03/09	02/10	05/10	02/11	08/11	02/12	08/12	GCTL
Benzene	0.4 U	0.21 U	0.27 U	0.25 U	0.25 U	0.25 U	0.25 U	[1]
Ethylbenzene	0.43 U	0.20 U	0.26 U	0.25 U	0.25 U	0.25 U	0.25 U	[30]
Total Xylenes	1.2 U	0.54 U	0.50 U	0.75 U	0.75 U	0.75 U	0.75 U	[20]
1,2,4-Trimethylbenene	3.5 U	0.22 U	0.28 U	0.25 U	0.25 U	0.25 U	0.25 U	[10]
1,3,5-Trimethylbenene	0.20 U	0.21 U	0.26 U	0.25 U	0.25 U	0.25 U	0.25 U	[10]
Naphthalene	4.3	0.96 U	0.03 U	0.0467 U	0.0467 U	0.05 U	0.691 J	[14]
1-Methylnaphthalene	6.9	0.48 U	0.03 U	0.0467 U	0.0467 U	0.05 U	0.463 U	[28]
2-Methylnaphthalene	5.2	0.48 U	0.03 U	0.0467 U	0.0467 U	0.05 U	0.463 U	[28]
Isopropylbenzene	2.4	0.20 U	0.20 U	0.25 U	0.25 U	0.25 U	0.25 U	[0.8]

CEF-CS3 (16.5-31.5)	03/09	02/10	02/11	GCTL
Benzene	0.4 U	0.21 U	0.25 U	[1]
Ethylbenzene	0.43 U	0.20 U	0.25 U	[30]
Total Xylenes	1.2 U	0.54 U	0.75 U	[20]
1,2,4-Trimethylbenene	0.22 U	0.22 U	0.25 U	[10]
1,3,5-Trimethylbenene	0.20 U	0.21 U	0.25 U	[10]
Naphthalene	0.24 U	0.96 U	0.0467 U	[14]
1-Methylnaphthalene	0.24 U	0.48 U	0.0467 U	[28]
2-Methylnaphthalene	0.24 U	0.48 U	0.0467 U	[28]
Isopropylbenzene	0.20 U	0.20 U	0.25 U	[0.8]

CEF-CS8 (17.4-32.4)	03/09	02/10	02/11	GCTL
Benzene	0.4 U	0.21 U	0.25 U	[1]
Ethylbenzene	0.43 U	0.20 U	0.25 U	[30]
Total Xylenes	1.2 U	0.54 U	0.75 U	[20]
1,2,4-Trimethylbenene	0.22 U	0.22 U	0.25 U	[10]
1,3,5-Trimethylbenene	0.20 U	0.21 U	0.25 U	[10]
Naphthalene	0.24 U	0.98 U	0.0467 U	[14]
1-Methylnaphthalene	0.24 U	0.49 U	0.0467 U	[28]
2-Methylnaphthalene	0.24 U	0.49 U	0.0467 U	[28]
Isopropylbenzene	0.20 U	0.20 U	0.25 U	[0.8]

FIGURE 10.7-1
SITE LOCATION MAP AND HISTORICAL ANALYTICAL DATA IN GROUNDWATER
OCALA F-18 CRASH SITE
NAS CECIL FIELD
JACKSONVILLE, FLORIDA

Monitoring Well

Groundwater Flow Direction

NOTE: Highlighted wells are currently in the LTM program

CEF-CS8 = Sample ID
(17.4-32.4) = Well screen interval, feet below ground surface
0.4 = Detected concentration (Sample/Duplicate in µg/L)
* = GCTL value exceeded
J = Estimated concentration

U = Not detected at or above MDL (associated value)
[1] = Ground Cleanup Target Level (GCTL)

1 inch = 100 feet

0 25 50 75 100 Feet

NAVFAC Naval Facilities Engineering Command

RESOLUTION CONSULTANTS

REQUESTED BY: K. Wimble	DATE: 1/28/2013
DRAWN BY: N. Rinehart	PROJECT NUMBER: 0888812660

X:\Navy\NAS_CecilField\PetroSiteOcalaCrashMap.mxd

SOURCE: ARCGIS ONLINE BING AERIAL (c) 2010 MICROSOFT CORPORATION AND ITS DATA SUPPLIERS

According to the 2005 NAMP, three wells were to be sampled at the site for VOCs and SVOCs, and one well was to be sampled for SVOCs only, semi-annually. Every year for the first five years of monitoring, the annual report was to recommend whether to continue semi-annual sampling or to begin annual sampling. Annual sampling began with Year 3 based on discussions during the July 2008 BCT meeting. The COCs at the site were defined as benzene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, naphthalene, 1-methylnaphthalene, and 2-methylnaphthalene.

Soil sampling was completed at the site in March 2009 based on a decision approved during the July 2008 BCT meeting to further investigate the potential contributing source of contamination to the area surrounding well CEF-CS1A. A *Supplemental Soil Sampling Work Plan* (TtNUS, 2009) was prepared, specifying that eight soil samples would be collected from five soil borings and analyzed for VOCs, SVOCs, and total organic carbon. Soil sampling was conducted concurrently with the Year 4 annual groundwater sampling event, but it was determined at the May 2009 BCT meeting that continued soil sampling was not required, and annual sampling events would be for groundwater only (Decision 756, May 2009 BCT meeting). Annual sampling continued through Year 6, February 2011, and it was recommended in the Year 6 Annual Groundwater Monitoring Report that sampling be changed to semi-annual frequency to monitor seasonal fluctuations. This recommendation was accepted by FDEP, and the first semi-annual Year 7 sampling event was conducted in August 2011.

Currently, two wells (CEF-CS1AR and CEF-CS10) are sampled semi-annually for BTEX, isopropylbenzene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, naphthalene, 1-methylnapthalene, and 2-methylnaphthalene. Monitoring well CEF-CS1A has been replaced with CEF-CS01AR. Groundwater elevations are measured at ten wells (CEF-CS1AR, CEF-CS2, CEF-CS3, CEF-CS4, CEF-CS5, CEF-CS6, CEF-CS7, CEF-CS8, CEF-CS9, and CEF-CS10) at the site.

10.7.3 Conceptual Site Model — Ocala Crash Site

A summary of the CSM based on post-removal action site conditions at the Ocala F-18 Crash Site is shown on Figure 10.7-2. The text below describes the CSM.

10.7.3.1 Sources of Contamination — Ocala Crash Site

Soil and shallow groundwater (near the top of the water table) are contaminated in the area of the F-18 crash. 1,2,4-Trimethylbenzene and 1-methylnaphthalene were detected in the soil remaining at the site at concentrations slightly exceeding their respective SCTLs for leachability during a supplemental soil sampling event in March 2009. These SCTL exceedances are in the same area as GCTL exceedances of ethylbenzene, total xylenes, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, and isopropylbenzene.

10.7.3.2 Potential Contaminant Migration Mechanisms — Ocala Crash Site

The contaminant migration pathways from the Ocala F-18 Crash Site include overland runoff and infiltration. Overland runoff at the site would flow toward the southeast. The site is located in Ocala National Forest, and thus there are no manmade drainage ditches present at or near the site. Vegetation at the site serves to minimize fugitive particulates; therefore, the airborne contaminant transport pathway is not a concern at the site.

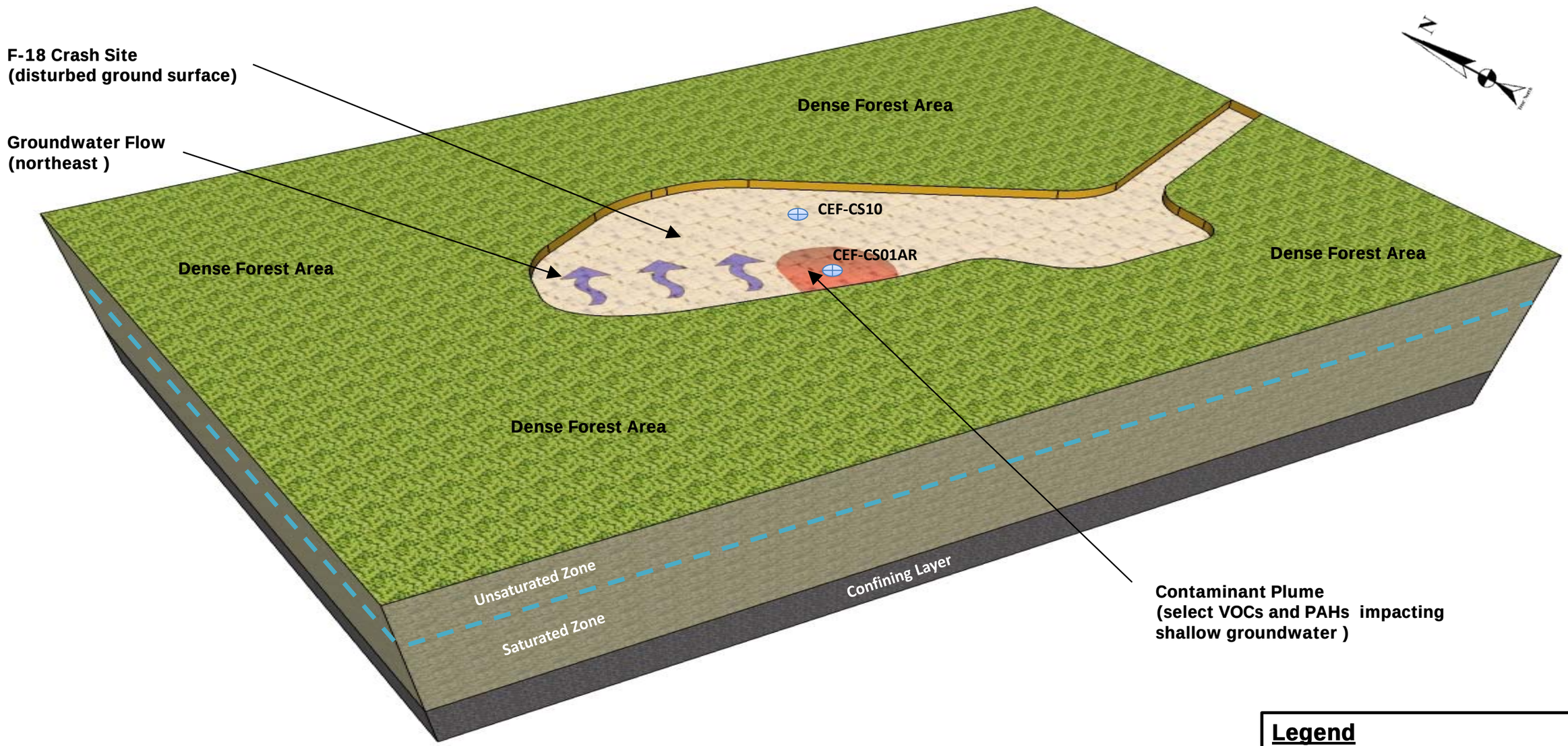
Infiltrating precipitation can cause contamination to leach from surface soil to subsurface soil to groundwater. Upon entering the water column, chemicals, particularly VOCs, are carried with the flow of groundwater downgradient in a north-northeasterly direction. At the Ocala F-18 Crash Site, depth to groundwater measurements taken in February 2011 indicate that water levels at the site are between 20.65 feet to 24.28 feet below top of casing (btoc). Thus, contaminant migration in groundwater would be in the shallow zone of the surficial aquifer.

Results of groundwater sampling show that concentrations of VOCs and SVOCs have decreased, and that these chemicals are not migrating outside the boundaries of the Ocala F-18 Crash Site at unacceptable concentrations.

10.7.3.3 Land Uses and Potential Exposure — Ocala Crash Site

Humans do not inhabit or work near the Ocala F-18 Crash Site in the Ocala National Forest; therefore, human exposure to contaminated site groundwater through ingestion, inhalation, or direct contact with potable water is not a consideration. Ecological receptors are not exposed to groundwater; however, contamination exceeding regulatory criteria remains.

The Ocala F-18 Crash Site is not located in a highly developed area, considering that the site is a cleared area within Ocala National Forest. There is an ecological habitat at the Site, and ecological receptors could possibly be affected by contamination levels in soil. Direct exposure of potential human receptors to soil and groundwater is restricted based upon the current and likely future land use.



Legend

- Groundwater Monitoring Well

Contaminant Source:

Jet fuel released to soil as a result of F-18 crash

Receptors:

Human: None due to lack of exposure
Ecological: Possible ecological receptors due to contamination in soil

Land Use Controls:

Formal land use controls and associated boundary not established for this site

NOTES:

1. Conceptual Site Model not to scale. Horizontal dimensions based on recent aerial imaging, site visits, and historic knowledge. Vertical dimensions exaggerated for purpose of conveying pertinent site information.
2. Groundwater monitoring well locations are approximated based on geographic information system data.

Figure 10.7-2
Conceptual Site Model
Ocala F-18 Crash Site
Former NAS Cecil Field, Jacksonville, Florida

NAVFAC Naval Facilities Engineering Command
RESOLUTION CONSULTANTS

REQUEST BY: Kara Wimble	DATE: 11/02/2012
DRAWN BY: David Myers	CTO NO. JM34

SAP WORKSHEET #11: PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS FOR OCALA F-18 CRASH SITE

11.7 Problem Definition

During the most recent (Second semi-annual, Year 7) groundwater monitoring event, isopropylbenzene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, 2-methylnaphthalene, naphthalane, and xylene exceeded their respective NADCs and GCTLs in source area well CEF-CS01AR. There were no exceedances in downgradient well CEF-CS10AR. LTM results appear to indicate that no contaminant migration is occurring. The source of contamination is the JP-5 that leaked from the airplane crash and the soil that was immediately affected, and the plume appears to be limited in extent. Groundwater is monitored semi-annually. To confirm whether natural attenuation is occurring at the site and ensure that contamination is not migrating offsite, concentrations of VOCs and SVOCs in the groundwater will be evaluated.

11.7.1 Study Boundaries

The Ocala F-18 Crash Site area covers an area of approximately 150 feet by 150 feet, or 22,500 square feet. This is delineated based on the area of the forest cleared by the airplane crash event, as shown on Figure 10.7-1. The vertical boundary for the groundwater plume is from 20 feet to no deeper than 35 feet bgs. The temporal decision unit is each round of monitoring when determining whether an exceedance of GCTL has occurred and it is two consecutive monitoring rounds when determining whether parameters or wells may be eliminated from monitoring. The groundwater sampling frequency must be semi-annual to satisfy project objectives.

11.7.2 Analytical Approach

A direct comparison of measured concentrations within the groundwater will be made against the appropriate PAL. PALs are detailed for each COC in Worksheet #15. Additionally, if none of the measured COC concentrations within any groundwater sample exceed criteria after two consecutive rounds of monitoring, then the monitoring program will be discontinued after coordination with the BCT.

Decision Rule #1: If all measured concentrations of COCs in all wells are less than action levels for two consecutive sampling rounds, then no further monitoring will be recommended; otherwise, proceed to Decision Rule #2.

Decision Rule #2: If any measured source well COC concentration is greater than or equal to the GCTL, then continue monitoring until source well COC concentrations are less than the GCTL for two consecutive monitoring rounds. The BCT may also consider taking additional action.

Decision Rule #3: If any compliance well COC concentration is greater than or equal to the GCTL, then confirm the exceedance. If the exceedance is confirmed, conduct additional delineation of groundwater contamination via additional groundwater sampling and installation of new monitoring wells. The additional delineation will be performed by Resolution Consultants at the direction and approval of the BRAC BCT Team and an FTMR will be issued to govern the delineation.

Decision Rule #4: Throughout the groundwater monitoring, if any particular measured COC concentration is less than GCTL for two consecutive sampling rounds, or all measured COC concentrations in any particular well are less than GCTLs for at least two consecutive sampling rounds, then the BCT will discuss the elimination of the well or COC from the monitoring program, in accordance with the Navy guidance on groundwater monitoring well optimization. The well (or COC) will be eliminated unless the well is a compliance well, or if the BCT determines that the inclusion of the well (or COC) provides useful information on evaluating the overall program and should not be removed.

Decision Rule #5: If post-active remediation monitoring concentrations are greater than NADCs, confirm exceedances. If exceedances are confirmed, then convene the BCT to discuss restarting the BS and bioventing remedial systems. If post-active remediation monitoring concentrations are less than or equal to NADCs, monitor for NA. The BCT may discuss restarting the BS and bioventing systems if concentrations exceed GCTLs only for several events.

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES FOR OCALA F-18 CRASH SITE

Site:	Ocala F-18 Crash Site
Matrix:	Groundwater
Analytical Group:	Volatile Organic Compounds

Analyte	CAS No.	Project Action Level (µg/L)	Project Action Level Source (µg/L)	Project Quantitation Limit Goal (µg/L)	Laboratory Limit of Quantitation[1] (µg/L)	Laboratory Limit of Detection[1] (µg/L)	Laboratory Method Detection Limit[1] (µg/L)
Benzene	71-43-2	1	FDEP GCTL	0.3	1	0.5	0.25
Ethylbenzene	100-41-4	30	FDEP GCTL	10	1	0.5	0.25
Isopropylbenzene	98-82-8	0.8	FDEP GCTL	0.27	**1**	0.5	0.25
1,2,4-Trimethylbenzene	95-63-6	10	FDEP GCTL	3.3	1	0.5	0.25
1,3,5-Trimethylbenzene	108-67-8	10	FDEP GCTL	3.3	1	0.5	0.25
Toluene	108-88-3	40	FDEP GCTL	13	1	0.5	0.25
Total Xylenes	1330-20-7	20	FDEP GCTL	6.7	3	1.5	0.75

Notes:

[1] Laboratory quantitation, detection, and method detection limits, provided by Empirical Laboratory, are targets that are achievable under optimal conditions and may vary during the course of the project. Physical characteristics, such as matrix interference, will affect the actual limits achieved.

CAS No. = Chemical Abstract Services number
µg/L = Micrograms per liter
FDEP GCTL = Florida Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005; http://www.dep.state.fl.us/legal/Rules/waste/62-777/62-777_TableI_GroundwaterCTLs.pdf
Bold = Project action level is less than the laboratory limit of quantitation but the limit of detection is sufficiently low to meet the intended data use

SAP WORKSHEET #15: REFERENCE LIMITS AND EVALUATION TABLES FOR OCALA F-18 CRASH SITE

Site:	Ocala F-18 Crash Site
Matrix:	Groundwater
Analytical Group:	Polynuclear Aromatic Hydrocarbons

Analyte	CAS No.	Project Action Level (µg/L)	Project Action Level Source (µg/L)	Project Quantitation Limit Goal (µg/L)	Laboratory Limit of Quantitation[1] (µg/L)	Laboratory Limit of Detection[1] (µg/L)	Laboratory Method Detection Limit[1] (µg/L)
Naphthalene	91-20-3	14	FDEP GCTL	4.6	0.2	0.1	0.05
1-Methylnaphthalene	90-12-0	28	FDEP GCTL	9.3	0.2	0.1	0.05
2-Methylnaphthalene	91-57-6	28	FDEP GCTL	9.3	0.2	0.1	0.05

Notes:
[1] Laboratory quantitation, detection, and method detection limits, provided by Empirical Laboratory, are targets that are achievable under optimal conditions and may vary during the course of the project. Physical characteristics, such as matrix interference, will affect the actual limits achieved.

CAS No. = Chemical Abstract Services number
µg/L = Micrograms per liter
FDEP GCTL = Florida Groundwater Cleanup Target Levels F.A.C. 62-777 Table I, April 2005; http://www.dep.state.fl.us/legal/Rules/waste/62-777/62-777_TableI_GroundwaterCTLs.pdf

SAP WORKSHEET #17: SAMPLING DESIGN AND RATIONALE FOR OCALA F-18 CRASH SITE

SITE-SPECIFIC SAMPLING DESIGN

Two intermediate wells were chosen based on historical groundwater flow data, detections of the COCs in the wells, and their location in relation to the source area of the plume. Monitoring well CEF-CS01AR is the source area well and monitoring well CEF-CS10 is to be sampled as the downgradient well. LTM will indicate whether contaminant concentrations are naturally attenuating, and to verify that contamination is not migrating from the site. The sampling locations are detailed in Worksheet #18. A map of the monitoring wells is provided on Figure 10.7-1.

SAP WORKSHEET #12: FIELD QUALITY CONTROL SAMPLES

(UFP-QAPP Manual Section 2.6.2)

Measurement Performance Criteria Table — Field QC Samples				
QC Sample	**Analytical Group**	**Frequency**	**Data Quality Indicators**	**Measurement Performance Criteria**
Trip Blank	VOCs	One per cooler	Accuracy/Bias/ Contamination	No analytes ≥ ½ LOQ, except common lab contaminants, which must be < LOQ.
Equipment Rinsate Blank	VOCs, SVOCs, PAHs, TRPH	One per week per matrix per sampling equipment	Bias/Contamination	No analytes ≥ ½ LOQ, except common laboratory contaminants, which must be < LOQ.
Field Duplicate	VOCs, SVOCs, PAHs, TRPH	One per 20 field samples	Precision	Values > 5X LOQ: RPD must be ≤30% (aqueous)(1)
Matrix Spike/Matrix Spike Duplicate	VOCs, SVOCs, PAHs, TRPH	One pair per 20 field samples	Accuracy/Bias/ Precision	Percent recoveries — DoD QSM Limits RPD must be ≤ 30% (organics)
Cooler Temperature Indicator	VOCs, SVOCs, PAHs, TRPH	One per cooler	Representativeness	Temperature must be above freezing and less than or equal to 6 °C.

Notes:

(1) = If duplicate values for non-metals are less than five times the LOQ, the absolute difference should be less than or equal to two times the LOQ.
QC = Quality control
VOCs = Volatile organic compounds
SVOCs = Semivolatile organic compounds
PAHs = Polynuclear aromatic hydrocarbons
LOQ = Limit of quantitation
DoD QSM = Department of Defense Quality Systems Manual for Environmental Laboratories, Version 4.2, 2010 October, or most recent version at the time of sampling
RPD = Relative percent difference
°C = Degrees Celsius
TRPH = Total recoverable petroleum hydrocarbons

SAP WORKSHEET #13: SECONDARY DATA CRITERIA AND LIMITATIONS TABLE

(UFP-QAPP Manual Section 2.7)

North-South Apron Plume				
Secondary Data	**Data Source (originating organization, report title, and date)**	**Data Generator(s) (originating organization, data types, data generation/collection dates)**	**How Data Will Be Used**	**Limitations on Data Use**
Historical groundwater data	Supplemental Site Assessment Letter II, 3 August 2005	TtNUS, groundwater data	For milestones and historical reference	None
Groundwater data since NAMPAO	GWMR, Year 7, First Semi-Annual Event, 21 March 2012	TtNUS, groundwater data since 2005 with most recent sampling event	For milestones, historical references, and path forward	None
Building 82, Tank G82				
Secondary Data	**Data Source (originating organization, report title, and date)**	**Data Generator(s) (originating organization, data types, data generation/collection dates)**	**How Data Will Be Used**	**Limitations on Data Use**
Groundwater data	GWMR — Year 4, Second Semi-Annual (April 2012), TtNUS, 18 July 2012	TtNUS, groundwater data	Information from previous site activities is provided, and quarterly monitoring data since the NAMP was approved is detailed. Data will be used to check against current data to monitor progress of the contamination levels in the groundwater plume.	None
Groundwater data	Natural Attenuation Work Plan , CH2M Hill, 28 May 2008	CH2M Hill, groundwater data	Data will be used as a guide for how the monitoring sampling is conducted for current and future events.	None
Groundwater data	Evaluation of Groundwater Analytical Results BP Wells and Tank G82, CH2M Hill, 27 April 2007	CH2M Hill, groundwater data collected in November 2006	Data used for 2008 Natural Attenuation Work Plan.	None
BP Wells				
Secondary Data	**Data Source (originating organization, report title, and date)**	**Data Generator(s) (originating organization, data types, data generation/collection dates)**	**How Data Will Be Used**	**Limitations on Data Use**
Recent groundwater data	GWMR, First Post Injection Event, TtNUS, 20 September 2012	TtNUS, groundwater from 2012	To determine the path forward	None
Groundwater data	Natural Attenuation Work Plan CH2M Hill, 28 May 2008	CH2M Hill, groundwater data	Data will be used as a guide for how the monitoring sampling is conducted for current and future events.	None

BP Wells (continued)				
Secondary Data	**Data Source (originating organization, report title, and date)**	**Data Generator(s) (originating organization, data types, data generation/collection dates)**	**How Data Will Be Used**	**Limitations on Data Use**
Groundwater data	Treatability Study Evaluation, TtNUS, 8 April 2004	Results from Treatability Study conducted from 2002 to 2004	Natural Attenuation Parameters will be used for historical reference	None
Hangar 815 Wash Rack				
Secondary Data	**Data Source (originating organization, report title, and date)**	**Data Generator(s) (originating organization, data types, data generation/collection dates)**	**How Data Will Be Used**	**Limitations on Data Use**
Groundwater data	GWMR, Year 4 Annual Event, 21 March 2012	TtNUS, groundwater data collected in 2012	Data will be compared with current data to monitor progress of the contamination levels in the groundwater plume.	None
Groundwater data for new well installation	SARA, TtNUS, 15 May 2008	TtNUS, groundwater data collected from new well installed	To include in new recommendation for NAMP.	None
Soil and groundwater data	Source Removal Report, TtNUS, 14 July 2000	TtNUS, soil and groundwater	To verify that the soil is no longer contributing to the contamination because it's been removed and to have old groundwater data to compare current results with.	None
Tanks 81 A, B, C				
Secondary Data	**Data Source (originating organization, report title, and date)**	**Data Generator(s) (originating organization, data types, data generation/collection dates)**	**How Data Will Be Used**	**Limitations on Data Use**
Long-term monitoring data	GWMR Letter, Year 2 — Second Semi-Annual for Tanks 81 A, B, and C, 12 June 2012	TtNUS, groundwater data, 2012	Data will be used to check against current data to monitor progress of the contamination levels in the groundwater plume.	None
Results from DPT investigation and subsequent monitoring well installation, presented to BCT Team in August 2009	TtNUS, August 2009	TtNUS, groundwater data, June 2009	Groundwater data collected from monitoring wells installed in June 2009, based on DPT results generated in March 2009. Data will be used to determine and monitor the stability of the location of the contamination plume through quarterly monitoring.	None

South Fuel Farm				
Secondary Data	**Data Source (originating organization, report title, and date)**	**Data Generator(s) (originating organization, data types, data generation/collection dates)**	**How Data Will Be Used**	**Limitations on Data Use**
Groundwater Data	Site Assessment Report/TtNUS/December 2011	TtNUS, groundwater data from CH2M HILL	LTM of groundwater compares current data to that observed during previous events.	None
Site Assessment Report Groundwater Data	TtNUS/December 2011	Thirteenth groundwater sampling event, Ninth soil sampling event (starting in 1998 and 1999 respectively)	LTM of groundwater compares current data to that observed during previous events.	None
Ocala F-18 Crash Site				
Secondary Data	**Data Source (originating organization, report title, and date)**	**Data Generator(s) (originating organization, data types, data generation/collection dates)**	**How Data Will Be Used**	**Limitations on Data Use**
Ocala F-18 Crash Site LTM Data	TtNUS Semi-Annual Groundwater Monitoring Report, Year 7, 27 April 2012	TtNUS year 7 groundwater data, soil data, collected and historical LTM data (starting from August 1998)	LTM of groundwater — compares current data to that observed during previous events. Soil data could be used if it is determined that soil samples will be collected at Ocala F-18 Crash Site.	None

Notes:

NAMPAO = Natural Attenuation Monitoring Plan Approval Order
GWMR = Groundwater Monitoring Report
NAMP = Natural Attenuation Monitoring Plan
DPT = Direct Push Technology
BCT = Base Cleanup Team
LTM = Long-term groundwater monitoring
TtNUS = Tetra Tech Nuclear Utilities Services
BP = British Petroleum
SARA = Site Assessment Report Addendum (TtNUS, May 2008)

SAP WORKSHEET #14: SUMMARY OF PROJECT TASKS

(UFP-QAPP Manual Section 2.8.1)

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 provided in Appendix B. The field tasks are as follows:

- Mobilization/Demobilization
- Sample Collection and Sample Handling Tasks
- Monitoring Equipment Calibration
- Well Installation and Development
- Groundwater Level Measurements
- Groundwater Sampling
- Investigation-Derived Waste (IDW) Management
- Field Decontamination Procedures
- Field Documentation Procedures
- Quality Control Tasks

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 Team Leader (FTL) or designee will coordinate with the Former NAS Cecil Field 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.

Sample Collection and Sample Handling Tasks

The sampling and analysis program is outlined in Worksheets #10 and #18. Sample collection and handling will be in accordance with the SOPs listed in Worksheet #21. Sample labeling will be in accordance with Resolution Consultants SOP-3-03. Methods for sample handling will be in accordance with Resolution Consultants SOP-3-04. Sample containers will be provided in "certified-

clean" condition (I-Chem 300 or equivalent) from the analytical laboratory. The selection of sample containers, sample preservation, packaging, and shipping will be in accordance with Resolution Consultants SOP-3-04 and Worksheets #19 and #30. Field and laboratory QC samples will be collected as outlined in Worksheet #20.

Monitoring Equipment Calibration

Field equipment will be calibrated in accordance 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.

Permanent Monitoring Well Installation and Development

Due to ongoing construction activities at the Former NAS Cecil Field, it may be necessary to install new monitoring wells. These wells may be replacement wells or wells that are added to an already existing LTM network. The location of these wells has not been identified; however, this SAP has included the SOPs to install and develop monitoring wells if the need arises in the near future.

Permanent monitoring 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. A geologist/engineer will log geologic conditions based on soil cuttings and utilize a photo-ionization detector to screen for organic vapors during drilling. Monitoring wells will be constructed with 2-inch diameter poly-vinyl chloride materials to depths of approximately 15 feet with 10-foot long well screened intervals, placed to bracket the water table at the site. Well completions will be flush mount, at a minimum consisting of a steel protective cover with bolt-on lid set in concrete. Each well will be sealed with an expansion plug cap and lock, and identified with a permanent well identification plate.

Following installation, each monitoring well will be developed to remove residual fines remaining after well installation and to establish natural flow conditions in the well that may have been disturbed during well construction. Wells may be developed by surging, bailing, and or pumping no sooner than 24 hours after installation. Development will be conducted until the water purged from the well is free of visible sediment and indicator parameters (temperature, pH, and specific conductivity) have stabilized. Stabilization will be achieved when the temperature varies by no more than 1°C, the pH varies by no more than 0.1 standard units, and the specific conductivity

varies by no more than 5% over three consecutive measurements. If stabilization is achieved and the water remains turbid (>10 nephelometric units), well development will continue until the turbidity stabilizes over three consecutive readings. Each of the permanent monitoring wells will be developed in accordance with Resolution Consultants SOP-3-13.

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 Resolution Consultants SOP-3-14. The depth will be measured in units of feet (to the nearest 0.01-foot) with respect to the top of the well casing to determine the depth-to-water below the ground surface. Water levels will be recorded on a Resolution Consultant water level measurement form. The water level meter will be decontaminated prior to use and between each monitoring well.

Groundwater Sampling

All monitoring wells will be purged prior to sampling using low-flow sampling techniques in accordance with FDEP FS2200. Groundwater samples will be collected in accordance with FDEP FS2200. Worksheets #17 and #18 specify the sample locations and target analytes for this investigation, and Worksheet #23 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 Empirical Laboratories for analysis.

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. Waste water will be generated during DPT grab groundwater sampling, temporary well development, well purging and sampling, and decontamination procedures. IDW will be transferred daily from each site to a temporary staging area located at Former Cecil Field. Aqueous IDW will be contained in smaller poly tanks or Department of Transportation-approved 55-gallon drums. Resolution Consultants estimates that approximately 28 drums will be required to store the IDW generated at NAS Cecil Field (for both Petroleum and IR Sites). Every effort will be made to minimize the number of drums staged at NAS Cecil Field. 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.

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 Resolution Consultants SOP-3-06.

Field Documentation Procedures

Field documentation will be performed in accordance with Resolution Consultants SOP-3-02. 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-3-04.

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.

Quality Control Tasks

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

Additional Project-Related Tasks

Additional project-related tasks include:

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

Analytical Tasks

Chemical analyses will be performed by Empirical Laboratories, which is a current Department of Defense Environmental Laboratory Accreditation Program-accredited laboratory for these analyses. Copies of the pertinent laboratory accreditations are included in Appendix C. Copies of pertinent laboratory standard operating procedures are included in Appendix D. Analyses will be performed in accordance with the analytical methods identified in Worksheets #19 and #30. Empirical Laboratories will meet the screening criteria specified in Worksheet #15 and will perform the chemical analyses following the laboratory-specific SOPs identified in Worksheet #23.

The analytical data packages provided by Empirical Laboratories will be in a Contract Laboratory Program-like format and will be fully validatable and contain raw data, summary forms for all sample and laboratory method blank data, and summary forms containing all method-specific QC information (results, percent recoveries [%Rs], RPDs, relative standard deviations [RSDs], percent differences or percent drifts [%Ds], etc.).

Data Management

The principal data generated for this project will be from field data and laboratory analytical data. Field sampling log sheets will be organized by date and medium, and filed in the project files. 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. Project personnel completing concurrent field sampling activities may maintain multiple field logbooks. When possible, logbooks will be segregated by sampling activity. The field logbooks will be titled based on date and activity. The data handling procedures to be followed by Empirical Laboratories will meet the requirements of the technical specifications. Electronic data results will be automatically downloaded into the Resolution Consultants database in accordance with the proprietary Resolution Consultants processes. The Resolution Consultants TOM (or designee) is responsible for the overall tracking and control of data generated for the project.

Data Tracking

Data are tracked from generation to archiving in the Resolution Consultants project-specific files. The Resolution Consultants Project Chemist (or designee) is responsible for tracking the samples collected and shipped to Empirical Laboratories. Upon receipt of the data packages from Empirical Laboratories, the Resolution Consultants Project Chemist will monitor the data validation effort, which includes verifying that the data packages are complete and results for all samples have been delivered by Empirical Laboratories.

Data Storage, Archiving, and Retrieval

The data packages received from Empirical Laboratories are tracked in the data validation logbook. 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 log books, sample logs, chain-of-custody records, and field calibration logs will be submitted by the Resolution Consultants FTL to be entered into the Navy CLEAN file system prior to archiving in secure project files. Project files are audited for accuracy and completeness. At the completion of the Navy contract, the records will be stored by Resolution Consultants.

Data Security

Access to Resolution Consultants project files is restricted to designated personnel only. Records can only be borrowed temporarily from the project file using a sign-out system. 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 electronic data will be compiled into a NIRIS Electronic Data Deliverable and loaded into NIRIS.

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		
NSAP Year 9 Annual Sampling Event	Resolution Consultants	16 January 2014	16 January 2014	GWMR	16 April 2014
Building 82, Tank G82 Year 5, Second Semi-Annual	Resolution Consultants	25 April 2013	27 April 2013	GWMR	27 July 2013
Building 82, Tank G82 Year 6, First Semi-Annual	Resolution Consultants	22 October 2013	24 October 2013	GWMR	24 January 2014
BP Wells — 3rd Post-ORC Injection	Resolution Consultants	25 June 2013	25 June 2013	GWMR	25 September 2013
815 Wash Rack — Year 6 Annual Event	Resolution Consultants	19 January 2014	19 January 2014	GWMR	19 April 2014
Tanks 81 A, B, and C — Year 3, Second Semi-Annual Event	Resolution Consultants	16 April 2013	18 April 2013	GWMR	12 July 2013
Tanks 81 A, B, and C — Year 4, First Semi-Annual Event	Resolution Consultants	16 October 2013	18 October 2013	GWMR	18 January 2014
South Fuel Farm — First Semi-Annual Event	Resolution Consultants	22 February 2013	24 February 2013	GWMR	24 May 2013
South Fuel Farm — Second Semi-Annual Event	Resolution Consultants	23 August 2013	25 August 2013	GWMR	25 November 2013
Ocala Crash Site — Year 9, First Semi-Annual Event	Resolution Consultants	26 August 2013	26 August 2013	GWMR	26 November 2013
Ocala Crash Site — Year 9, Second Semi-Annual Event	Resolution Consultants	25 February 2014	25 February 2014	GWMR	25 May 2014

Notes:
NSAP = North-south apron plume
GWMR = Groundwater Monitoring Report

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

(UFP-QAPP Manual Sections 3.1.1)

Sampling Location/ ID Number	Well Rationale	Matrix	Depth (units)	Analytical Group	Number of Samples	Sampling SOP Reference[1]
North-South Apron						
CEF-M18-04I CEF-M18-04I-GW-MMYYYY	Source Well	Groundwater	30-35 feet bgs	VOCs: Benzene only	1	FS2200
CEF-M18-05I CEF-M18-05I-GW-MMYYYY	Downgradient Well	Groundwater	30-35 feet bgs	VOCs: Benzene only	1	FS2200
Building G82, Tanks G82						
CEF-G82-1S CEF-G82-1S-GW-MMYYYY	Source well	Groundwater	4 to 15 feet bgs	VOCs: Benzene, Isopropylbenzene, 1,2,4-trimethylbenzene SVOCs: Naphthalene, 1-methylnaphthalene, 2-methylnaphthalene TRPH	1	FS2200
CEF-G82-2S CEF-G82-2S-GW-MMYYYY	Downgradient well	Groundwater	4 to 15 feet bgs		1	FS2200
CEF-G82-3S CEF-G82-3S-GW-MMYYYY	Upgradient well	Groundwater	4 to 15 feet bgs		1	FS2200
CEF-G82-4S CEF-G82-4S-GW-MMYYYY	Sidegradient well	Groundwater	4 to 15 feet bgs		1	FS2200
CEF-G82-5S CEF-G82-5S-GW-MMYYYY	Compliance well	Groundwater	4 to 15 feet bgs		1	FS2200
CEF-G82-6S CEF-G82-6S-GW-MMYYYY	Compliance well	Groundwater	4 to 15 feet bgs		1	FS2200
CEF-G82-2I CEF-G82-2I-GW-MMYYYY	Vertical Well	Groundwater	30 to 35 feet bgs		1	FS2200

Sampling Location/ ID Number	Well Rationale	Matrix	Depth (units)	Analytical Group	Number of Samples	Sampling SOP Reference[1]
BP Wells						
CEF-BP-1SR CEF-BP-1SR-GW-MMYYYY	Source Well	Groundwater	4 to 15 feet bgs	VOCs: Ethylbenzene isopropylbenzene, 1,2,4-trimethylbenzene 1,3,5-trimethylbenzenee, total xylenes SVOCs: 2-methylnaphthalene, naphthalene TRPH	1	FS2200
CEF-BP-6SR CEF-BP-6SR-GW-MMYYYY	Downgradient well	Groundwater	4 to 15 feet bgs		1	FS2200
CEF-BP-12S CEF-BP-12S-GW-MMYYYY	Compliance Well	Groundwater	4 to 15 feet bgs		1	FS2200
815 Wash Rack — Annually						
CEF-815-01S CEF-815-01S-GW-MMYYYY	Source Well	Groundwater	4 to 15 feet bgs	PAHs: Naphthalene only	1	FS2200
CEF-815-05S CEF-815-05S-GW-MMYYYY	Downgradient Well	Groundwater	4 to 15 feet bgs	PAHs: Naphthalene only	1	FS2200
NG-12S NG-12S-GW-MMYYYY	Side Gradient Well	Groundwater	4 to 15 feet bgs or 4 to 14 feet bgs	PAHs: Naphthalene only	1	FS2200
CEF-059-028-015 CEF-059-028-015-GW-MMYYYY	Compliance Well	Groundwater	4 to 15 feet bgs	PAHs: Naphthalene only	1	FS2200

Sampling Location/ ID Number	Well Rationale	Matrix	Depth (units)	Analytical Group	Number of Samples	Sampling SOP Reference[1]
Tanks 81 A, B, C						
CEF-81-04I CEF-81-04I-GW-MMYYYY	Source well	Groundwater	30 to 35 feet bgs	VOCs: Isopropylbenzene only	1	FS2200
CEF-81-22I CEF-81-22I-GW-MMYYYY	Downgradient well	Groundwater	30 to 35 feet bgs	VOCs: Isopropylbenzene only	1	FS2200
CEF-81-24I CEF-81-24I-GW-MMYYYY	Downgradient Well	Groundwater	30 to 35 feet bgs	VOCs: Isopropylbenzene only	1	FS2200
CEF-81-25I CEF-81-25I-GW-MMYYYY	Downgradient well	Groundwater	30 to 35 feet bgs	VOCs: Isopropylbenzene only	1	FS2200
CEF-81-26I CEF-81-26I-GW-MMYYYY	Downgradient well	Groundwater	30 to 35 feet bgs	VOCs: Isopropylbenzene only	1	FS2200
CEF-81-27D CEF-81-27D-GW-MMYYYY	Downgradient well	Groundwater	45 to 55 feet bgs	VOCs: Isopropylbenzene only	1	FS2200
CEF-81-28D CEF-81-28D-GW-MMYYYY	Source well	Groundwater	45 to 55 feet bgs	VOCs: Isopropylbenzene only	1	FS2200
South Fuel Farm						
CEF-043-02N CEF-043-02N-GW-MMYYYY	NA	Groundwater	3 to 15 feet bgs	VOCs: Benzene, ethylbenzene, isopropylbenzene, xylenes, PAHs: naphthalene TRPH	1	FS2200
CEF-043-04N CEF-043-04N-GW-MMYYYY	NA	Groundwater	3 to 15 feet bgs		1	FS2200
CEF-043-06N CEF-043-06N-GW-MMYYYY	NA	Groundwater	3 to 15 feet bgs		1	FS2200
CEF-043-07N CEF-043-07N-GW-MMYYYY	NA	Groundwater	3 to 15 feet bgs		1	FS2200
CEF-043-09N CEF-043-09N-GW-MMYYYY	NA	Groundwater	3 to 15 feet bgs		1	FS2200
CEF-043-40A CEF-043-40A-GW-MMYYYY	NA	Groundwater	3 to 15 feet bgs		1	FS2200

Sampling Location/ ID Number	Well Rationale	Matrix	Depth (units)	Analytical Group	Number of Samples	Sampling SOP Reference[1]
CEF-043-23 CEF-043-23-GW-MMYYYY	Downgradient well	Groundwater	3 to 15 feet bgs	VOCs: Benzene, ethylbenzene, isopropylbenzene, xylenes, PAHs: naphthalene TRPH	1	FS2200
Ocala F-18 Crash Site						
CEF-CS01AR CEF-CS01AR-GW-YYYY	Source well	Groundwater	20 to 35 feet bgs	VOCs: Benzene, isopropylbenzene, ethylbenzene, toluene, xylenes, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene PAHs: 1-methylnaphthalene, 2-methylnaphthalene, naphthalene	1	FS2200
CEF-CS10 CEF-CS10-GW-YYYY	Downgradient well	Groundwater	18 to 33 feet bgs		1	, FS2200

Notes:
[1] Standard operating procedure (SOP) or worksheet that describes the sample collection procedures

MM = Month
YYYY = Year
GW = Groundwater
VOCs = Volatile organic compounds
SOP = Standard Operating Procedure
TRPH = Total Recoverable Petroleum Hydrocarbons
PAHs = Polyaromatic Hydrocarbonds
PCBs = Polychlorinated Biphenol

SAP WORKSHEET #19: FIELD SAMPLING REQUIREMENTS TABLE

(UFP-QAPP Manual Sections 3.1.1)

Matrix	Analytical Group	Analytical and Preparation Method/ Laboratory SOP Reference	Containers (number, size, and type)	Sample Volume	Preservation Requirements[1]	Maximum Holding Time[2] (preparation/analysis)
Groundwater	VOCs	SW-846 5030/8260B/ *Empirical SOP 202*	(3) 40 mL glass volatile vials	40 mL	Hydrochloric acid to a pH less than 2; Cool to 0-6°C; no headspace	14 days
Groundwater	PAHs	SW-846 3510C/8270D *Empirical SOP 201*	(2) 1 Liter amber glass bottles	1,000 mL	Cool to 0-6°C	7 days to preparation 40 days to analysis
Groundwater	TRPH	Florida PRO *Empirical SOP 338*	(2) 1 Liter amber glass bottles	1,000 mL	Hydrochloric acid to a pH less than 2; Cool to 0-6 °C	7 days to preparation 40 days to analysis

Notes:
[1] Chemical, temperature, and light protected
[2] Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted
SOP = Standard operating procedure
VOCs = Volatile organic compounds
PAHs = Polynuclear aromatic hydrocarbons
TRPH = Total recoverable petroleum hydrocarbons
mL = Milliliter
°C = Degrees Celsius

SAP WORKSHEET #20: FIELD QUALITY CONTROL SAMPLE SUMMARY TABLE

(UFP-QAPP Manual Sections 3.1.1)

Matrix	Analytical Group	Number of Sampling Locations	Number of Field Duplicates	Number of MS/MSD	Number of Trip blanks	Total Number of Samples to Lab
North-South Apron Plume						
Groundwater	VOCs (Benzene Only)	2	1	0	1	4
Building 82, Tank G82						
Groundwater	VOCs	7	1	0	1	9
	PAHs	7	1	0	0	8
	TRPH	7	1	0	0	8
BP Wells						
Groundwater	VOCs	3	1	0	1	5
	PAHs	3	1	0	0	4
	TRPH	3	1	0	0	4
815 Wash Rack						
Groundwater	PAHs (Naphthalene Only)	4	1	0	1	6
Tanks 81 A, B, C						
Groundwater	VOC (isopropyl-benzene only)	7	1	1/1	1	11
South Fuel Farm						
Groundwater	VOCs	7	1	1/1	1	10
	Naphthalene	7	1	1/1	0	9
	TRPH	7	1	1/1	0	9
Ocala F-18 Crash Site						
Groundwater	VOCs	2	1	1/1	1	6
	PAHs	2	1	1/1	0	5

Notes:

VOCs = Volatile organic compounds
PAHs = Polynuclear aromatic hydrocarbons
TRPH = Total recoverable petroleum hydrocarbons
MS/MSD = Matrix spike/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	Modified for Project Work? (Yes/No)	Comments
SOP-3-01	Utility Clearance, 2012 May	Resolution Consultants	No	
SOP-3-02	Field Log Books, 2012 May	Resolution Consultants	No	
SOP-3-03A	Sample Labeling and Chain of Custody, 2012 May	Resolution Consultants	No	
SOP-3-04A	Packaging and Shipping Procedures for Low Concentration Samples, 2012 May	Resolution Consultants	No	
SOP-3-05	Investigative Derived Waste Management, 2012 May	Resolution Consultants	No	
SOP-3-06	Equipment Decontamination, 2012 May	Resolution Consultants	No	
SOP-3-07	Land Surveying, Revision 0	Resolution Consultants	No	
SOP-3-24	Water Quality Parameter Testing for Groundwater Sampling, 2012 May	Resolution Consultants	No	
FS2200	Groundwater Sampling, 31 March 2008	FDEP	No	
FT1000	Field Testing General, 31 March 2008	FDEP	No	
FT1100	Field pH, 31 March 2008	FDEP	No	
FT1200	Field Specific Conductance, 31 March 2008	FDEP	No	
FT1300	Field Salinity, 31 March 2008	FDEP	No	
FT1400	Field Temperature, 31 March 2008	FDEP	No	
FT1500	Field Dissolved Oxygen, 31 March 2008	FDEP	No	
FT1600	Field Turbidity, 31 March 2008	FDEP	No	

Notes:
All field SOPs are located in Appendix B.
SOP = Standard operating procedure
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 Criteria	Corrective Action	Responsible Person	SOP Reference	Comments
YSI 600 Series Water Quality Meter	Visual Inspection Calibration/ Verification	Daily Beginning and end of day	Manufacturer's guidance	Operator correction or replacement	FTL or designee	FDEP FT1000 through 1500 Manufacturer's Guidance Manual	To be used to determine purge completion.
Turbidity Meter (LaMotte 2020 or equivalent)	Visual Inspection Calibration/ Verification	Daily Beginning and end of day	Manufacturer's guidance Calibrations must bracket expected values. ICV must be <5 NTU.	Operator correction or replacement	FTL or designee	FDEP FT1600 Manufacturer's Guidance Manual	To be used to determine purge completion.
Water Level Indicator and Oil/Water Interface Probe	Visual Inspection Field checks as per manufacturer	Daily Once upon receiving from vendor	0.01 foot accuracy	Operator correction or replacement	FTL or designee	Manufacturer's Guidance Manual	None
Global Positioning System	Positioning	Beginning and end of each day used	Accuracy: sub-meter horizontal dilution of precision < 3 feet, number of satellites must be at least six	Wait for better signal, replace unit, or choose alternate location technique	FTL or designee	Manufacturer's Guidance Manual, Resolution Consultants SOP-3-07	None

Notes:

FTL = Field Team Lead
ICV = Initial Calibration Verification
NTU = Nephelometric Turbidity Unit
SOP = Standard operating procedure

SAP WORKSHEET #23: ANALYTICAL SOP REFERENCES TABLE

(UFP-QAPP Manual Section 3.2.1)

Laboratory Name and Address: Empirical Laboratories, LLC, 621 Mainstream Drive, Suite 270, Nashville, Tennessee 37228

Laboratory Point of Contact/Project Manager: Sonya Gordon, sgordon@empirlabs.com, (615) 345-1115

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work? (Yes/No)
SOP 202	*GC/MS Volatiles by EPA Method 624 & SW846 Method 8260B Including Appendix IX Compounds*, Revision 24, 09/13/2011	Definitive	VOCs Groundwater	Gas Chromatography/Mass Spectrophotometer	None	No
SOP 201	*GC/MS Semi-volatiles and Low-Concentration PAHs by EPA Method 625 and SW846 Method 8270C and 8270D, including Additional Appendix IX Compounds, Revision 22,* 08/20/2012	Definitive	PAHs Groundwater	Gas Chromatography/Mass Spectrophotometer	None	No
SOP 338	*FLPRO Method for Determination of Petroleum Range Organics* Revision 10, 09/12/2012	Definitive	TRPH Groundwater	Gas Chromatography/ Flame Ionization Detector	None	No

Notes:

[1] Analytical procedure produces definitive results; however, the end use of the data will be screening level to assess remedial effectiveness

SOP = Standard operating procedure
QSM = Department of Defense Quality Systems Manual for Environmental Laboratories, Version 4.2, October 2010
VOCs = Volatile organic compounds
PAHs = Polynuclear aromatic hydrocarbons
TRPH = Total recoverable petroleum hydrocarbons

SAP WORKSHEET #24: ANALYTICAL INSTRUMENT CALIBRATION TABLE

(UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
GC/MS VOCs	Tuning	Prior to ICAL and at the beginning of each 12-hour period.	Refer to method for specific ion criteria.	Retune instrument and verify. Rerun affected samples. Flagging criteria are not appropriate.	Analyst, Supervisor	Empirical SOP 202
GC/MS VOCs	ICAL Minimum five-point initial calibration for all analytes (six-points for quadratic)	Initial calibration prior to sample analysis	Average RF for SPCCs: ≥ 0.3 and each analyte must meet one of the following: Option 1: %RSD for each analyte ≤ 15%; Option 2: linear least squares regression for each analyte: $r^2 \geq 0.99$; Option 3: non-linear least squares regression (quadratic) for each analyte: $r^2 \geq 0.99$.	Repeat calibration if criterion is not met	Analyst, Supervisor	Empirical SOP 202
GC/MS VOCs	Second source ICV	Once after each ICAL	All analytes within ± 20% of expected value	Remake standard, recalibrate if necessary	Analyst, Supervisor	Empirical SOP 202
GC/MS VOCs	CCV	CV daily, before sample analysis, and every 12 hours of analysis time	Average RF for SPCCs: ≥ 0.3; %D ≤ 20 for all target compounds	Repeat initial calibration and reanalyze all samples analyzed since the last successful CV.	Analyst, Supervisor	Empirical SOP 202
GC/MS VOCs	RRT Evaluation	Prior to sample analysis	RRT of each target analyte within ± 0.06 RRT units of the RRT standard.	CCV fails, perform column maintenance, inspect pumps, and leak checks	Analyst, Supervisor	Empirical SOP 202
GC/MS PAHs	Tuning	Prior to ICAL and at the beginning of each 12-hour period.	Refer to method for specific ion criteria.	Retune instrument and verify. Rerun affected samples. Flagging criteria are not appropriate.	Analyst, Supervisor	Empirical SOP 201
GC/MS PAHs	ICAL Minimum five-point initial calibration for all analytes (six-points for quadratic)	Initial calibration prior to sample analysis	Average RF for SPCCs: ≥ 0.05 and each analyte must meet one of the following: Option 1: %RSD for each analyte ≤ 15%; Option 2: linear least squares regression for each analyte: r ≥ 0.995; Option 3: non-linear least squares regression (quadratic) for each analyte: $r^2 \geq 0.99$.	Repeat calibration if criterion is not met	Analyst, Supervisor	Empirical SOP 201

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
GC/MS PAHs	Second source ICV	Once after each ICAL	All analytes within ± 20% of expected value	Remake standard, recalibrate if necessary	Analyst, Supervisor	Empirical SOP 201
GC/MS PAHs	CCV	CV daily, before sample analysis, and every 12 hours of analysis time	Average RF for SPCCs: VOCs ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane; ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane; %D ≤20 for all target compounds	Repeat initial calibration and reanalyze all samples analyzed since the last successful CV.	Analyst, Supervisor	Empirical SOP 201
GC/MS PAHs	Breakdown (DDT)	At the beginning of each 12-hour period, prior to analysis of samples	Degradation ≤20% for DDT, Benzidine and pentachlorophenol should be present at their normal responses, and should not exceed a tailing factor of 2	No samples shall be run until degradation ≤ 20%.	Analyst, Supervisor	Empirical SOP 201
GC/MS PAHs	RRT Evaluation	Prior to sample analysis	RRT of each target analyte within ± 0.06 RRT units of the RRT standard.	CCV fails, perform column maintenance, inspect pumps, and leak checks	Analyst, Supervisor	Empirical SOP 201
GC/FID TRPH	ICAL Minimum five-point initial calibration for all analytes (six-points for quadratic)	Initial calibration prior to sample analysis	Each analyte must meet <u>one</u> of the following: <u>Option 1</u>: %RSD for each analyte ≤ 20%; <u>Option 2</u>: linear least squares regression for each analyte: r ≥ 0.995; <u>Option 3</u>: non-linear least squares regression (quadratic) for each analyte: $r^2 \geq 0.99$.	Perform instrument maintenance as needed. Reanalyze or re-prepare calibration standards.	Analyst, Supervisor	Empirical SOP 338
GC/FID TRPH	Second source ICV	Once after each ICAL	All analytes within ± 25% of expected value	Correct problem and verify ICV using a freshly-prepared second standard. If the ICV still does not meet criteria, analyze an ICV prepared from a third source. If this ICV meets criteria, proceed with sample analysis. If that fails, correct problem and repeat ICAL.	Analyst, Supervisor	Empirical SOP 338
GC/FID TRPH	Solvent Blank	Beginning of each 24 hour shift.	< ½ LOQ for the initial solvent blank	Solvent blanks should also be analyzed after samples with high concentrations to ensure that there is no carryover.	Analyst, Supervisor	Empirical SOP 338

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	SOP Reference
GC/FID TRPH	CCV	CCV after every 10 samples and at the end of the analytical sequence	%D or Drift < 25% for all analytes	If %D>25% and sample results are <LOQ, narrate. If %D >25% and is likely the result of matrix interference, narrate. All samples must be reanalyzed that fall within the standard that exceeded criteria and the last standard that was acceptable.	Analyst, Supervisor	Empirical SOP 338

Notes:

SOP = Standard operating procedure
GC/MS = Gas chromatograph/mass spectrometer
VOCs = Volatile organic compounds
PAH = Polynuclear aromatic hydrocarbons
TRPH = Total recoverable petroleum hydrocarbons
ICAL = Initial calibration
RF = Response factor
SPCC = System Performance Check Compound
%RSD = Percent relative standard deviation
r^2 = Least squares regression coefficient
ICV = Initial calibration verification
CCV = Continuing calibration verification
CV = Calibration verification
RRT = Relative retention times
DDT = 4,4'-Dichlorodiphenyltrichloroethane
LOQ = Limit of quantitation
%D = Percent difference

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

(UFP-QAPP Manual Section 3.2.3)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS	Clean source, replace vacuum pump oil, replace filament, replace inlet liner, replace septa, and bake out instrument.	VOCs and PAHs	Inspect vacuum pressure	Clean source and replace vacuum pump oil annually or as needed. Routine maintenance as necessary. Tune instrument after major maintenance. Inspect vacuum pressure daily.	Bromofluorobenzene and DFTPP tunes must meet the criteria listed in the method. Per instrument manufacturer's instructions	Inspect system and correct problem; Re-tune instrument if necessary. Perform new ICAL	Analyst, Department Manager	Empirical SOP 201 and SOP 202
GC/FID	Replace septa, replace inlet liner, clip column, clean or replace FID jet, bake out detector, recondition column.	TRPH	Check connections, replace disposables, bake out instrument, recondition column and perform leak checks	Replace liner, septa, and clip column as indicated by instrument change in response and chromatography. Clean or replace FID jet. Bake out detector and columns if signal elevated	Per instrument manufacturer's instructions.	Inspect system; correct problem; perform new initial calibration and affected samples	Analyst, Department Manager	Empirical SOP 338

Notes:

SOP = Standard operating procedure
GC/MS = Gas chromatograph/mass spectrometer
FID = Flame ionization detector
VOCs = Volatile organic compounds
PAH = Polynuclear aromatic hydrocarbons
TRPH = Total recoverable petroleum hydrocarbons
DFTPP = Decafluorotriphenylphosphine
ICAL = Initial calibration

SAP WORKSHEET #26: SAMPLE HANDLING SYSTEM

(UFP-QAPP Manual Appendix A)

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT	
Sample Collection (Personnel/Organization):	FTL/Resolution Consultants
Sample Packaging (Personnel/Organization):	FTL/Resolution Consultants
Coordination of Shipment (Personnel/Organization):	FTL/Resolution Consultants
Type of Shipment/Carrier:	Overnight via FedEx
SAMPLE RECEIPT AND ANALYSIS	
Sample Receipt (Personnel/Organization):	Sample Receiving Supervisor: Empirical Laboratories
Sample Custody and Storage (Personnel/Organization):	Sample Receiving Supervisor: Empirical Laboratories
Sample Preparation (Personnel/Organization):	Sample Preparation/Extractions Group Leader: Empirical Laboratories
Sample Determinative Analysis (Personnel/Organization):	Laboratory Manager/Director: Empirical Laboratories
SAMPLE ARCHIVING	
Field Sample Storage (No. of days from sample collection):	180 Days from Receipt of Samples
Sample Extract/Digestate Storage (No. of days from extraction/digestion):	180 Days from Receipt of Samples
SAMPLE DISPOSAL	
Personnel/Organization:	Waste Manager: Empirical Laboratories
Number of Days from Analysis:	180 Days from Receipt of Samples

Note:
FTL = Field Team Lead

SAP WORKSHEET #27: SAMPLE CUSTODY REQUIREMENTS

(UFP-QAPP Manual Section 3.3.3)

27.1 SAMPLE NOMENCLATURE, SAMPLE COLLECTION DOCUMENTATION, HANDLING, AND TRACKING PROCEDURES

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.

27.1.1 Sample Nomenclature

Sample labeling will be conducted in general accordance with the procedures outlined in Resolution Consultants SOP-3-03A (Appendix B). The sample nomenclature includes the site being investigated, sample media identifier, and sample location number.

Sample nomenclature has been developed based on historical usage. The sample nomenclature includes the historical monitoring well identifier and the date the well was sampled (i.e., CEF-81-MW01-DDMMYYYY). Duplicate samples will be submitted to the laboratory as blind duplicates. The field QC blank codes that will be used during LTM are limited to trip blanks (TB). Field QC blanks will be labeled sequentially followed by the month, day, and year sampled (i.e., TBMMDDYY). Samples to be used for matrix spike/matrix spike duplicate (MS/MSD) will be labeled MS/MSD on the container label and noted on the chain-of-custody; however, "MS/MSD" will not be part of the unique sample identifier in order to maintain consistency with the project database. Worksheet #18 provides anticipated sample identifiers for this scope of work.

27.1.2 Sample Collection Documentation

Field observations will be recorded in a field logbook and/or field log sheets including daily field forms, sample collection logs, boring logs, and monitoring well construction logs. These documents will be used to record information about each sample including the sample identification number, sample time and date, location, sample matrix, and analytical matrix. Field sample log sheets will be used to document sample collection details; 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/field forms 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 on site
- Visitor names, affiliations, arrival, and departure times
- Health and safety issues, including personal protective equipment

27.1.3 Sample Handling and Tracking System

Following collection, all samples will be immediately placed on ice in a cooler. The glass sample containers will be enclosed in bubble-wrap in order to protect bottles during shipment. Samples will be packed with wet icein each cooler. A temperature blank (a small polypropylene bottle or 40 mL vial filled with de-ionized water), typically provided by the laboratory, will be placed in each cooler and will be used to determine the core temperature of the received samples by the laboratory technician. The cooler will be secured using strapping tape along with a signed custody seal. One copy of the chain-of-custody will be placed in each cooler.

Sample coolers will be either delivered to a local courier location for priority overnight delivery or hand delivered 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. 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 (provided in Appendix B) provides further details on the chain-of-custody procedure.

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.

27.2 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 (see 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. Each chain-of-custody is 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. Chain-of-custody forms will be completed daily to manage samples and to track samples for shipment. Chain-of-custody forms include the following information:

- Sample identification number
- Sample matrix
- Sample time
- Sample date
- Analytical methods
- Project number

- Site name
- Types of sample preservative
- Custody signatures and the date and time of receipt/relinquishment

The Resolution Consultants FTL 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.

27.3 Laboratory Chain of Custody

Laboratory sample custody procedures (receipt of samples, archiving, and disposal) will be used according to Empirical Laboratories 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 TOM and FTL verbally or via email of any problems immediately that an issue is identified.

SAP WORKSHEET #28: LABORATORY QC SAMPLES TABLE

(UFP-QAPP Manual Section 3.4)

Matrix:	Groundwater
Analytical Group:	Volatile Organic Compounds
Analytical Method:	SW-846 8260B
SOP Reference:	Empirical SOP 202

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicators	Measurement Performance Criteria
Method Blank	One per preparatory batch	No analytes detected > ½ LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. No common laboratory contaminants analytes detected > LOQ. (See Box D-1 in QSM V4.2).	Correct problem; reanalyze any sample associated with a blank that fails criteria.	Analyst, Supervisor, QA Manager	Bias, Contamination	No analytes detected > ½ LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. No common laboratory contaminants analytes detected. > LOQ. (See Box D-1 in QSM V4.2).
Surrogates	All field and QC samples	QC acceptance criteria specified in DoD QSM Version 4.2	Reanalyze if sufficient sample is available. If reanalysis confirms failing recoveries, report and narrate.	Analyst, Supervisor, QA Manager	Accuracy, Bias	QC acceptance criteria specified in DoD QSM Version 4.2
LCS	One LCS per preparatory batch	QC acceptance criteria specified in DoD QSM Version 4.2	Correct problem. If the LCS recoveries are high but the sample results are <LOQ narrate. Otherwise, re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst, Supervisor, QA Manager	Accuracy, Bias	QC acceptance criteria specified in DoD QSM Version 4.2
Internal Standards	In all field samples and standards	Retention time ± 30 seconds from retention time of the midpoint standard in the ICAL; EICP area within -50% to +100% of ICAL midpoint standard or daily CCV.	Inspect MS or GC for malfunctions. Reanalyze all samples with internal standard failures. If reanalysis confirms matrix interference, report sample and narrate.	Analyst, Supervisor, QA Manager	Accuracy, Bias	Retention time ± 30 seconds; EICP area within -50% to +100% of midpoint of ICAL
MS/MSD	One per preparatory batch per matrix	For matrix evaluation, use LCS recovery criteria; RPD ≤30%.	Contact the client to determine if additional measures are required.	Analyst, Supervisor, QA Manager	Accuracy, Bias, Precision	For matrix evaluation, use LCS recovery criteria; RPD ≤30%.

Notes:

SOP = Standard operating procedure
QC = Quality control
LOQ = Limit of quantitation
QA = Quality assurance
DoD QSM = Department of Defense Quality Systems Manual
LCS = Laboratory control sample
ICAL = Initial calibration
EICP = Extracted ion current profile
MS = Mass Spectrometer
GC = Gas chromatograph
MS/MSD = Matrix spike/matrix spike duplicate
RPD = Relative percent difference

SAP WORKSHEET #28: LABORATORY QC TABLES (CONTINUED)

Matrix:	Groundwater
Analytical Group:	Low Level Polynuclear Aromatic Hydrocarbons
Analytical Method:	SW-846 8270D
SOP Reference:	Empirical SOP 201

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicators	Measurement Performance Criteria
Method Blank	One per preparatory batch	No analytes detected > ½ LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. No common laboratory contaminants analytes detected > LOQ. (See Box D-1 in QSM V4.2).	Correct problem; re-prepare and/or reanalyze any sample associated with a blank that fails criteria.	Analyst, Supervisor, QA Manager	Bias, Contamination	No analytes detected > ½ LOQ and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. No common laboratory contaminants analytes detected > LOQ. (See Box D-1 in QSM V4.2).
Surrogates	All field and QC samples	%Rs must be within: 2-Fluorobiphenyl — 50-110% Terphenyl-d14 — 50-135%	Re-prepare and/or reanalyze if sufficient sample is available. If reanalysis confirms failing recoveries, report and narrate.	Analyst, Supervisor, QA Manager	Accuracy, Bias	%Rs must be within: 2-Fluorobiphenyl — 50-110% Terphenyl-d14 — 50-135%
LCS	One LCS per preparatory batch	QC acceptance criteria specified in DoD QSM Version 4.2	Correct problem. If the LCS recoveries are high but the sample results are <LOQ narrate. Otherwise, re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst, Supervisor, QA Manager	Accuracy, Bias	QC acceptance criteria specified in DoD QSM Version 4.2
Internal Standards	In all field samples and standards	Retention time ± 30 seconds from retention time of the midpoint standard in the ICAL; EICP area within -50% to +100% of ICAL midpoint standard or daily CCV.	Inspect MS or GC for malfunctions. Reanalyze all samples with internal standard. If reanalysis confirms matrix interference, report sample and narrate.	Analyst, Supervisor, QA Manager	Accuracy, Bias	Retention time ± 30 seconds; EICP area within -50% to +100% of midpoint of ICAL
MS/MSD	One per preparatory batch per matrix	For matrix evaluation, use LCS recovery criteria; RPD ≤30%.	Contact the client to determine if additional measures are required.	Analyst, Supervisor, QA Manager	Accuracy, Bias, Precision	For matrix evaluation, use LCS recovery criteria; RPD ≤30%.

Notes:

SOP = Standard operating procedure
QC = Quality control
LOQ = Limit of quantitation
QA = Quality assurance
DoD QSM = Department of Defense Quality Systems Manual
LCS = Laboratory control sample
ICAL = Initial calibration
EICP = Extracted ion current profile
MS = Mass Spectrometer
GC = Gas chromatograph
MS/MSD = Matrix spike/matrix spike duplicate
RPD = Relative percent difference

SAP WORKSHEET #28: LABORATORY QC TABLES (CONTINUED)

Matrix:	Groundwater
Analytical Group:	Total recoverable Petroleum Hydrocarbons
Analytical Method:	Florida Residual Petroleum Organic Method (FL-PRO)
SOP Reference:	Empirical SOP 338

QC Sample	Frequency & Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicators	Measurement Performance Criteria
Method Blank	One per preparatory batch	No analytes detected > ½ LOQ	Correct problem; re-prepare and/or reanalyze any sample associated with a blank that fails criteria.	Analyst, Supervisor, QA Manager	Bias, Contamination	No analytes detected > ½ LOQ
Surrogates	All field and QC samples	%Rs must be within: 2-Fluorobiphenyl — 82-142% (QC) 2-Fluorobiphenyl – 30%-140% (samples) o-Terphenyl — 50-150%	Re-prepare and/or reanalyze if sufficient sample is available for confirmation of matrix interference when appropriate. If reanalysis confirms failing recoveries, report and narrate.	Analyst, Supervisor, QA Manager	Accuracy, Bias	%Rs must be within: 2-Fluorobiphenyl — 82-142% (QC) 2-Fluorobiphenyl – 30%-140% (samples) o-Terphenyl — 50-150%
LCS	One LCS per preparatory batch	%R must be within 55-118%	Correct problem. If the LCS recoveries are high but the sample results are <LOQ narrate. Otherwise, re-prepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst, Supervisor, QA Manager	Accuracy, Bias	%R must be within 55-118%
MS/MSD	One per preparatory batch per matrix	%R should be within 40-100% RPD should be ≤ 20%	Contact the client to determine if additional measures are required.	Analyst, Supervisor, QA Manager	Accuracy, Bias, Precision	%R should be within 40-100% RPD should be ≤ 20%

Notes:

SOP = Standard operating procedure
QC = Quality control
LOQ = Limit of quantitation
QA = Quality assurance
%R = Percent recovery
LCS = Laboratory control sample
MS/MSD = Matrix spike/matrix spike duplicate
RPD = Relative percent difference
FL-PRO = Florida Residual Petroleum Organic Method

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 Well permits Field sampling standard operating procedures Safe work permit forms	Resolution Consultants project file (may include hard copy as well as electronic information).
Analytical Results Documents and Records Sample receipt/log-in forms Sample preparation logs Equipment calibration logs Sample analysis run logs Reported field sample results and raw data Reported results for standards, quality control checks Reported results for standards, quality control samples Data completeness checklists Data validation memoranda	Resolution Consultants project file (may include hard-copy as well as electronic information), long-term data package storage at third-party secure professional document storage firm. Electronic analytical results will be maintained in a database on a password protected Structured Query Language server.
Other Documents Health and Safety Plan All versions of Sampling and Analysis Plan All versions of reports (e.g., status reports, monitoring reports, etc.)	All versions of the subject document and all support documents will be stored in hard-copy in the Resolution Consultants project file and electronically in the server library.
Final Document/Records Repository Administrative Record files (e.g., progress reports, validation reports, remedial investigation report) Site files Post decision files Analytical data Spatial data Maps	All final documents and records will be stored in accordance with in the NAVFAC Environmental Restoration Recordkeeping Manual. Resolution Consultants will update and manage the project related documents, data and maps in the Navy's Naval Installation Restoration Information Solution data management system.

SAP WORKSHEET #30: ANALYTICAL SERVICES TABLE

(UFP-QAPP Manual Section 3.5.2.3)

Matrix	Analytical Group	Sample Locations/ID Numbers	Analytical SOP	Final Data Package Turnaround Time	Laboratory/Organization[1] (name and address, contact person and telephone number)	Backup Laboratory/ Organization
Groundwater	VOCs	See Worksheet #18	SOP 202	21 Days	Empirical Laboratories, LLC, 621 Mainstream Drive, Suite 270, Nashville, Tennessee 37228 Sonya Gordon, sgordon@empirlabs.com, 615-345-1115	None
Groundwater	PAHs	See Worksheet #18	SOP 201	21 Days	Empirical Laboratories, LLC, 621 Mainstream Drive, Suite 270, Nashville, Tennessee 37228 Sonya Gordon, sgordon@empirlabs.com, 615-345-1115	None
Groundwater	Total Recoverable Petroleum Hydrocarbons	See Worksheet #18	SOP 338	21 Days	Empirical Laboratories, LLC, 621 Mainstream Drive, Suite 270, Nashville, Tennessee 37228 Sonya Gordon, sgordon@empirlabs.com, 615-345-1115	None

Notes:
[1]Laboratory meets accreditation requirements to support project needs.
SOP = Standard operating procedure
VOCs = Volatile organic compounds
ID = Identification
PAH = Polynuclear aromatic hydrocarbons

SAP WORKSHEET #31: PLANNED PROJECT ASSESSMENTS TABLE

(UFP-QAPP Manual Section 4.1.1)

Worksheet Not Applicable — No assessments are planned.

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

(UFP-QAPP Manual Section 4.1.2)

Worksheet Not Applicable — No assessments are planned.

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 sample delivery group	Within 4 weeks after receiving the data from the laboratory	Project Chemist or Data Validator, Resolution Consultants	TOM, Resolution Consultants; project file
Project Monthly Progress Report	Monthly for duration of the project	Monthly	TOM, Resolution Consultants	TOM, Resolution Consultants; Program Manager, Resolution Consultants; BRAC BCT; project file
Laboratory QA Report	When significant plan deviations result from unanticipated circumstances	Immediately upon detection of problem	Laboratory PM, Empirical Laboratories	TOM and project file, Resolution Consultants

Notes:

TOM = Task Order Manager
PM = Project Manager
BRAC BCT = Base Realignment and Closure Base Cleanup Team
QA = Quality assurance

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
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, 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.	FTL 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.	FTL 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.	FTL 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, 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.	FTL, 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
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 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

Data Review Input	Description	Responsible for Verification (name, organization)	Step I/ IIa/IIb [1]	Internal/ External
Validation Laboratory data results for accuracy	Ensure that the laboratory QC samples were analyzed and that the measurement performance criteria, 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 Worksheet #12 and 28.	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 measurement performance criteria 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
Validation Groundwater — VOCs	Validate VOC using SW846 8260B method-specific criteria, data quality indicators provided in the DoD QSM and those listed in Worksheets # 12, 19, and 28. All data will be validated and raw instrument outputs assessed and recalculated for 10% of the reported results. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, (October 1999) will be used to apply qualifiers to data to the extent possible.	Project chemist or data validators, Resolution Consultants	IIa/IIb	External
Validation Groundwater — PAHs	Validate PAH data using SW846 8270D method-specific criteria, data quality indicators provided in the DoD QSM and those listed in Worksheets # 12, 19, and 28. All data will be validated and raw instrument outputs assessed and recalculated for 10% of the reported results. *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, (October 1999) will be used to apply qualifiers to data to the extent possible.	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</th></tr>
<tr><td>Validation
Groundwater — TRPH</td><td>Validate TRPH data using method-specific criteria provided in Florida Residual Petroleum Organic Method (FL-PRO) and those listed in Worksheets # 12, 19, and 28. All data will be validated and raw instrument outputs assessed and recalculated for 10% of the reported results. USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, (October 1999) will be used to apply qualifiers to data to the extent possible.</td><td>Project chemist or data validators, Resolution Consultants</td><td>IIa/IIb</td><td>External</td></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></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]
DoD QSM = *Department of Defense Quality Systems Manual for Environmental Laboratories*, Version 4.2, October 2010
SAP = Sampling and analysis plan
FTL = Field team 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
VOCs = Volatile organic compounds
PAHs = Polynuclear aromatic hydrocarbons
TRPH = Total recoverable petroleum hydrocarbons
USEPA = U.S. Environmental Protection Agency

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. 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 FTL, 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 TOM determines that the deviations compromise the ability to meet project objectives the BRAC BCT will be contacted, as necessary (determined by the BRAC BCT), 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 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) %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. 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, MS/MSD, 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 TOM 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 TOM, 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. Although rejected data will generally not be used, there may be reason to use them in a weight-of-evidence argument, especially when they supplement data that have not been rejected. If rejected data are used, their use will be supported by technically defensible rationales.

Identify the personnel responsible for performing the usability assessment:

The Resolution Consultants TOM, project chemist, and FTL 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.

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Appendix A

August 2009 BCT Meeting Minutes

UFP SAP QAPP Project Team Kick-Off Meeting
Meeting Minutes

August 13, 2009

Attendance:

Art Sanford – BRAC PMO RPM
Ron Kotun – Tetra Tech DQO UFP Facilitator
Doyle Brittian – US EPA
Dave Grabka - FDEP
Rob Simcik – Tetra Tech NUS Project Manager (note taker)
Kara Wimble – Tetra Tech NUS Petroleum Lead
Mark Jonnet – Tetra Tech NUS EGIS
Mike Halil – CH2MHill RAC PM BCT Team Member

Additional Tetra Tech project team members not in attendance:
Joe Samchuck – Project Chemist
Megan Ritchie – IR Site SAP Lead

DQO Process Overview.
Ron provided an overview of the process and goals of today's presentation/discussion. Worksheets 10 and 11 will be reviewed for the 10 sites currently scoped for UFP (Uniform Federal Policy) SAPs (Sampling Analysis Plans).

Worksheet 10: Problem Definition
- Site Description and History
- History of Environmental Investigations and Actions
- Conceptual Site Model
- Potential Sources of Contamination
- Potential Contamination Migration Mechanisms
- Land Use and Problem Definitions
- Problem Definition

Worksheet 11: Identification of Study Goals
- Decision Statement
- Information Inputs
- Study Boundaries
- Analytic Approach
- Decision Rule
- Performance Criteria
- Plan for Sampling

There are five IR sites and five Petroleum sites scoped to have UPF SAPs prepared. The information for the worksheets 10 and 11 has been pulled together. Each site will be discussed.

It was identified that all of these sites are in long term monitoring programs and that the process for decision-making are already in place and the objective of this effort is to take the process that is working for Cecil field in put it in the UFP format. Doyle identified that the national guidance identified for QAPP is and has been followed. These procedures will now be put into the UFP format.

QAPP Discussion:

Petroleum Sites:

<u>Tank 81 a,b,c</u>
Problem Definition

- Contaminant plumes of isopropyl benzene are located northwest of the original site in the intermediate (30-35' bls) and deep (45-55' bls) zones of the aquifer.
- Long-term monitoring is necessary to ensure that the plume location is stable for an extended period of time.
- Once the plume location is stable, consistent data over a certain period of time is necessary to consider an RMO II award.

COCs

- Isopropyl benzene (cumene)
    - USEPA Method 8260
    - GCTL = 0.8 µg/L
    - NADC = 8.0 µg/L
    - PQL = 2.0 ug/L

Decision Statement

- Determine whether the groundwater COC concentration exceeds its GCTL and if the plume location is stable.
- If the COC exceeds its action level or the plume location moves as determined by compliance wells, the exceedence will be verified, and if confirmed to exceed then further delineation of the plume boundaries will be required.
- If the COC does not exceed its GCTL for 2 consecutive events in all wells being monitored, an NFA will be recommended.
- Typically if the COC incerased to mor than its Natural Attenuation Default Concentrations (NADC) remediation would be evaluated however because the isopropylbenzene GCTL is based on organoleptic concerns, it was identified that FDEP would be agreeable to continue groundwater monitoring even if its NADC was exceeded in source wells.

Decision Rule

- If the isopropyl benzene concentration is greater than its GCTL in non-compliance/source wells, long-term monitoring will continue.
- If any sign that concentration of isopropyl benzene is greater than its GCTL in the compliance wells, then additional delineation will be required.

- If any isopropyl benzene concentration exceeds the GCTL, but no migration is detected outside of the compliance wells for four consecutive monitoring events, then a permanent groundwater restriction can be considered (RMO II).
- If all concentrations of isopropyl benzene are below action levels for 2 consecutive quarters in all wells, then an NFA will be recommended.

Discussion on Boundary

- Wells to be included in sampling plan will be: CEF-81-04I; CEF-81-22I; CEF-81-24I; CEF-81-25I; CEF-81-26I; CEF-81-27D; and CEF-81-28D
- Delineation of the plume will continue as needed within the boundaries of the former NAS Cecil Field property.

<u>Hangar 815 Wash Rack</u>

Problem Definition

- Naphthalene groundwater contamination remains in the area of the former wash rack to the north of Building 815.
- Long-term monitoring verified no contaminant migration is occurring.
- The source of contamination is no longer contributing to the plume.

COCs

- Naphthalene
    - USEPA Method 8270
    - GCTL = 14 µg/L
    - NADC = 140 µg/L
    -

Decision Statement

- Determine whether the groundwater COC concentration exceeds its GCTL and if the plume location is stable.
- If the COC exceeds its action levels or the plume location moves as determined by compliance wells, then further delineation of the plume boundaries will be required
- If the COC does not exceed its GCTL for 2 consecutive events, then an NFA will be recommended.
- If the COC increases to above the NADCs, then in accordance with 62-770 rule, the well will be resample to verify the exceedance. Then there are 3 options: supplemental assessment (attempt to locate a previously undetected source), continue monitoring (with different concentrations as triggers), or pursue active remediation by submitting a RAP.

Decision Rule

- If the naphthalene concentration is greater than its GCTL in non-compliance/source wells, long-term monitoring will continue.
- If any sign that concentration of naphthalene is greater than the GCTL in the compliance wells, then additional delineation will be required.

- If any naphthalene concentration exceeds the GCTL, but no migration is detected outside of the compliance wells for four consecutive monitoring events, then a permanent groundwater restriction will be considered (RMO II).
- If all concentrations of naphthalene are below action levels for 2 consecutive quarters in all wells, then an NFA will be recommended.

<u>North South Apron Plume (NSAP)</u>

Problem Definition

- Benzene groundwater contamination remains in the area of the North-South Apron Site. Concentrations exceed FDEP GCTLs.
- Long-term monitoring verified no contaminant migration is occurring.
- Source of contamination is unknown and the plume appears to be contained.
- Frequency of groundwater monitoring is semi-annual

COCs

- Benzene
    - USEPA Method 8260
    - GCTL = 1 µg/L
    - NADC = 100 µg/L

Decision Statement

- Determine whether the groundwater COC concentration exceeds its GCTL and if the plume location is stable.
- If the COC exceeds action levels or the plume location moves as determined by compliance wells, further delineation of the plume boundaries will be required
- If the COC does not exceed its GCTL for 2 consecutive events, an NFA will be recommended.
- If the COC increases to above the NADCs, then in accordance with 62-770 rule, the well will be resample to verify the exceedance. Then there are 3 options: supplemental assessment (attempt to locate a previously undetected source), continue monitoring (with different concentrations as triggers), or pursue active remediation by submitting a RAP.

Decision Rule

- If the benzene concentration is greater than the GCTLs in non-compliance/source wells, long-term monitoring will continue.
- If any sign that concentration of benzene is greater than the GCTL in the compliance well, then additional delineation will be required.
- If any benzene concentration exceeds the GCTL, but no migration is detected outside of the compliance wells for four consecutive quarters, then a permanent groundwater restriction will be considered (RMO III).
- If all concentrations of benzene are below action levels for 2 consecutive quarters in all wells, then an NFA will be recommended.

Tank G82

Problem Definition

- Contaminant concentrations in source area wells (CEF-G82-2S) exceed action levels.
- There is still soil contamination remaining at this site that exceeds leachability. This impacted soil was not accessible for removal due to proximity to Building 82 and is now capped with concrete handicap ramp.

Concentrations of the following contaminants exceeded their respective GCTLs at the site:

- Benzene
- naphthalene
- isopropyl benzene
- 1,2,4-trimethylbenzene
- 1-methylnaphthalene
- and 2-methylnaphthlene

COCs

COCs	**Method**	**GCTLs (µg/L)**	**NADCs (µg/L)**
Benzene	EPA 8260	1	100
Naphthalene	EPA 8270	14	140
Isopropyl benzene PQL = 2.0 µg/L	EPA 8260	0.8	8
1,2,4-Trimethylbenzene	EPA 8260	10	100
1-Methylnaphthalene	EPA 8270	28	280
2-Methylnaphthalene	EPA 8270	28	280

Decision Statement

- Determine whether groundwater COC concentrations exceed their respective GCTLS and if the plume location is stable.
- If COCs exceed action levels in the compliance wells, further delineation of the plume boundaries will be required
- If COCs do not exceed GCTLs for 2 consecutive events, an NFA will be recommended
- If the COC increases to above the NADCs, then in accordance with 62-770 rule, the well will be resample to verify the exceedance. Then there are 3 options: supplemental assessment (attempt to locate a previously undetected source), continue monitoring (with different concentrations as triggers), or pursue active remediation by submitting a RAP.

Decision Rule

- If any COC concentrations are greater than the GCTLs in the source wells, long-term monitoring will continue.
- If any sign that any COC concentrations are greater than their respective GCTLs in the compliance wells, then additional delineation will be required.
- If COC concentrations exceed the GCTLs, but no migration is detected outside of the compliance wells for four consecutive quarters, then a permanent groundwater restriction will be considered (RMO III).
- If all COC concentrations are below action levels for 2 consecutive quarters in all wells, then an NFA will be recommended.

<u>BP Wells</u>

Problem Definition

- The COCs exceeded their action levels (GCTLs and NADCs)
- Contaminant concentrations appear to be increasing and migrating downgradient.
- The current downgradient well (CEF-BP-6S) exceeded the GCTL from July 2008 to July 2009 and has not shown GCTL exceedances prior to July 2008.

COCs

COC	**Method**	**GCTL (µg/L)**	**NADC (µg/L)**
Ethylbenzene	EPA 8260	30	300
2-Methylnaphthalene	EPA 8270	28	280
Isopropyl benzene PQL = 2 µg/L	EPA 8260	0.8	8
Naphthalene	EPA 8270	14	140
1,2,4-Trimethylbenzene	EPA 8260	10	100
1,3,5-Trimethylbenzene	EPA 8260	10	100
Total Xylenes	EPA 8260	20	200

Decision Statement

- Determine whether groundwater COC concentrations exceed action levels (GCTLs and NADCs) and if the plume location is stable.
- If COCs exceed action levels or the plume location moves as determined by compliance wells, further delineation of the plume boundaries will be required.
- Currently at the point of verifying the exceedance at the compliance well.
- If COCs do not exceed GCTLs for 2 consecutive events, an NFA will be recommended

- If the COC increases to above the NADCs, then in accordance with 62-770 rule, the well will be resample to verify the exceedance. Then there are 3 options: supplemental assessment (attempt to locate a previously undetected source), continue monitoring (with different concentrations as triggers), or pursue active remediation by submitting a RAP.
- If COCs are between GCTLs and NADCs in the source wells, then a Monitoring Only Plan will be developed.

Decision Rule

- If any COC concentrations are greater than the GCTLs in the source wells, long-term monitoring will continue;
- If any sign that any COC concentrations are greater than its GCTL in the compliance well, then additional delineation will be required.
- If COC concentration exceed the GCTLs, but no migration is detected outside of the compliance wells for four consecutive quarters, then a permanent groundwater restriction will be considered (RMO III).
- If all COC concentrations are below action levels for 2 consecutive quarters in all wells, then an NFA will be recommended.
- If COCs are between GCTLs and NADCs in the source wells, then a Monitored Natural Attenuation Plan will be developed.

Installation Restoration (IR) Sites:

<u>Site 1&2 - Old Landfill and Recent Landfill</u>

Problem Definition

- Land use controls have been implemented to prevent the disturbance of the landfill area, the Site 2 tributary, Rowell Creek, and the site's adjacent wetlands.
- The selected remedial alternative allows contaminants to remain on site.
- A detailed evaluation of the site is conducted every 5 years. Annual monitoring is conducted to verify contaminants do not migrate off site in the interim.

Decision Statements

- Determine whether the landfills are adversely impacting the surface water and/or sediments of Rowell Creek. If the surface water and/or sediments of Rowell Creek are not adversely impacted then monitoring will continue as identified in the monitoring plan. If the surface water and/or sediments in Rowell Creek are adversely impacted then additional actions will be evaluated.

Surface Water Inputs (Annual Events)

- Collect SW samples from 3 locations; RR-08, RR-10, and RR-17.
- Analyze for aluminum, cadmium, chromium, copper, cyanide, iron, lead, manganese, vanadium, and zinc by SW-846 6010B.
- Compare SW results to:
  - -EPA Region 4 Surface Water Screening Levels
  - -Florida Surface Water Quality Standards
  - -EPA Tier II value

-IBDS values

Surface Water Inputs (5-Year Event)

- Collect SW samples from 11 locations; RR-01, RR-02, RR-03, RR-04, RR-07, RR-08, RR-09, RR-10, RR-11, RR-14, and RR-17.
- Analyze for 4,4-DDD, 4,4-DDE, 4,4-DDT, Dieldrin, Endrin, Chlordane, gamma-Chlordane, gamma-BHC (Lindane), and Toxaphene by SW-846 8081.
- Analyze for Aroclor-1254 and Aroclor-1260 by SW-846 8082.
- Analyze for Arsenic, Barium, Cadmium, Chromium, Copper, Iron, Lead, and Zinc by SW-846 6010B.
- Compare SW results to the same action levels as the annual event.

Sediment Inputs (Annual Event)

- Collect sediment samples from 3 locations; RR-08, RR-10, and RR-17.
- Analyze for acetone by SW-846 8260B.
- Analyze for PAHs by SW-846 8270C.
- Analyze for 4,4-DDD, 4,4-DDE, 4,4-DDT, Dieldrin, Endrin, Chlordane, gamma-Chlordane, gamma-BHC (Lindane), and Toxaphene by SW-846 8081.
- Analyze for Aroclor-1254 and Aroclor-1260 by SW-846 8082.
- Analyze for Arsenic, Barium, Cadmium, Chromium, Copper, Iron, Lead, and Zinc by SW-846 6010B.
- Compare sediment results to:

-EPA Region 4 Sediment Screening Levels --Sediment Quality in Florida Coastal Groundwater (every five years)

-ORNL Screening Levels

-IBDS Values

-EPA Sediment Quality Benchmarks

Sediment Inputs (5- Year Event)

- Collect sediment samples from 11 locations; RR-01, RR-02, RR-03, RR-04, RR-07, RR-08, RR-09, RR-10, RR-11, RR-14, and RR-17.
- Analyze for the same analytes as the annual monitoring.
- Compare sediment results to the same action levels as the annual event.

Decision Rules

- If the surface water and/or sediment concentration in the compliance points of Rowell Creek are less than or equal to the action level (as identified above), the monitoring will continue on an annual or five-year basis.
- If the surface water and/or sediment concentration in the compliance points of Rowell Creek is greater than or equal to the action level (as identified above), then resampling will be conducted to verify the exceedance. If the exceedences are verified then appropriate actions may be taken to mitigate adverse impact on Rowell Creek and downgradient receptors.

<u>Site 32 – Hazardous Material Warehouse Storage Area</u>

Problem Definition

- PAHs, 4-methylphenol, and metals contamination remains in the paved area soil. Contaminants of concern are limited to only those which exceed leachability

which includes 4-methylphenol and specific metals (antimony, arsenic, barium, cadmium, lead, nickel, selenium, and vanadium).
- Concentrations of contaminants in soil exceed leachability FDEP SCTLs.
- Exposure to contaminants is limited by the asphalt cap.
- Long-term monitoring will consist of the periodic collection and analysis of groundwater samples to verify that no soil contaminant migration to groundwater is occurring.

Decision Statement
- Determine if contaminated soil beneath the asphalt parking lot is impacting groundwater.
- If COCs in groundwater exceed action levels, then soil contaminant migration to groundwater may be occurring, so the BCT will determine the next course of action to delineate the impact or mitigate the contamination.
- If COCs are below action levels, no action is required, so groundwater monitoring will continue on a five-year basis as outlined in the ROD.

Inputs to the Decision
- Collect groundwater samples from onsite monitoring well CEF-1032-01 and down gradient monitoring well CEF-1033-02.
- In accordance with the FTMR the analyze was revised 4-Methylphenol by SW-846 Method 8270C and seleced metals (antimony, arsenic, barium, cadmium, lead, nickel, selenium, and vanadium by SW-846 Method 6010B).
- Compare results to FDEP GCTLs and IBDS.

Decision Rules
- If any COC concentration in groundwater exceeds the greater of the IBDS or FDEP GCTL, then soil contaminant migration to groundwater may be occurring, so the BCT will determine the next course of action to delineate the impact or mitigate the contamination.
- If all COC concentrations are below the greater of the IBDS or FDEP GCTL, no action will be taken and groundwater monitoring will continue on a five-year basis.

<u>Site 45 - Steam Generating Plant</u>

Problem Definition
- Long-term monitoring will consist of the periodic collection and analysis groundwater samples in downgradient wells to verify that no contaminant migration is occurring either from soil to groundwater or within the surficial aquifer. Long-term monitoring will be used to assess natural attenuation of groundwater contamination.
- Soil needs to be identified.

Decision Statements
- Determine whether vanadium concentrations in source area groundwater exceed action levels. If > AL, then resample in 5 years. If ≤ AL, then follow up with confirmatory sample one year later. If confirmatory sample is ≤ AL, then pursue

NFA. If confirmatory sample is > AL, then continue monitoring on the 5-year schedule.

- Determine whether vanadium concentrations in downgradient groundwater exceed action levels. If > AL, confirm exceedance. If confirmatory sample is > AL, delineate. If ≤ AL, continue with annual monitoring.

Groundwater Inputs

- Collect groundwater samples every 5 years from onsite monitoring wells CEF-007-01SA, CEF-F11-01SA, CEF-P45-02S, CEF-P45-03S, and CEF-P45-04S.
- Collect groundwater samples annually from five down gradient monitoring wells CEF-P45-06S, CEF-P45-12S, CEF-F11-02SB, CEF-P45-08S, and CEF-P45-13S.
- Analyze for vanadium by SW-846 Method 6010B.
- Compare groundwater vanadium results to FDEP GCTL of 49 µg/L.

Decision Rules [rework these to reflect decision statement]

- If any groundwater vanadium concentration from a source area well is > the FDEP GTCL action level of 49 micrograms per liter (µg/L), groundwater monitoring will continue on a five-year basis. If all source area groundwater vanadium concentrations are ≤ the AL then follow up with confirmatory sample one year later. If confirmatory sample is ≤ AL, then pursue NFA. If confirmatory sample is > AL, then continue monitoring on the 5-year schedule.

- If any groundwater vanadium concentration from a down gradient well is > the FDEP GTCL action level of 49 micrograms per liter (µg/L), confirm exceedance. If confirmatory sample is > AL, delineate. If all down gradient groundwater vanadium concentrations are ≤ the AL, continue with annual monitoring.

<u>Site 36/37 – Control Tower TCE Plume and Hangars 13 and 14 DCE Plume</u>

Problem Definition

- Investigations indicated the presence of groundwater contamination from past operating practices. This contamination could pose an unacceptable human health risk if the groundwater was used as a potable water source. Potential migration of contaminated groundwater to surface drainage ditches and, eventually to Sal Taylor Creek could also cause adverse effects on aquatic organisms.

- Based on data from the first 8 years of groundwater monitoring, the following is recommended:
    - Hot Spot 1 –Semi-annual monitoring program, including the monitoring to determine if concentrations remain less than system action levels.
    - Hot Spot 2 – Continuation of the offline status of the AS system to evaluate rebound. Continuation of monitoring with an emphasis on the deep downgradient wells due to increasing trends in benzene and TCE concentrations.
    - Hot Spot 3 - The modified AS system will be returned to operation and will include a deeper sparging component. When the new AS system is operational source area wells and new wells will be sampled quarterly.

Decision Statement

- Determine whether Hot Spot 1 groundwater COC concentrations exceed remedial action levels (RALs). If concentrations are greater than RALs, then install/operate an AS system. If they are less than or equal to the RAL, continue monitoring. The RALs for benzene and TCE needs to be included.
- Determine whether Hot Spots 2 and 3 groundwater COC concentrations exceed RALs. If concentrations are greater than RALs, then continue operating the AS system. If they are less than or equal to the RALs, turn off the system and continue PARM for one year. If PARM concentrations are greater than RALS, the turn AS back on. If PARM concentrations are less than or equal to RALs, monitor for natural attenuation.
- Determine whether COC concentrations in groundwater exceed GCTLs. If concentrations in gw monitoring wells in the LTM program at Site 36/37 are less than or equal to GCTLs for 2 consecutive monitoring events, then pursue NFA. If they are greater than GCTLs, continue monitoring.
- Determine whether the contaminant plumes are migrating. If concentrations in sentinel wells less than or equal to GCTLs, then continue monitoring. If concentrations in sentinel well are greater than GCTLs, further delineate the plume.

Inputs to the Decision

- Collect groundwater samples from shallow, intermediate, and deep zones (see map).
- Analyze for COCs (see list) by SW-846 Methods.
- Analyze for TRPH by FL-PRO.
- Analyze for NA parameters by various methods.
- Compare results to RALs for benzene (1,000 µg/L) and TCE (100 µg/L).
- Compare results to FDEP GCTLs for all other organics.
- Compare results to IBDS values for Fe and Mn.

Contaminants of Concern

VOCs by SW-846 8260B

- BTEX
- PCE
- 1,1,2- TCA
- TCE
- 1,2- DCA
- 1,1-DCA
- 1,1-DCE
- cis-1,2-DCE
- VC

SVOCs by SW-846 8270C

- Naphthalene
- 1-Methylnaphthalene
- 2-Methylnaphthalene
- 2-Methylphenol
- 3-Methylphenol

- 4-Methylphenol

Metals by SW-846 6010B
- Fe
- Mn

Additional Parameters
- TRPH
- NA Parameters including:
  alkalinity
  chloride
  dissolved iron
  methane/ethane/ethene
  nitrate
  nitrite
  orthophosphate
  sulfate
  dissolved sulfide
  TOC
- Field tests including:
  pH
  specific conductance
  temperature
  turbidity
  DO
  hydrogen sulfide
  sulfide
  carbon dioxide
  ferrous iron
  ORP
  alkalinity

Decision Rules

- If Hot Spot 1 groundwater COC concentrations > RALs, then install/operate an AS system. If they are ≤ RAL, continue monitoring.

- If Hot Spots 2 and 3 groundwater COC concentrations > RALs, then continue operating the AS system. If they are ≤ RALs, turn off the system and continue PARM for one year. If PARM concentrations are > RALS, the turn AS back on. If PARM concentrations are ≤ RALs, monitor for natural attenuation.

- If concentrations in groundwater monitoring wells in the LTM program at Site 36/37 are ≤ GCTLs for 2 consecutive monitoring events, then pursue NFA. If they are > GCTLs, continue monitoring.

- If concentrations in sentinel wells ≤ GCTLs, then continue monitoring. If concentrations in sentinel well are > GCTLs, further delineate the plume.

Site 59 – Building 324/Hangar 1845

Problem Definition

- Investigations indicated groundwater contains TCE at concentrations greater than the FDEP GCTL and EPA MCL from past operating practices. This contamination could pose an unacceptable human health risk if the groundwater was used as a potable water source. Potential migration of contaminated groundwater could occur.
- Monitoring will consist of regularly collecting and analyzing groundwater samples from within and downgradient of the TCE Plumes and TCE Hot Spots to assess the performance of in-situ biological treatment and natural attenuation and to evaluate potential TCE migration.
- Active remediation is being conducted at locations which exceed the NADC for TCE (300 ug/L) This value is established as the RAL.

Decision Statement

- Determine whether COC concentrations in groundwater exceed GCTLs. If concentrations in gw monitoring wells in the LTM program at Site 59 are less than or equal to GCTLs for 2 consecutive monitoring events, then pursue NFA. If they are greater than GCTLs, continue monitoring.
- Determine whether the contaminant plumes are migrating. If concentrations in sentinel wells less than or equal to GCTLs, then continue monitoring. If concentrations in sentinel well are greater than GCTLs, further delineate the plume.

Inputs to the Decision

- Collect groundwater samples from site monitoring wells.
- Analyze all samples for COCs by SW-846 8260B.
- Analyze select wells for NA parameters by various methods.
- Compare TCE results to FDEP GCTL of 3 µg/L and degradation products to FDEP GCTLs.

Contaminants of Concern

VOCs by SW-846 8260B

- TCE
- cis-1,2-DCE
- trans-1,2-DCE
- VC

NA Parameters including:

alkalinity
chloride
dissolved iron and sodium
methane/ethane/ethene
sulfate
dissolved sulfide
TOC

Metabolic Acids

Decision Rules

- If concentrations in groundwater monitoring wells in the LTM program at Site 59 are ≤ GCTLs for 2 consecutive monitoring events, then pursue NFA. If they are > GCTLs, continue monitoring.

- If concentrations in sentinel wells ≤ GCTLs, then continue monitoring. If concentrations in sentinel well are > GCTLs, further delineate the plume.

Appendix B
Resolution Consultants Field 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.

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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.

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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

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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)

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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.

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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;

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- 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.

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

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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.

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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.

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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.

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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).

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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

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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

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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.

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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

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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

Project Name: 1	COC No. 7	Page of 9	
Site Location: 2	PO No. 8	Project No. 10	
Contract Task Order No. 3		Lab Name 11	

Sampler/Site Phone# 4

Send Results To: 5

Data Shipping Address: 6

Sample Analysis Requested (Enter number of containers for each test)

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			Samples Iced?(check) 33 Yes___ No___
2			2			Method of Shipment: 34
3			3			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**=Field 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).

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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,

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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	

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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.

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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

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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.

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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.

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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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1997a. *Sending Wastes Off Site? OSC and RPM Responsibilities under the Off-Site Rule*. EPA/540-F-97-006, Office of Solid Waste and Emergency Response. September.

1997b. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846.* 3rd ed., Final Update IIIA. Office of Solid Waste. Updates available: www.epa.gov/epaoswer/hazwaste/test/new-meth.htm.

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

(No Date). *Compliance with the Off-Site Rule During Removal Actions.* Office of Regional Counsel (Region 3). Hendershot, Michael.

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)

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Equipment Decontamination

Procedure 3-06

1.0 Purpose and Scope

1.1 This standard operating procedure (SOP) describes methods of equipment decontamination, to be used for activities where samples for chemical analysis are collected or where equipment will need to be cleaned before leaving the site or before use in subsequent activities.

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

It is the responsibility of the **Site Safety Officer (SSO)** to set up the site zones (i.e., exclusion, transition, and clean) and decontamination areas. Generally the decontamination area is located within the transition zone, upwind of intrusive activities, and serves as the washing area for both personnel and equipment to minimize the spread of contamination into the clean zone. Typically, for equipment, a series of buckets are set up on a visqueen-lined bermed area. Separate spray bottles containing cleaning solvents as described in this procedure or the Contract Task Order (CTO) Work Plan (WP) and distilled water are used for final rinsing of equipment. Depending on the nature of the hazards and the site location, decontamination of heavy equipment, such as augers, pump drop pipe, and vehicles, may be accomplished using a variety of techniques.

All **Field Personnel** responsible for equipment decontamination must adhere to the site-specific health and safety plan (HSP) and must wear the personal protective equipment (PPE) specified in the site-specific HSP. Generally this includes, at a minimum, Tyvek® coveralls, steel-toed boots with boot covers or steel-toed rubber boots, safety glasses, American National Standards Institute-standard hard hats, and hearing protection (if heavy equipment is in operation). Air monitoring by the **SSO** may result in an upgrade to the use of respirators and cartridges in the decontamination area; therefore, this equipment must be available on site. If safe alternatives are not achievable, discontinue site activities immediately.

In addition to the aforementioned precautions, the following sections describe safe work practices that will be employed.

2.1 Chemical Hazards associated with Equipment Decontamination

- Avoid skin contact with and/or incidental ingestion of decontamination solutions and water.
- Utilize PPE as specified in the site-specific HSP to maximize splash protection.
- Refer to material safety data sheets, safety personnel, and/or consult sampling personnel regarding appropriate safety measures (i.e., handling, PPE including skin and respiratory).
- Take the necessary precautions when handling detergents and reagents.

2.2 Physical Hazards associated with Equipment Decontamination

- To avoid possible back strain, it is recommended to raise the decontamination area 1 to 2 feet above ground level.
- To avoid heat stress, over exertion, and exhaustion, it is recommended to rotate equipment decontamination among all site personnel.

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- Take necessary precautions when handling field sampling equipment.

3.0 Terms and Definitions

None.

4.0 Training and Qualifications

4.1 The **CTO Manager** is responsible for ensuring that decontamination activities comply with this procedure. The **CTO Manager** is responsible for ensuring that all personnel involved in equipment decontamination 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 field equipment is decontaminated according to this procedure.

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

5.0 Procedure

Decontamination of equipment used in soil/sediment sampling, groundwater monitoring, well drilling and well development, as well as equipment used to sample groundwater, surface water, sediment, waste, wipe, asbestos, and unsaturated zone, is necessary to prevent cross-contamination and to maintain the highest integrity possible in collected samples. Planning a decontamination program requires consideration of the following factors:

- Location where the decontamination procedures will be conducted
- Types of equipment requiring decontamination
- Frequency of equipment decontamination
- Cleaning technique and types of cleaning solutions appropriate to the contaminants of concern
- Method for containing the residual contaminants and wash water from the decontamination process
- Use of a quality control measure to determine the effectiveness of the decontamination procedure

The following subsections describe standards for decontamination, including the frequency of decontamination, cleaning solutions and techniques, containment of residual contaminants and cleaning solutions, and effectiveness.

5.1 Decontamination Area

Select an appropriate location for the decontamination area at a site based on the ability to control access to the area, the ability to control residual material removed from equipment, the need to store clean equipment, and the ability to restrict access to the area being investigated. Locate the decontamination area an adequate distance away and upwind from potential contaminant sources to avoid contamination of clean equipment.

5.2 Types of Equipment

Drilling equipment that must be decontaminated includes drill bits, auger sections, drill-string tools, drill rods, split barrel samplers, tremie pipes, clamps, hand tools, and steel cable. Decontamination of monitoring well development and groundwater sampling equipment includes submersible pumps, bailers, interface probes, water level meters, bladder pumps, airlift pumps, peristaltic pumps, and lysimeters. Other sampling equipment that requires decontamination includes, but is not limited to, hand trowels,

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hand augers, slide hammer samplers, shovels, stainless-steel spoons and bowls, soil sample liners and caps, wipe sampling templates, composite liquid waste samplers, and dippers. Equipment with a porous surface, such as rope, cloth hoses, and wooden blocks, cannot be thoroughly decontaminated and shall be properly disposed of after one use.

5.3 Frequency of Equipment Decontamination

Decontaminate down-hole drilling equipment and equipment used in monitoring well development and purging prior to initial use and between each borehole or well. Down-hole drilling equipment, however, may require more frequent cleaning to prevent cross-contamination between vertical zones within a single borehole. When drilling through a shallow contaminated zone and installing a surface casing to seal off the contaminated zone, decontaminate the drilling tools prior to drilling deeper. Initiate groundwater sampling by sampling groundwater from the monitoring well where the least contamination is suspected. Decontaminate groundwater, surface water, and soil sampling devices prior to initial use and between collection of each sample to prevent the possible introduction of contaminants into successive samples.

5.4 Cleaning Solutions and Techniques

Decontamination can be accomplished using a variety of techniques and fluids. The preferred method of decontaminating major equipment, such as drill bits, augers, drill string, and pump drop-pipe, is steam cleaning. To steam clean, use a portable, high-pressure steam cleaner equipped with a pressure hose and fittings. For this method, thoroughly steam wash equipment and rinse it with potable tap water to remove particulates and contaminants.

A rinse decontamination procedure is acceptable for equipment such as bailers, water level meters, new and re-used soil sample liners, and hand tools. The decontamination procedure shall consist of the following: (1) wash with a non-phosphate detergent (Alconox®, Liquinox®, or other suitable detergent) and potable water solution; (2) rinse with potable water; (3) spray with laboratory-grade isopropyl alcohol; (4) rinse with deionized or distilled water; and (5) spray with deionized or distilled water. If possible, disassemble equipment prior to cleaning. Add a second wash at the beginning of the process if equipment is very soiled.

Decontaminating submersible pumps requires additional effort because internal surfaces become contaminated during usage. Decontaminate these pumps by washing and rinsing the outside surfaces using the procedure described for small equipment or by steam cleaning. Decontaminate the internal surfaces by recirculating fluids through the pump while it is operating. This recirculation may be done using a relatively long (typically 4 feet) large-diameter pipe (4-inch or greater) equipped with a bottom cap. Fill the pipe with the decontamination fluids, place the pump within the capped pipe, and operate the pump while recirculating the fluids back into the pipe. The decontamination sequence shall include: (1) detergent and potable water; (2) potable water rinse; (3) potable water rinse; and (4) deionized water rinse. Change the decontamination fluids after each decontamination cycle.

Solvents other than isopropyl alcohol may be used, depending upon the contaminants involved. For example, if polychlorinated biphenyls or chlorinated pesticides are contaminants of concern, hexane may be used as the decontamination solvent; however, if samples are also to be analyzed for volatile organics, hexane shall not be used. In addition, some decontamination solvents have health effects that must be considered. Decontamination water shall consist of distilled or deionized water. Steam-distilled water shall not be used in the decontamination process as this type of water usually contains elevated concentrations of metals. Decontamination solvents to be used during field activities will be specified in the CTO WP.

Rinse equipment used for measuring field parameters, such as pH (indicates the hydrogen ion concentration – acidity or basicity), temperature, specific conductivity, and turbidity with deionized or distilled water after each measurement. Also wash new, unused soil sample liners and caps with a fresh

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detergent solution and rinse them with potable water followed by distilled or deionized water to remove any dirt or cutting oils that might be on them prior to use.

5.5 Containment of Residual Contaminants and Cleaning Solutions

A decontamination program for equipment exposed to potentially hazardous materials requires a provision for catchment and disposal of the contaminated material, cleaning solution, and wash water.

When contaminated material and cleaning fluids must be contained from heavy equipment, such as drill rigs and support vehicles, the area must be properly floored, preferably with a concrete pad that slopes toward a sump pit. If a concrete pad is impractical, planking can be used to construct solid flooring that is then covered by a nonporous surface and sloped toward a collection sump. If the decontamination area lacks a collection sump, use plastic sheeting and blocks or other objects to create a bermed area for collection of equipment decontamination water. Situate items, such as auger flights, which can be placed on metal stands or other similar equipment, on this equipment during decontamination to prevent contact with fluids generated by previous equipment decontamination. Store clean equipment in a separate location to prevent recontamination. Collect decontamination fluids contained within the bermed area and store them in secured containers as described below.

Use wash buckets or tubs to catch fluids from the decontamination of lighter-weight drilling equipment and hand-held sampling devices. Collect the decontamination fluids and store them on site in secured containers, such as U.S. Department of Transportation-approved drums, until their disposition is determined by laboratory analytical results. Label containers in accordance with Procedure 3-05, *IDW Management*.

6.0 Quality Control and Assurance

A decontamination program must incorporate quality control measures to determine the effectiveness of cleaning methods. Quality control measures typically include collection of equipment blank samples or wipe testing. Equipment blanks consist of analyte-free water that has been poured over or through the sample collection equipment after its final decontamination rinse. Wipe testing is performed by wiping a cloth over the surface of the equipment after cleaning. These quality control measures provide "after-the fact" information that may be useful in determining whether or not cleaning methods were effective in removing the contaminants of concern.

7.0 Records, Data Analysis, Calculations

Any project where sampling and analysis is performed shall be executed in accordance with an approved sampling and analysis plan. This procedure may be incorporated by reference or may be incorporated with modifications described in the plan.

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**.

8.0 Attachments or References

8.1 ASTM Standard D5088. 2008. *Standard Practice for Decontamination of Field Equipment Used at Waste Sites.* ASTM International, West Conshohocken, PA. 2008. DOI: 10.1520/D5088-02R08. www.astm.org.

8.2 NAVSEA T0300-AZ-PRO-010. *Navy Environmental Compliance Sampling and Field Testing Procedures Manual*. August 2009.

8.3 Procedure 3-05, *IDW Management*.

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

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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;

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- 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 7.3 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

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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.

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- 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.

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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

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Standard Operating Procedure SOP-3-24
Water Quality Parameter Testing for Groundwater Sampling

1.0 PURPOSE

This standard operating procedure (SOP) represents minimum standard of practice. State and federal requirements may vary, and this SOP does not replace state and federal requirements that must be consulted before work begins. Further, if a project-specific work plan has been created, the work plan should be considered the ruling document. This SOP may be modified to meet specific regulatory, client, or project specific criteria.

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 water quality parameter testing, then those procedures may be added as an appendix to the project-specific Sampling and Analysis Plan (SAP).

2.0 SCOPE

This procedure provides guidance for expected sampling methods and protocols by all personnel related to the measurement of water quality parameters.

Field measurements of water quality parameters are commonly performed to evaluate surface water and groundwater. These tests are often performed to evaluate basic water quality parameters, to evaluate natural attenuation parameters, and to assess the presence of pore water entering a well.

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 either the Contract Task Order (CTO) Manager or the Quality Assurance (QA) Manager, and documented.

3.0 DEFINITIONS

3.1 Barometric Pressure (BP)

The density of the atmosphere, which varies according to altitude and weather conditions.

3.2 Conductivity/Specific Conductance

A measure of the ability of water to pass electrical current, which increases with the amount of dissolved ionic substances (i.e., salts). Conductivity is inversely related to the resistance of a solution and is measured in units of mhos per centimeter (mhos/cm) (inverse ohms/cm, Siemens/cm). The conductivity of water increases with increasing temperature.

Specific Conductance is corrected for 25 degrees Celsius (°C); for this reason, it is best to record Specific Conductance. If Conductivity is recorded, the temperature of the sample MUST recorded.

3.3 Dissolved Oxygen (DO)

The amount of oxygen present in water and available for respiration. DO is typically measured in milligrams per liter (mg/L). Oxygen is less soluble in warm and salty waters, so the instrument compensates the apparent percent saturation for changes in temperature and conductivity. Most probes measure the current resulting from the electrochemical reduction of oxygen (at a gold cathode) diffusing through a selective membrane. Because oxygen is being removed from the sample to perform the measurement, sample flow is required to prevent false low readings due to depletion of oxygen in the solution in front of the probe. Optical DO probes do not remove oxygen from the sample and are less affected by salts. The common range of DO in groundwater is 0.0 to 3.0 mg/L. Measurements outside of this range suggest that the meter may not be operating correctly.

3.4 Nephelometric Turbidity Unit (NTU)

The measurement of light passing through a sample based on the scattering of light caused by suspended particles.

3.5 pH

A measure of acidity and alkalinity of a solution using a logarithmic scale on which a value of 7 represents neutrality, lower numbers indicate increasing acidity, and higher numbers are increasingly basic.

3.6 Oxidation-Reduction Potential (ORP)

Also known as redox or eH, ORP is a measurement of the potential for a reaction to occur, which generally indicates the oxygen status of a sample. The probe consists of a platinum electrode, the potential of which is measured with respect to a reference electrode that rapidly equilibrates with the potential of the sample solution. A positive value indicates that oxygen is present. A negative value indicates an anaerobic environment or reducing condition. For this reason, negative ORP readings should be associated with DO readings of less than 0.5 mg/l; with negative ORP readings the water may exhibit a sulfur odor or gray color. Positive ORP readings should be associated with DO readings greater than 0.5 mg/L and lack of sulfur odors. Because of the complex relationship between ORP and temperature, no compensation is attempted; it is thus best to report both the ORP and temperature of a water sample.

3.7 Total Dissolved Solids

A measure of the quantity of materials in water that are either dissolved or too small to be filtered.

3.8 Turbidity

Measure of the clarity of water in NTUs. Potable water typically has NTU values between 0.0 and 0.3 NTUs, depending on the state or regulatory program.

4.0 RESPONSIBILITIES

The CTO Manager, or designee, is responsible for ensuring that these standard groundwater sampling activities are followed and shall review all groundwater sampling forms at the conclusion of a sampling event. The CTO Manager is responsible for ensuring that all personnel involved in monitoring well sampling shall have the appropriate education, experience, and training to perform their assigned tasks. The QA Manager or Technical Director is responsible for ensuring overall compliance with this procedure. The Field Manager is responsible for ensuring that all project field staff follows these procedures.

Field sampling personnel are responsible for the implementation of this procedure. Personnel are required to be knowledgeable of the procedures in this SOP. Training and familiarization with this SOP shall be documented in the training file for each employee. The field sampler and/or Field Manager is responsible for directly supervising the calibration procedures to ensure that they are conducted according to this procedure, and for recording all pertinent data. If deviations from the procedure are required because of anomalous field conditions, they must first be approved by the CTO Manager, QA Manager, or Technical Director and then documented in the field logbook and associated report or equivalent document.

5.0 PROCEDURES

5.1 Purpose

The procedures will vary depending on parameters being measured, method of sampling, and the method of measurement used. The information here is a general guidance and the site-specific documents and manufacturer manuals supersede these procedures.

5.2 Cautions

Improper use of water quality testing equipment could result in equipment damage or compromised sampling results. Personnel should be trained to operate the test equipment being used for a field operation and should be trained in the proper techniques for collecting and

logging water quality parameters. Personnel should also be able to recognize problems with test equipment and have someone available for basic troubleshooting and repair.

5.3 Interferences

During field testing, water quality data that is documented from field testing equipment may be influenced by certain outside factors that are unrelated to the actual site water quality. Such parameters and equipment include the following:

pH Meters

- Coatings of oils, greases, and particles may impair the electrode's response. Pat the electrode bulb dry with lint-free paper or cloth and rinse with de-ionized water. For cleaning hard-to-remove films, use isopropyl alcohol very sparingly so that the electronic surface is not damaged.

- Poorly buffered solutions with low specific conductance (less than 200 microsiemens per centimeter) may cause fluctuations in the pH readings. Equilibrate electrode by immersing in several aliquots of sample before taking pH.

Dissolved Oxygen

- Dissolved gases (e.g., hydrogen sulfide, halogens, sulfur dioxide) are a factor with the performance of DO probes. The effect is less pronounced on optical DO meters. Meter type and potential interferences should be considered based on potential sulfate/sulfide or nitrate/nitrite reducing environments.

- Exposure of the sample to the atmosphere will cause elevated DO measurements.

Turbidity Meter

- If the weather is warm and humidity is high, condensation may collect on the cuvet. To avoid this, allow the sample to warm and dry the outside of the cuvet before making the measurement. One method used to accomplish this is to place the cuvet against one's body (armpits work well).

Temperature

- Sample temperature will change rapidly when there are significant differences between the sample and ambient air.

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5.4 Apparatus and Materials

Field personnel shall consult the site work plan and SAP to review the equipment requirements for the sampling procedures to be followed during the sampling effort. The specific apparatus and materials required will depend on the water quality parameters being monitored. Table 1 shows the common equipment used in water quality parameter testing.

Table 1
Water Quality Parameter Testing — Common Equipment

Water Quality Parameter Instrument	Calibration Standards Required	Other Equipment
pH Meter	Yes - 2 or 3 Point Standards depending on groundwater range. Calibration must cover the range to be measured. If samples are above or below typical buffer standards (4, 7 and 10), special order buffers that fall outside groundwater pH range.	Container or flow thru cell for holding sample
Specific Conductance	Yes	Container or flow thru cell for holding sample
ORP Meter	Yes	Container or flow thru cell for holding sample
Turbidity Meter	Yes	Container or flow thru cell for holding sample
DO	No	Container or flow thru cell for holding sample
Thermometer	No	Container or flow thru cell for holding sample
Flow Rate	No	Calibrated Container

Notes:
ORP = Oxidation-Reduction Potential
DO = Dissolved Oxygen

5.5 Instrument or Method Calibration

Most monitoring instruments require calibration before use, and this calibration must be conducted in the field under the ambient climatic conditions that will be present during field sampling. Calibration of monitoring instruments shall be performed in accordance with the manufacturer's specifications and recorded in the provided form in Attachment 1. Site-specific instrument calibration requirements should be specified in the SAP. The following minimum calibration requirements apply to the various types of meters used to gather water quality measurements.

Initial Calibration (IC): Before use, the instrument or meter electronics are adjusted (manually or automatically) to a theoretical value (e.g., DO saturation) or a known value of a

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calibration standard. An IC is performed in preparation for the first use of an instrument or if a calibration verification does not meet acceptance criteria.

Initial Calibration Verification (ICV): The instrument or meter calibration is checked or verified directly following IC by measuring a calibration standard of known value as if it were a sample and comparing the measured result to the calibration acceptance criteria for the instrument/parameter. If an ICV fails to meet acceptance criteria, immediately recalibrate the instrument using the applicable initial calibration procedure or remove it from service.

Continuing Calibration Verification (CCV): After use, the instrument or meter calibration is checked or verified by measuring a calibration standard of known value as if it were a sample and comparing the measured result to the calibration acceptance criteria for the instrument/parameter.

5.5.1 Calibration Checks

Calibration checks are conducted by measuring a known standard. They must be completed after calibration and should be performed at least one other time (i.e., after lunch) and anytime suspect measurements are encountered. Table 2 provides general acceptance ranges to be used during calibration checks. If a meter is found to be outside of the acceptance range, the meter **must** be recalibrated. If the meter remains out of range, the project manager and/or the supplier of the meter should be contacted to determine alternative measures.

Table 2
Calibration Check Acceptance Limits

Parameter	Acceptance Criteria
Dissolved Oxygen	±0.3 mg/L of the theoretical oxygen solubility
Oxidation-Reduction Potential	±10 mv from the theoretical standard value at that temperature
pH	±0.2 Standard pH Units
Specific Conductance	±5% of the standard
Turbidity	0.1 to 10 NTU: ±10% of the standard 11 to 40 NTU: ±8% of the standard 41 to 100 NTU: ±6.5% of the standard

Notes:
mg/L = milligrams per liter
mv = millivolts
NTU = nephelometric turbidity units

5.5.2 Possible and Suspected Ranges

The concentration for each parameter range should be known so that concentrations outside of the range can be noted. Table 3 presents the maximum range of the parameter in groundwater. The table also presents the suspected range. Measurements outside of the maximum/minimum range should be considered in error and the measurement method should be checked. Concentrations outside the normal range should be treated as suspect but may be the result of contaminant impact. For example, a pH of 2.0 would be out of the normally suspected range for groundwater but not at a site impacted with an acid.

Table 3
Minimum and Maximum Result Ranges

Parameter	Units	Possible Min	Possible Max	Normal Min	Normal Max	Notes
Dissolved Oxygen	mg/L	0.0	14.6 (0°C) 10.1 (15°C) 8.3 (2°C)	0.0	5	The colder the sample, the higher the DO reading. DO greater than 1 mg/L, ORP positive should not have sulfur odor, sulfide, ferrous iron and/or gray color. DO less than 1 mg/L, ORP negative, may have sulfur odor, sulfide, ferrous iron and/or gray color.
pH	SU	0	14	5	9	pH values exceeding 10 could indicate grout contamination
ORP	mv					DO greater than 1 mg/L, ORP positive should not have sulfur odor, sulfide, ferrous iron and/or gray color. DO less than 1 mg/L, ORP negative, may have sulfur odor, sulfide, ferrous iron and/or gray color.
Specific Conductance	µS/cm			varies	varies	
Temperature	°C	0	100	5	30	
Turbidity	NTU	0	Greater than 1,000	0	Greater than 1,000	50 NTU or greater suggests cloudiness.

Notes:

mg/L = milligrams per liter
°C = degrees Celsius
DO = dissolved oxygen
SU = standard units
ORP = oxidation reduction potential
mv = millivolts
mS/cm = micro Siemens per cm
NTU = nephelometric turbidity units

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5.5.3 Field Instruments and Calibration Criteria

The calibration acceptance criteria for each instrument are summarized in Table 4 along with special considerations related to each field instrument.

Table 4
Calibration Check Acceptance Limits

Parameter	Acceptance Criteria
Dissolved Oxygen	±0.3 mg/L of the theoretical oxygen solubility.
Oxidation-Reduction Potential	±10 mv from the theoretical standard value at that temperature.
pH	±0.2 Standard pH Units
Specific Conductance	±5% of the standard
Turbidity	0.1 to 10 NTU: ±10% of the standard 11 to 40 NTU: ±8% of the standard 41 to 100 NTU: ±6.5% of the standard

Notes:
mg/L = milligrams per liter
mv = millivolts
NTU = nephelometric turbidity units

pH Meters

- For the most accurate of pH measurements, pH meters should receive a three-point calibration. However, if a two-point calibration will bracket the groundwater pH of the site, a two-point calibration is acceptable. Three-point calibrations typically include calibrating to solutions of pH 7.00, 4.00, and 10.00. If groundwater pH is outside the calibration range of the solution standards, special buffers must be ordered to bracket the pH. Some meters will report the slope of the calibration and this may be used in checking the meter calibration (refer to the meter's manual). When performing an ICV, the result must be within +/- 0.2 pH units of the stated buffer value.

- pH meters should be calibrated across the range of values to be measured. The maximum and minimum calibration solutions shall be outside the range of anticipated values. For example, if the expected range is between 7.50 and 9.00, the 7.00 and the 10.00 standard should be used for calibration. Perform the IC using at least two buffers, and always use the pH 7.00 buffer first. A reading that is above the maximum (or below the minimum) calibration standard is an estimate only and is not valid. This condition requires obtaining a new standard that is above (or below) the reported value, depending on the measurement.

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- A percent slope of less than 90 percent indicates a bad electrode that must be changed or repaired. If percent slope cannot be determined, or the manufacturer's optimum specifications are different, follow the manufacturer's recommendation for maintaining optimum meter performance.

Specific Conductivity Meters

- For IC, when the sample measurements are expected to be 100 microsiemens per centimeter (µS/cm) or greater, use two standard potassium chloride (KCl) solutions that bracket the range of expected sample conductivities. Calibrate the instrument with the first standard. Verify the calibration of the instrument with the second standard, bracketing the range of expected sample values.

- If the instrument can be calibrated with more than one standard, choose additional calibration standards within the range of expected sample values.

- When the sample measurements are expected to be less than 100 µS/cm, a lower bracket is not required, but one standard (KCl) solution that is within the range of expected measurements must be used for the IC and the ICV.

- Accept the calibration if the meter reads within +/- 5 percent of the value of any calibration standard used to verify the calibration.

- Most field instruments read conductivity directly. Record all readings and calculations in the calibration records.

- For CCV, check the meter with at least one KCl standard with a specific conductance in the range of conductivity measured in environmental samples. The reading for the calibration verification must also be within +/- 5 percent of the standard value.

- If new environmental samples are encountered outside the range of the IC, verify the instrument calibration with two standards bracketing the range of sample values. If these calibration verifications fail, recalibrate the instrument.

Dissolved Oxygen Meters

- Before calibrating, check the probe membrane for bubbles, tears, or wrinkles. These conditions require replacement of the membrane in accordance with the manufacturer's directions.

- If the meter provides readings that are off-scale, will not calibrate, or drift, check the leads, contacts, etc., for corrosion and/or short circuits. These conditions require replacement maintenance in accordance with the manufacturer's directions.
- Most DO meters must be calibrated based on an environment of 100 percent humidity and a known elevation and barometric pressure (BP).

- For 100 percent humidity, place the probe in the calibration container with a moist towel and allow the probe to remain, undisturbed, for 10 to 20 minutes.

- The IC is an air calibration at 100% saturation. Before use, verify the meter calibration in water-saturated air to make sure it is properly calibrated and operating correctly. Make a similar verification at the end of the day or sampling event. Follow the manufacturer's instructions for your specific instrument. Allow an appropriate warm up period before IC. Wet the inside of the calibration chamber with water, pour out the excess water (leave a few drops), wipe any droplets off the membrane/sensor and insert the sensor into the chamber (this ensures 100 percent humidity). Allow adequate time for the DO sensor and the air inside the calibration chamber to equilibrate. Once the probe/calibration chamber is stable at ambient temperature, check the air temperature and determine, from the DO versus temperature table (see Attachment 2) what DO should measure. The acceptance criterion for DO ICV is +/- 0.3 mg/L.

- Use the same procedure as above for CCV.

ORP Meters

- Verify electrode response before use in the field.

- Equilibrate the standard solution to the temperature of the sample. The standard solution is based on a 25°C temperature; however, the calibration solution standard's value will require adjustment based on the temperature.

- Immerse the electrodes and gently stir the standard solution in a beaker (or flow cell). Turn the meter on, placing the function switch in the millivolt (mv) mode.

- Let the electrode equilibrate and record the reading to the nearest millivolt. The reading must be within ±10 mv from the theoretical redox standard value at that temperature. If not, determine the problem and correct it before proceeding. Switch to temperature display and read the value.

- Record the mv reading and temperature in the field notebook or in form. Rinse the electrode with distilled water and proceed with the sample measurement, unless using a flow cell. If a flow cell is used, rinse between sample locations.

Turbidity Meters

- Perform an initial calibration using at least two primary standards.

- If the instrument cannot be calibrated with two standards, calibrate the instrument with one standard and verify with a second standard.

- Perform an ICV by reading at least one primary standard as a sample. The acceptance criterion for the ICV depends on the range of turbidity of the standard value:

    1. Standard Value = 0.1 to 10 NTU: the response must be within 10 percent of the standard;

    2. Standard Value = 11 to 40 NTU: the response must be within 8 percent of the standard;

    3. Standard Value = 41 to 100 NTU: the response must be within 6.5 percent of the standard; and

    4. Standard Value greater than 100 NTU: the response must be within 5 percent of the standard.

- Determining the Values of Secondary Standards: Use only those certified by the manufacturer for a specific instrument. Secondary standards may be used for CCVs.

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To initially determine the value of a secondary standard, assign the value that is determined immediately after an ICV or verification with primary standards. This is done by reading the secondary standard as a sample. This result must be within the manufacturer's stated tolerance range and +/- 10 percent of the assigned standard value. If the +/- 10 percent criterion is not met, assign this reading as the value of the standard. If the reading is outside the manufacturer's stated tolerance range, discard the secondary standard.

- CCV: Perform a CCV using at least one primary or secondary standard. The calibration acceptance criteria are the same as those for an ICV.

5.6 Direct Measurements

Direct measurements with meters are the most common methods and can be accomplished by placing a sample in a container with the probe or by allowing the water to flow past the probe in a flow cell. The use of a flow-through cell improves measurement quality by allowing the constant flow of water over the probes and reduces interaction of the sample with the atmosphere. Sample cups should be avoided. The quantity of samples, timing, and methodology should be described in the project SAP.

Following calibration of required probes, connect the bottom flow-cell port to the discharge line of the pump. Connect the top port to a discharge line directed to a bucket to collect the purge water. Allow the flow cell to completely fill. As the water flows over the probe, record the measurements. Continue to record the measurements at regular intervals, as specified in the SAP.

When the ambient air temperatures are much higher or lower than the temperature of the water sample, it is best to keep the length of tubing between the wellhead and the flow cell as short as possible to prevent heating or cooling of the water. Tubing and flow-through cell should not be exposed to direct sunlight, particularly in the summer, if at all possible, to avoid heating of water samples.

5.7 Data Acquisitions, Calculations, and Data Reduction

5.7.1 Specific Conductivity Correction Factions

If the meter does not automatically correct for temperature (i.e., read Specific Conductivity) record Conductivity and adjust for temperature upon returning to the office. The following equation can be used to convert Conductivity to Specific Conductivity.

$$K = \frac{(Km)(C))}{1 + 0.0191(\mathrm{T} - 25)}$$

Where:

K	=	Conductivity in μmhos/cm at 25°C
Km	=	Measured conductivity in μmhos/cm at T degrees Celsius
C	=	Cell constant
T	=	Measured temperature of the sample in degrees Celsius;

If the cell constant is 1, the formula for determining conductivity becomes:

$$K = \frac{(Km)}{1 + 0.0191(\mathrm{T} - 25)}$$

5.7.2 Percentage Difference Calculation

For evaluating slope of readings from either a flow cell or a sample cup.

$$\%Difference = \frac{(Highest\ Value - Lowest\ Value)}{(Highest\ Value)}\ x\ 100$$

5.7.3 Convert mm mercury (mmHG) to inches mercury (inHG)

$$mmHG = inHG\ x\ 25.4$$

5.7.4 True Barometric Pressure

For converting BP obtained from a public domain source that is expressed in BP at sea level to BP at the subject site.

$$TrueBP = (BP) - \frac{(2.5\ x\ [Local\ Altitude])}{100}$$

Where: BP is in mmHG and Local Altitude is in feet

Example: BP at site A is 30.49 inHg and elevation is 544 feet, calculate TrueBP

Convert inHG to mmgHG:

mmHg = 30.49 inHg x 25.4 = 774.4 mmHg

Calculate True BP:

TrueBP = (774.4 mmHg) – [2.5 * (544 /100)] = 774.4-13.6 = 760.8 mmHg

6.0 RECORDS

Data will be recorded promptly, legibly, and in indelible ink on the appropriate logbooks and forms. At the completion of a field effort, all logbooks, field data forms, and calibration logs shall be scanned and made electronically available to the project team. The original field forms, calibrations logs, and log book will be maintained in the project file.

7.0 HEALTH AND SAFETY

Detailed Health and Safety requirements can be found in the site specific Health and Safety Plan. Ensure that a Safe Work Assessment and Permit form is filled out daily prior to any work in the field and reviewed with all project personnel in a daily safety brief.

Safety glasses with side shields or goggles and disposable gloves shall be worn during calibration activities.

8.0 REFERENCES

None

9.0 ATTACHMENTS

Attachment 1: Example Field Instrument Calibration Form
Attachment 2: Solubility of Oxygen at Given Temperatures
Attachment 3: Example Field Data Form

Attachment 1

Example Field Instrument Calibration Form

Field Instrument Calibration Form

Calibrated by: _____ Equipment (Make/Model/Serial#): _____

Date: _____ Equipment (Make/Model/Serial#): _____

pH (su) — Standard: ± 0.2 standard units

	Initial Calibration		Initial Calibration Verification	
	Hach SL	Reading	Pine SL	Reading
pH7				
pH4				

Continuing Calibration Verification

	Hach SL	Reading	Deviation	Acceptable Variance (Y/N)
pH7				
pH4				

DO (mg/L) — Standard: ± 0.3 mg/L of theoretical*

IC (Temp:)		ICV (Temp:)	
Saturation (%)	Reading (%)	Theoretical (mg/L)	Reading (mg/L)
100			

CCV (Temp:)

Saturation (%)	Reading (%)	Deviation	Acceptable Variance (Y/N)
100			

Theoretical (mg/L)	Reading (mg/L)	Deviation	Acceptable Variance (Y/N)

ORP (mV) — Standard: NA

IC (Zobell SL:)		ICV (Pine SL:)	
TCS (Std/Temp)	Reading	TCS (Std/Temp)	Reading

CCV (Zobell SL:)

TCS (Std/Temp)	Reading	Deviation	Acceptable Variance (Y/N)

Turbidity (ntu) — Standard: ±10% of Standard

Initial Calibration

Standard	Reading

Continuing Calibration Verification

Standard	Reading	Deviation	Acceptable Variance (Y/N)

Conductivity (ms^{c}/cm) — Standard: ± 5% of standard value

IC (YSI SL:)		ICV (Pine SL:)	
Standard	Reading	Standard	Reading

CCV (YSI SL:)

Standard	Reading	Deviation	Acceptable Variance (Y/N)

Comments:

Notes:

SL	solution lot	su	standard units	ntu	Nephelometric Turbidity Units
TCS	temperature corrected standard	mV	millivolts	°C	degrees Celsius
Std	standard	%	percent	ms°/cm	millisiemens per centimeter (temperature corrected)
Temp	temperature	mg/L	milligrams per liter	*	Theoretical value

Attachment 2

Solubility of Oxygen at Given Temperatures

Field Measurement of Dissolved Oxygen

Solubility of Oxygen in Water at Atmospheric Pressure			
Temperature	**Oxygen Solubility**	**Temperature**	**Oxygen Solubility**
°C	**mg/L**	**°C**	**mg/L**
0.0	14.621	26.0	8.113
1.0	14.216	27.0	7.968
2.0	13.829	28.0	7.827
3.0	13.460	29.0	7.691
4.0	13.107	30.0	7.559
5.0	12.770	31.0	7.430
6.0	12.447	32.0	7.305
7.0	12.139	33.0	7.183
8.0	11.843	34.0	7.065
9.0	11.559	35.0	6.950
10.0	11.288	36.0	6.837
11.0	11.027	37.0	6.727
12.0	10.777	38.0	6.620
13.0	10.537	39.0	6.515
14.0	10.306	40.0	6.412
15.0	10.084	41.0	6.312
16.0	9.870	42.0	6.213
17.0	9.665	43.0	6.116
18.0	9.467	44.0	6.021
19.0	9.276	45.0	5.927
20.0	9.092	46.0	5.835
21.0	8.915	47.0	5.744
22.0	8.743	48.0	5.654
23.0	8.578	49.0	5.565
24.0	8.418	50.0	5.477
25.0	8.263		

Notes:

The table provides three decimals to aid interpolation

Under equilibrium conditions, the partial pressure of oxygen in air-saturated water is equal to that of the oxygen in water saturated

°C = degrees Celsius

mg/L = milligrams per liter

Attachment 3
Example Field Data Form

WELL DEVELOPMENT & GROUNDWATER SAMPLING FORM

DATE:	JOB NUMBER:	EQUIPMENT (Make/Model #/Serial #):
PROJECT:	EVENT:	/ /
WELL ID:	LOCATION:	/ /
WEATHER CONDITIONS:	AMBIENT TEMP:	/ /
REVIEWED BY:	PERSONNEL:	/ /

WELL DIA:	**WELL DEVELOPMENT**	
TOTAL DEPTH from TOC (ft.):	START:	FINISH:
DEPTH TO WATER from TOC (ft.):	VOLUME PURGED (gal):	
LENGTH OF WATER COL. (ft.):	**GROUNDWATER SAMPLING**	
1 VOLUME OF WATER (gal):	START:	FINISH:
3 VOLUMES OF WATER (gal):	VOLUME PURGED (gal):	
	ANALYSIS:	

WELL DEVELOPMENT PARAMETERS		GW SAMPLING PARAMETERS	
Temperature:	± 1.0° C	Temperature:	± 0.2° C
pH:	± 0.5 standard units	pH:	± 0.2 standard units
Specific Conductance:	± 10% of the past measurement	Specific Conductance:	± 5% of the past measurement
Turbidity:	relatively stable	DO:	≤ 20% saturation
		ORP:	± 10 millivolts
		Turbidity:	≤ 10 NTU

IN-SITU TESTING

Circle one: DEVELOPMENT SAMPLING ☐ Bailer ☐ Pump Description:

Time (hh:mm):												
pH (units):												
Conductivity (mS/cm):												
Turbidity (NTU):												
DO (mg/L): YSI 556												
DO (mg/L): YSI 550												
Temperature (C°):												
ORP (mV):												
Volume Purged (gal):												
Depth to Water (ft):												
								Well Goes Dry While Purging ☐				

SAMPLE DATA

☐ Bailer ☐ Pump Description:

Sample ID	Date (m/d/y)	Time (hh:mm)	Bottles (total to lab)	Filtered (0.45 µm)	Remarks
Purging/Sampling Device Decon Process:					

COMMENTS:

Purge water placed in drum#_____

Page __ of __

FS 2100. Surface Water Sampling

See also the following Standard Operating Procedures:

- FA 1000 and 2000 Administrative Procedures
- FC 1000 Cleaning/Decontamination Procedures
- FD 1000-9000 Documentation Procedures
- FM 1000 Field Planning and Mobilization
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FS 2000 General Aqueous Sampling
- FS 2400 Wastewater Sampling
- FT 1000 General Field Testing and Measurement

1. INTRODUCTION AND SCOPE

1.1. This section presents standard operating procedures to be used to consistently collect representative surface water samples. Each collection event must be performed so that samples are neither contaminated nor altered from improper handling.

1.2. The following topics include acceptable equipment selection and equipment construction materials; and standard grab, depth-specific and depth-composited surface water sampling techniques. Information regarding sample types and flow- or time-weighted aqueous sampling is found in FS 2420.

2. GENERAL CAUTIONS

2.1. When using watercraft, take samples near the bow, away and upwind from any gasoline outboard engine. Orient watercraft so that bow is positioned in the upstream direction.

2.2. When wading, collect samples upstream from the body.

2.3. Avoid disturbing sediments in immediate area of sample collection.

2.4. Collect water samples prior to taking sediment samples when obtaining both from the same area (site).

2.5. Consider the representativeness of selected sampling locations, for example, when attempting to characterize a water body that may be stratified or heterogeneous.

2.6. Unless dictated by permit, program or order, sampling at or near structures (e.g., dams, weirs or bridges) may not provide representative data because of unnatural flow patterns.

2.7. Collect surface water samples from downstream towards upstream.

3. EQUIPMENT AND SUPPLIES

3.1. Use sampling equipment constructed of materials consistent with the analytes of interest. Refer to FS 1000, Tables 1000-1 and 1000-2 for material selection. Select equipment based on the analytes of interest, the specific equipment use and the available equipment. Refer to FS 1000, Table 1000-3 for selection of appropriate equipment.

3.2. For information on sample container size and construction, preservation and holding time requirements, see FS 1000, Tables 1000-4 through 1000-9.

3.3. For information on sampling equipment cleaning requirements, see FC 1000.

3.4. For information on documentation requirements, see FD 1000.

FS 2110. SURFACE WATER SAMPLING TECHNIQUES

Use the following protocols when collecting surface water samples. Adhere to all general protocols applicable to aqueous sampling detailed in FS 2000 when following the surface water sampling procedures addressed below.

1. MANUAL SAMPLING: Use manual sampling for collecting grab samples for immediate in-situ field analyses. Also use manual sampling in lieu of automatic equipment over extended periods of time for composite sampling, especially when it is necessary to observe and/or note unusual conditions.

1.1. Surface Grab Samples

Collect surface grab samples within the top 12 inches of the water column. Avoid skimming the surface of the water during collection unless specifically required by the sampling plan. Very shallow water bodies may require careful techniques of sample collection to avoid disturbing sediments

Where practical, use the actual sample container as the collection device (direct grab). Sample containers attached to poles are also considered direct grabs.

The use of unpreserved sample containers is encouraged since the same container can be submitted for laboratory analysis after appropriate preservation. This procedure reduces sample handling and potential loss of analytes or contamination of the sample from other sources (e.g., additional sampling equipment, environment, etc.).

1.1.1. Direct Grab Technique

1.1.1.1. Use an unpreserved sample container to collect the sample.

1.1.1.2. Slowly remove the container cap and slowly submerge the container, opening first, into the water.

1.1.1.3. Invert the bottle so the opening is upright and pointing towards the direction of water flow (if applicable). Allow water to run slowly into the container until filled.

1.1.1.4. Return the filled container quickly to the surface.

1.1.1.5. Pour out a small volume of sample away from and downstream of the sampling location. This procedure allows for addition of preservatives and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.

1.1.1.6. Add preservatives, if required, securely cap container, label and complete field notes.

1.1.1.7. If preservatives have been added, invert the container several times to ensure sufficient mixing of sample and preservatives.

1.1.1.8. Check preservation of the sample and adjust pH with additional preservative, if necessary.

1.1.2. Sampling with an Intermediate Vessel or Container: If the sample cannot be collected directly into the sample container to be submitted to the laboratory or if the laboratory provides prepreserved sample containers, use an unpreserved sample container or an intermediate vessel (e.g., beakers, buckets or dippers) to obtain the sample. These vessels must be constructed appropriately including any poles or extension arms used to access the sample location.

1.1.2.1. Rinse the intermediate vessel with ample amounts of site water prior to collecting the first sample. Discard rinsate away from or downstream of the sampling location.

1.1.2.2. After adequate rinsing, fill the intermediate vessel with sample water. Minimize agitation of the sample.

1.1.2.3. Fill sample containers from the intermediate vessel. Minimize agitation during filling. Do not touch the sample container with the intermediate vessel.

1.1.2.4. Leave adequate headspace in the sample container. This procedure allows for addition of preservatives (if required) and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.

1.1.2.5. Add preservatives if required, securely cap container, label and complete field notes.

1.1.2.6. Invert the container several times to ensure sufficient mixing of sample and preservatives.

1.1.2.7. Check preservation of the sample and adjust pH with additional preservative, if necessary.

1.1.3. Pump and Tubing: Use appropriate pumps, equipment and tubing. (See restrictions listed in FS 1000 Tables FS 1000-1 through 1000-3).

Do not collect oil & grease, TRPH or FL-PRO samples with a pump. See FS 2000 for proper collection procedures for extractable organics and volatile organic compounds.

1.1.3.1. Lower tubing to a depth 6-12 inches below water surface, where possible.

1.1.3.2. Pump several tubing volumes through the system to flush the tubing prior to collecting the first sample.

1.1.3.3. Fill individual sample bottles via the discharge tubing, being careful not to remove the inlet tubing from the water.

1.1.3.4. Do not touch the discharge tubing to the sample container.

1.1.3.5. Leave adequate headspace in the sample container. This procedure allows for addition of preservatives (if required) and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.

1.1.3.6. Add preservatives if required, securely cap container, label and complete field notes.

1.1.3.7. Invert the container several times to ensure sufficient mixing of sample and preservatives.

1.1.3.8. Check preservation of the sample and adjust pH with additional preservative, if necessary.

1.2. Depth Grab Samples: Examples of equipment that may be used for depth grab sampling include Kemmerer, Niskin, Van Dorn and similar samplers; pumps with tubing and double check-valve bailers. See restrictions listed in FS 1000 Tables 1000-1, 1000-2 and 1000-3. Do not collect oil & grease, TRPH or FL-PRO samples with a pump. See FS 2000 for proper collection procedures for extractable organics and volatile organic compounds.

1.2.1. Kemmerer, Niskin and Van Dorn Type Devices

1.2.1.1. Many of these samplers are constructed of plastic and rubber that preclude their use for all volatile and extractable organic sampling. Some newer devices are constructed of stainless steel or are all Teflon or Teflon-coated. These are acceptable for all analyte groups without restriction.

1.2.1.2. Measure the water column to determine maximum depth and sampling depth prior to lowering the sampling device.

1.2.1.3. Mark the line attached to the sampler with depth increments so that the sampling depth can be accurately recorded.

1.2.1.4. Lower the sampler slowly to the appropriate sampling depth, taking care not to disturb the sediments.

1.2.1.5. At the desired depth, send the messenger weight down to trip the closure mechanism.

1.2.1.6. Retrieve the sampler slowly.

1.2.1.7. Rinse the sampling device with ample amounts of site water prior to collecting the first sample. Discard rinsate away from and downstream of the sampling location.

1.2.1.8. Fill the individual sample bottles via the discharge tube. Sample bottles must be handled as described in sections 1.1.3.3 – 1.1.3.8 above.

1.2.2. Double Check-Valve Bailers: Collect samples using double check-valve bailers if the data requirements do not necessitate a sample from a strictly discrete interval of the water column. Bailers with an upper and lower check-valve can be lowered through the water column and water will continually be displaced through the bailer until the desired depth is reached, at which point the bailer is retrieved.

1.2.2.1. Sampling with this type of bailer must follow the same protocols outlined in section 1.2.1 above except that a messenger weight is not applicable.

1.2.2.2. Although not designed specifically for this kind of sampling, a bailer is acceptable when a mid-depth sample is required.

1.2.2.3. Note: This sampler does not perform as well as the devices described above or the pump and tubing described in section 1.2.3 below.

1.2.2.4. As the bailer is dropped through the water column, water is displaced through the body of the bailer. The degree of displacement depends upon the check-valve ball movement to allow water to flow freely through the bailer body.

1.2.2.5. Slowly lower the bailer to the appropriate depth. Upon retrieval, the two check-valves seat, preventing water from escaping or entering the bailer.

1.2.2.6. Rinse the sampling device with ample amounts of site water prior to collecting the first sample.

1.2.2.7. Fill the individual sample bottles via the discharge tube. Sample bottles must be handled as described in sections 1.1.3.3 – 1.1.3.8 above.

1.2.3. Pump and Tubing: Use appropriate pumps, equipment and tubing. (See restrictions listed in FS 1000 Tables 1000-1, 1000-2 and 1000-3). Do not collect oil & grease, TRPH or FL-PRO samples with a pump. See FS 2000 for proper collection procedures for extractable organics and volatile organic compounds.

1.2.3.1. Measure the water column to determine the maximum depth and the sampling depth.

1.2.3.2. Tubing will need to be tied to a stiff pole or be weighted down so the tubing placement will be secure. Do not use a lead or metallic weight if collecting metals samples. Any dense, non-contaminating, non-interfering material will work (brick, stainless steel weight, etc.). Tie the weight with a lanyard (braided or monofilament nylon, etc.) so that it is located below the inlet of the tubing.

1.2.3.3. Pump several tubing volumes through the system to flush the tubing prior to collecting the first sample.

1.2.3.4. Fill the individual sample bottles via the discharge tube, being careful not to remove the inlet tubing from the water. Do not touch the discharge tubing to the sample container.

1.2.3.5. Leave adequate headspace in the sample container. This procedure allows for addition of preservatives (if required) and sample expansion. Do not use this step for volatile organics or other analytes where headspace is not allowed in the sample container.

1.2.3.6. Add preservatives if required, securely cap container, label and complete field notes.

1.2.3.7. Invert the container several times to ensure sufficient mixing of sample and preservatives.

1.2.3.8. Check preservation of the sample and adjust pH with additional preservative, if necessary.

2. AUTOMATIC SAMPLERS: Use automatic samplers when several sites are to be sampled at frequent intervals or when a continuous sample is required. Composite samplers can be used to collect time composite or flow proportional samples. Use appropriate equipment and tubing. (See restrictions listed in FS 1000 Tables 1000-1, 1000-2 and 1000-3). Do not collect oil & grease, TRPH or FL-PRO samples with automatic samplers unless required by the sampling plan. See FS 2000 for proper collection procedures for extractable organics and volatile organic compounds

The use of automatic samplers for collecting surface water samples will more frequently run into situations where sampling equipment is deployed on-site for a long term or dedicated to the site.

2.1. Installing and Programming the Composite Sampler

2.1.1. Use all new or precleaned pump tubing each time the sampler is brought to the field and set up. If the automatic sampler is deployed in the field for extended periods, it is recommended to replace the tubing at a minimum of every six months. Other replacement schedules may be required, depending on the specific installation and

project requirements. Inspect the tubing each time the composite-sample container is picked up. If there is evidence of loss of elasticity or discoloration or other conditions that would impact the quality of the sample (such as algal growth), or the pumping flow rate, then replace the tubing. Select the tubing for the pump head and sampling train according to the analytes of interest and the allowable construction materials specified in FS 1000 Table FS 1000-1, 1000-2 and 1000-3.

2.1.1.1. Cut the proper length of precleaned Teflon or Tygon tubing.

2.1.1.2. Equipment Blanks: Collect equipment blanks each time the tubing is changed or at a frequency of 5% of the tubing changes, whichever is less. Collect a minimum of one blank each year. Collect the blank by passing analyte-free water through the equipment that is exposed to the sample.

- Composite sample containers may be cleaned either in the field or in a fixed base operation. Demonstrate cleaning effectiveness by collecting equipment blanks on the composite sample containers according to the frequency specified in FQ 1000. Collect sample container equipment blanks by adding analyte-free water to the cleaned sample container, mix the water thoroughly within the container and then pour off an aliquot for analysis.

2.1.1.3. Put the collection sieve and tubing in the appropriate sample location, using conduit if necessary to hold it in place. Ensure the supporting conduit does not contaminate the incoming sample water.

2.1.1.4. Program the sampler per manufacturer's directions and as required in the permit or work plan conditions.

2.1.1.5. Automatic Sampler Security: Place a lock or seal on the sampler to prevent or detect tampering. This procedure, however, does not prevent tampering with the sampler tubing. See additional discussions on sample security in FS 2410, section 2.3.2.

2.2. Sample Acquisition

2.3.1. At the end of each sampling period, stir the contents of the composite jug and siphon the contents (poured if no visible solids) into the respective containers. If the sampler was configured to collect discrete samples ensure that the contents of each container are adequately mixed while pouring the sample into the sample container.

2.3.2. Immediately preserve the sample, if required, securely cap container, label and complete field notes.

2.3. Long Term Deployment of Automatic Composite Samplers: In certain sampling situations, automatic composite samplers are permanently installed at surface water stations and remain in the field for months or even years. Under these conditions, there are specific sampling issues that need to be addressed.

2.3.1. Sample Preservation

2.3.1.1. If the only analyte of interest is Total Phosphorus and the project is unrelated to an NPDES permit, the sample must be chemically preserved with sulfuric acid (H_2SO_4) but it need not be cooled to 4°C with wet ice.

- The acid must be in the container prior to drawing the first composite sample into the container.

When using large (i.e., 3 gallon) composite sample containers, and there is potential for the sample size to vary greatly due to variable flow rates at the site, the volume of acid for preservation should be small (e.g., 1 to 2 mL of 50% H_2SO_4). **Do not over acidify the sample**. Upon sample pick-up, if needed, add additional acid to achieve the proper pH adjustment for preservation.

- If parameters other than total phosphorus are to be analyzed, appropriate additional preservation (e.g., cooling with ice or refrigeration) is required.

2.3.1.2. Deviations from these SOPs concerning preservation and holding times relating to remote and long term deployments due to site specific considerations must be agreed upon by project management.

2.3.2. Cleaning Requirements

2.3.2.1. Clean composite sampler containers after collection of each composite sample using cleaning solutions and procedures specified in FC 1140, sections 5 through 9.

2.3.2.2. Composite sample containers may be cleaned either in the field or in a fixed based operation. Demonstrate cleaning effectiveness by collecting equipment blanks on the composite sample containers according to the frequency specified in FQ 1000. Collect sampler container equipment blanks by adding analyte-free water to the cleaned sample container, mix the water thoroughly within the container and then pour off an aliquot for analysis.

2.3.2.3. Inspect and replace tubing at a minimum of every six months or when applicable, as discussed in section 2.1.1 above. Collect equipment blanks as specified in section 2.1.1.2 above. If the tubing is being replaced for multiple autosamplers at the same time, one equipment blank may be collected on the entire length of replacement tubing. Collect this equipment blank by passing analyte-free water through the entire length of new tubing.

FS 2120. REFERENCES

1. U.S. Environmental Protection Agency, Region 4, Environmental Investigations Standard Operating Procedures and Quality Assurance Manual, May 1996.

FS 2200. Groundwater Sampling

1. INTRODUCTION AND SCOPE

1.1 Use these Standard Operating Procedures to collect groundwater samples. They are designed to ensure that the collected samples will be representative of water in the aquifer or target formation and that the samples have not been altered or contaminated by the sampling and handling procedures. These procedures apply to permanently and temporarily installed monitoring wells, wells constructed using "direct-push" techniques, wells with installed plumbing, remedial groundwater treatment systems and excavations where groundwater is present. Use of alternative, DEP-approved and properly documented procedures (e.g., Corporate SOP, ASTM Standards, alternative equipment, etc.) is acceptable if they meet the intent (e.g., sample representativeness and integrity) of this standard (see FA 1000).

1.2 The topics in this SOP include equipment and supply selection, equipment construction materials, and purging and sampling techniques.

1.3 Use the following DEP SOPs in conjunction with FS 2200:

- FA 1000 Regulatory Scope and Administrative Procedures for Use of DEP SOPs
- FC 1000 Cleaning/Decontamination Procedures
- FD 1000 Documentation Procedures
- FQ 1000 Field Quality Control Requirements
- FS 1000 General Sampling Procedures
- FS 2000 General Aqueous Sampling
- FT 1000 Field Testing and Measurement
- FT 1100 Field pH
- FT 1200 Field Specific Conductance
- FT 1400 Field Temperature
- FT 1500 Field Dissolved Oxygen
- FT 1600 Field Turbidity

2. Groundwater samples may be collected from a number of different configurations. Each configuration is associated with a unique set of sampling equipment requirements and techniques:

3. Wells without Plumbing: These wells require that equipment be brought to the well to purge and sample unless dedicated equipment is placed in the well.

4. Wells with In-Place Plumbing: Wells with in-place plumbing do not require that equipment be brought to the well to purge and sample. In-place plumbing is generally considered permanent equipment routinely used for purposes other than purging and sampling, such as for water supply. They are generally found at wellfields, industrial facilities, and private residences. See FS 2300 for procedures to sample potable water wells. Air Strippers or Remedial Systems: These types of systems are installed as remediation devices. Sample these wells like drinking water wells (see FS 2300).

FS 2201 *Equipment and Supplies*

Use groundwater purging and sampling equipment constructed of only non-reactive, non-leachable materials that are compatible with the environment and the selected analytes. In selecting groundwater purging and sampling equipment, give consideration to the depth of the well, the depth to groundwater, the volume of water to be evacuated, the sampling and purging technique, and the analytes of interest. Refer to Tables FS 1000-1, FS 1000-2, FS 1000-3 and FS 2200-1 for selection of appropriate equipment.

Additional supplies such as reagents, preservatives, and field measurement equipment are often necessary.

1. FLOW CONTAINER: DEP recommends using a flow-through cell or container when collecting measurements for purging stabilization. The design must ensure that fresh formation water continuously contacts the measuring devices and does not aerate the sample or otherwise affect the groundwater properties.

2. PUMPS: All pumps or pump tubing must be lowered and retrieved from the well slowly and carefully to minimize disturbance to the formation water. This is especially critical at the air/water interface. Avoid the resuspension of sediment particles (turbidity) at the bottom of the well or adhered to the well casing during positioning of the pump or tubing.

2.1 Above-Ground Pumps

2.1.1 Variable Speed Peristaltic Pump: Use a variable speed peristaltic pump to purge groundwater from wells when the static water level in the well is no greater than 20-25 feet below land surface (BLS). If the water levels are deeper than 18-20 feet BLS, the pumping velocity will decrease.

2.1.1.1 A variable speed peristaltic pump can be used for normal purging and sampling (see FS 2213 and FS 2221), sampling low permeability aquifers or formations (see FS 2222) and collecting filtered groundwater samples (see FS 2225, section 1).

2.1.1.2 Most analyte groups can be sampled with a peristaltic pump if the tubing and pump configurations are appropriate. See Table FS 1000-3 for proper tubing selection and pump configurations.

2.1.2 Variable Speed Centrifugal Pump: A variable speed centrifugal pump can be used to purge groundwater from 2-inch and larger internal diameter wells. Do not use this type of pump to collect groundwater samples.

2.1.2.1 When purging is complete, do not allow the water that remains in the tubing to fall back into the well. Install a check valve at the end of the purge tubing, and withdraw the tubing slowly from the well while the pump is still running.

2.1.2.2 See Table FS 1000-3 for proper tubing selection and allowable analyte groups.

2.2 Submersible Pumps

2.2.1 Variable Speed Electric Submersible Pump: A variable speed submersible pump can be used to purge and sample groundwater from 2-inch and larger internal diameter wells.

2.2.1.1 A variable speed submersible pump can be used for normal purging and sampling (see FS 2213 and FS 2221), sampling low permeability aquifers or

formations (see FS 2222) and collecting filtered groundwater samples (see FS 2225, section 1).

2.2.1.2 Make sure that the pump housing, fittings, check valves and associated hardware are constructed of stainless steel. Make sure that any other materials are compatible with the analytes of interest. See Table FS 1000-3 for restrictions.

2.2.1.3 Install a check valve at the output side of the pump to prevent backflow.

2.2.1.4 If purging and sampling for organics:

- The entire length of the delivery tube must be Teflon, Polyethylene or Polypropylene (PP) tubing.
- The electrical cord must be sealed in Teflon, Polyethylene or PP and any cabling must be sealed in Teflon, Polyethylene or PP, or be constructed of stainless steel.
- All interior components that contact the sample water (impeller, seals, gaskets, etc.) must be constructed of stainless steel or Teflon.

2.2.2 Variable Speed Bladder Pump: A variable speed positive displacement bladder pump (no-gas contact) can be used to purge and sample groundwater from 3/4-inch and larger internal diameter wells.

2.2.2.1 A variable speed bladder pump can be used for normal purging and sampling (see FS 2213 and FS 2221), sampling low permeability aquifers or formations (see FS 2222) and collecting filtered groundwater samples (see FS 2225, section 1).

2.2.2.2 The bladder pump system is composed of the pump, the compressed air tubing, the water discharge tubing, the controller and a compressor or compressed gas supply.

2.2.2.3 The pump consists of a bladder and an exterior casing or pump body that surrounds the bladder and two (2) check valves. These parts can be composed of various materials, usually combinations of polyvinyl chloride (PVC), Teflon, Polyethylene, PP and stainless steel. Other materials must be compatible with the analytes of interest. See Table FS 1000-3 for restrictions.

2.2.2.4 If purging and sampling for organics:

- The pump body must be constructed of stainless steel and the valves and bladder must be Teflon, Polyethylene or PP
- The entire length of the delivery tube must be Teflon, Polyethylene or PP.
- Any cabling must be sealed in Teflon Polyethylene or PP, or be constructed of stainless steel.
- Permanently installed pumps may have a PVC pump body as long as the pump remains in contact with the water in the well.

3. BAILERS:

3.1 Purging: DEP does not recommend using bailers for purging unless no other equipment can be used or purging with a bailer has been specifically authorized by a DEP program, permit, contract or order (see Table FS 2200-3). Use a bailer if there is non-aqueous phase liquid (free product) in the well or non-aqueous phase liquid is suspected to

be in the well. If in doubt about the appropriateness of using a bailer at a site or during a particular sampling event, contact the appropriate DEP program or project manager. If a bailer is used, follow FS 2213, section 4, with no deviations.

3.2 Sampling: Bailers may be used to routinely collect some analyte groups or under specific circumstances for other analyte groups (see Table FS 2200-3).

3.3 Construction and Type:

3.3.1 Bailers must be constructed of materials compatible with the analytes of interest. See Table FS 1000-3 for restrictions.

3.3.2 Stainless steel, Teflon, Polyethylene and PP bailers may be used to sample all analytes.

3.3.3 Use disposable bailers when sampling grossly contaminated sample sources.

3.3.4 DEP recommends using dual check valve bailers when collecting samples.

3.3.5 Use bailers with a controlled flow bottom when collecting volatile organic samples.

3.3.6 Use bailers that can be pressurized when collecting filtered samples for metals.

3.4 Contamination Prevention:

3.4.1 Keep the bailer wrapped (foil, butcher paper, etc.) until just before use.

3.4.2 Use protective gloves to handle the bailer once it is removed from its wrapping.

3.4.3 Handle the bailer by the lanyard to minimize contact with the bailer surface.

4. LANYARDS

4.1 Lanyards must be made of non-reactive, non-leachable material such as cotton twine, nylon, or stainless steel; or, coated with Teflon, Polyethylene or PP.

4.1.1 Evaluate the appropriateness of the lanyard material with analyses of equipment blanks for the analytes of interest, as necessary.

4.2 Discard cotton twine, nylon, and non-stainless steel braided lanyards after sampling each monitoring well.

4.3 Decontaminate stainless steel, coated Teflon, Polyethylene and PP lanyards between monitoring wells (see FC 1003). They do not need to be decontaminated between purging and sampling operations.

4.4 Securely fasten lanyards to downhole equipment (bailers, pumps, etc.).

4.5 Do not allow lanyards used for downhole equipment to touch the ground surface.

FS 2210. GROUNDWATER PURGING

Perform procedures in the following sections to calculate purging parameters and to purge groundwater from monitoring wells, wells with installed plumbing, high-volume wells, air stripper systems and other remedial treatment systems.

FS 2211 *Water Level and Purge Volume Determination*

Collect representative groundwater samples from the aquifer. The amount of water that must be purged from a well is determined by the volume of water and/or field parameter stabilization.

1. GENERAL EQUIPMENT CONSIDERATIONS

1.1 Selection of appropriate purging equipment depends on the analytes of interest, the well diameter, transmissivity of the aquifer, the depth to groundwater and other site conditions.

1.2 Use a pump to purge the well.

1.3 Use a bailer if there is non-aqueous phase liquid in the well or non-aqueous phase liquid is suspected to be in the well.

1.4 Bailers may be used if approved by a DEP program, or if bailer use is specified in a permit, contract or DEP order (see Table FS 2200-3). If used, bailers must be of appropriate type and construction, and the user must follow the procedure outlined in FS 2213, section 4, with no deviations. If in doubt about the appropriateness of using a bailer at a site or during a particular sampling event, contact the appropriate DEP program or project manager. DEP does not recommend using bailers because improper bailing:

1.4.1 Introduces atmospheric oxygen which precipitates metals (i.e., iron) or causes other changes in the chemistry of the water in the sample (i.e., pH)

1.4.2 Agitates groundwater which biases volatile and semi-volatile organic analyses due to volatilization

1.4.3 Agitates the water in the aquifer and resuspends fine particulate matter

1.4.4 Surges the well, loosening particulate matter in the annular space around the well screen

1.4.5 Introduces dirt into the water column if the sides of the casing wall are scraped

2. INITIAL INSPECTION

2.1 Verify the identification of the monitoring well by examining markings, sign plates, placards or other designations.

2.2 Remove the well cover and remove all standing water around the top of the well casing (manhole) before opening the well cap.

2.3 Inspect the exterior protective casing of the monitoring well for damage and document the results of the inspection if there is a problem.

2.4 It is recommended that you place a protective covering around the well head. Replace the covering if it becomes soiled or ripped.

2.5 Inspect the well lock and determine whether the cap fits tightly. Replace the cap if necessary.

3. WATER LEVEL MEASUREMENTS: Use an electronic probe or chalked tape to determine the water level.

3.1 General Procedures

Perform these steps using either the electronic probe or chalked tape method.

3.1.1 Decontaminate all equipment that will contact the groundwater in the well before use.

3.1.2 Measure the depth to groundwater from the top of well casing to the nearest 0.01 foot and always measure from the same reference point or survey mark on the well casing. If there is no reference mark, measure from the north side of the casing.

3.1.3 Record the measurement and the reference point.

3.2 Electronic Probe

3.2.1 Follow the manufacturer's instructions for use.

3.2.2 Record the measurement.

3.3 Chalked Line Method: This method is not recommended if collecting samples for organic or inorganic parameters.

3.3.1 Lower chalked tape into the well until the lower end is in the water (usually determined by the sound of the weight hitting the water).

3.3.2 Record the length of the tape relative to the reference point (see section 3.2 above).

3.3.3 Quickly remove the tape from the well.

3.3.4 Record the length of the wetted portion to the nearest 0.01 foot.

3.3.5 Determine the depth to water by subtracting the length of the wetted portion (see section 3.5.3 above) from the total length (see section 3.5.2 above). Record the result.

4. WATER COLUMN DETERMINATION

4.1 Do not determine the total depth of the well by lowering the probe to the bottom of the well immediately before purging and sampling. If the well must be sounded, delay purging and sampling activities for at least 24 hours after the well was sounded or for a time sufficient to meet the purge stabilization criterion for turbidity. Alternatively, collect samples before sounding the well.

4.2 Subtract the depth to the top of the water column from the total well depth to determine the length of the water column.

4.3 The total well depth depends on the well construction. Some wells may be drilled in areas of sinkhole or karst formations or rock leaving an open borehole. Attempt to find the total borehole depth in cases where there is an open borehole below the cased portion.

5. WELL WATER VOLUME

5.1 Calculate the total volume of water in gallons in the well using the following equation:

V = (0.041)d x d x h

Where: V = volume in gallons

d = well diameter in inches

h = height of the water column in feet

5.2 The total volume of water in the well may also be determined with the following equation by using a casing volume per foot factor (Gallons per Foot of Water) for the appropriate diameter well:

V = [Gallons per Foot of Water] x h

Where: V = volume in gallons

h = height of the water column in feet

Casing Internal Diameter	Approximate Gallons per Foot of Water
0.75”	0.02
1”	0.04
1.25”	0.06
2”	0.16
3”	0.37
4”	0.65
5”	1.02
6”	1.47
12”	5.88

5.3 Record all measurements and calculations in the field records.

6. Purging Equipment Volume

Calculate the total volume of the pump, associated tubing and container that is used for in situ measurements (flow container), if used, using the following equation:

V = p + ((0.041)d x d x l) + fc

Where: V = volume in gallons

p = volume of pump in gallons

d = tubing diameter in inches

l = length of tubing in feet

fc = volume of flow cell in gallons

7. When collecting samples from multiple wells on a site, if the groundwater elevation data are to be used to construct groundwater elevation contour maps, all water level measurements must be taken within the same 24-hour time interval unless a shorter time period is required by a DEP program. If the site is tidally influenced, complete the water level measurements within the time frame of an incoming or outgoing tide.

FS 2212 *Well Purging Techniques*

The selection of the purging technique and equipment is dependent on the hydrogeologic properties of the aquifer, especially depth to groundwater and hydraulic conductivity. The intent of proper purging is to stabilize the water level in the well and minimize the hydraulic stress to the hydrogeologic formation.

Every attempt must be made to match the pumping rate with the recharge rate of the well before evaluating the purging completion criteria.

A flowchart which summarizes purging procedure options is presented in Figure FS 2200-2.

Select equipment using the construction and configuration requirements specified in Table FS 2200-1. See the discussions in FS 2201.

1. MEASURING THE PURGE VOLUME: The volume of water that is removed during purging must be recorded. Measure the volume during the purging operation.

1.1 Collect the water in a graduated container and multiply the number of times the container was emptied by the volume of the container, or

1.2 Estimate the volume based on pumping rate. Use this technique only if the pumping rate is constant. Determine the pumping rate by measuring the amount of water that is pumped for a fixed period of time or use a flow meter.

1.2.1 Calculate the amount of water that is discharged per minute:

$$D = \frac{\text{Measured amount}}{\text{Total time in minutes}}$$

1.2.2 Calculate the time needed to purge one (1) well volume or one (1) purging equipment volume:

$$\text{Time} = \frac{V}{D}$$

Where: V = well volume determined from FS 2211, section 5, or purging equipment volume

D = discharge rate calculated in section 1.2.1. above

1.2.3 Make new measurements (see section 1.2.1 above) each time the pumping rate is changed, or

1.3 Use a totalizing flow meter.

1.3.1 Record the reading on the totalizer prior to purging.

1.3.2 Record the reading on the totalizer at the end of purging.

1.3.3 Subtract the reading on the totalizer prior to purging from the reading on the totalizer at the end of purging to obtain the volume purged.

1.4 Record in the field records the times that purging begins and ends.

2. Stabilization Measurement Frequency

2.1 Begin to record stabilization measurements after pumping the minimum volume as prescribed in options 2.3 – 2.5 below. Every attempt must be made to match the pumping rate with the recharge rate of the well before evaluating the purging criteria.

2.2 If the well screened interval is not known, use option 2.3, below.

2.3 <u>Wells with Fully Submerged Screen and Pump or Intake Tubing Placed at the Top of the Water Column (conventional purge):</u> Purge until the water level has stabilized (well recovery rate equals the purge rate), then purge a minimum of one (1) well volume prior to collecting measurements of the stabilization parameters. Allow at least one quarter (1/4) well volume to purge between subsequent measurements.

2.4 <u>Wells with Fully Submerged Screen and Pump or Intake Tubing Placed Within the Screened Interval (minimizing purge volume):</u> Purge until the water level has stabilized (well recovery rate equals the purge rate), then purge a minimum of one (1) volume of the pump, associated tubing and flow container (if used) prior to collecting measurements of the stabilization parameters. Take measurements of the stabilization parameters no sooner

than two (2) minutes apart. Purge at least three (3) volumes of the pump, associated tubing and flow container, if used, prior to collecting a sample.

If the water level drops into the screened interval during purging, lower the pump or tubing intake as in FS 2213, section 1.3 below and follow purging procedures for partially submerged well screens (2.5 below).

2.5 Wells with a Partially Submerged Well Screen: Purge until the water level has stabilized (well recovery rate equals the purge rate), then purge a minimum of one (1) well volume prior to collecting measurements of the stabilization parameters. Take measurements of the stabilization parameters no sooner than two (2) minutes apart.

3. PURGING COMPLETION: DEP recommends the use of a flow-through container to measure the stabilization parameters discussed below. Alternatively, measure all parameters *in situ* by inserting measurement probes into the well at the depth appropriate for the purging option. Purging is considered complete if the criteria in section 3.1, 3.2 or 3.3 below are satisfied. Make every attempt to satisfy the criteria in section 3.1. Every attempt must be made to match the pumping rate with the recharge rate of the well before evaluating the purging criteria.

3.1 Three (3) consecutive measurements of the five (5) parameters listed below must be within the stated limits. The measurements evaluated must be the last three consecutive measurements taken before purging is stopped. The range between the highest and the lowest values for the last three measurements of temperature, pH and specific conductance cannot exceed the stated limits. The last three consecutive measurements of dissolved oxygen and turbidity must all be at or below the listed thresholds.

- Temperature: ± 0.2° C
- pH: ± 0.2 Standard Units
- Specific Conductance: ± 5.0% of reading
- Dissolved Oxygen: ≤20% Saturation
- Turbidity: ≤20 NTU

3.2 Naturally occurring conditions may prevent attaining the ≤20% saturation criterion for dissolved oxygen, typically in surficial aquifers. See section 3.5, below.

3.3 Naturally occurring conditions may prevent attaining the ≤20 NTU criterion for turbidity. However, when collecting groundwater samples for metals or certain inorganic (e.g., phosphorus forms) or extractable organic (e.g. polynuclear aromatic hydrocarbons) chemicals, make every attempt to reduce turbidity to ≤20 NTU to avoid a potential turbidity-associated bias for these analytes. See section 3.5, below.

3.4 Document and report the following, as applicable, except that the last four (4) items only need to be submitted once:

- Purging rate.
- Drawdown in the well, if any.
- Pump or tubing intake placement.
- Length and location of the screened interval.
- A description of the process and the data used to design the well.
- The equipment and procedure used to install the well.

- The well development procedure.
- Pertinent lithologic or hydrogeologic information.

3.5 If the criteria in section 3.1 above for dissolved oxygen and/or turbidity cannot be met, then three (3) consecutive measurements of the five (5) parameters listed below must be within the stated limits.

3.5.1 The measurements evaluated must be the last three consecutive measurements taken before purging is stopped. The range between the highest and the lowest values for the last three measurements cannot exceed the stated limits.

- Temperature: ± 0.2° C
- pH: ± 0.2 Standard Units
- Specific Conductance: ± 5.0% of reading
- Dissolved Oxygen: ± 0.2 mg/L or 10%, whichever is greater
- Turbidity: ± 5 NTUs or 10%, whichever is greater

3.5.2 Additionally, document and report the following, as applicable, except that the last four (4) items only need to be submitted once:

- Purging rate.
- Drawdown in the well, if any.
- Pump or tubing intake placement.
- Length and location of the screened interval.
- A description of conditions at the site that cause the dissolved oxygen to be high and/or dissolved oxygen measurements made within the screened or open borehole portion of the well with a downhole dissolved oxygen probe.
- A description of conditions at the site that cause the turbidity to be high and any procedures that will be used to minimize turbidity in the future.
- A description of the process and the data used to design the well.
- The equipment and procedure used to install the well.
- The well development procedure.
- Pertinent lithologic or hydrogeologic information.

3.5.3 If from review of the submitted data the Department determines that both the elevated Dissolved Oxygen and Turbidity measurements are due to naturally occurring conditions, then only the first four (4) items are required to be submitted in future reports. However, if the Department cannot determine if the Dissolved Oxygen or Turbidity is elevated due to naturally occurring conditions, then in addition to the first four (4) items, a description of the conditions at the site that caused the affected parameter(s) to be high is required to be submitted in future reports.

3.6 If the stabilization parameters in either section 3.1 or 3.2 cannot be met, and all attempts have been made to minimize the drawdown, check the instrument condition and calibration, purging flow rate and all tubing connections to determine if they might be affecting the ability to achieve stable measurements. All measurements that were made during the attempt must be documented. The sampling team leader may decide whether or

not to collect a sample or to continue purging after five (5) well volumes (conventional purge section 2.1 or 2.3 above) or five (5) volumes of the screened interval (minimizing purge volumes in section 2.2 above).

Further, the report in which the data are submitted must include the following, as applicable, except that the last four (4) items only need to be submitted once:

- Purging rate.
- Pump or tubing intake placement.
- Length and location of the screened interval.
- Drawdown in the well, if any.
- A description of conditions at the site that caused the dissolved oxygen to be high and/or dissolved oxygen measurements made within the screened or open borehole portion of the well with a downhole dissolved oxygen probe.
- A description of conditions at the site that caused the turbidity to be high and any procedures that will be used to minimize turbidity in the future.
- A description of the process and the data used to design the well.
- The equipment and procedure used to install the well.
- The well development procedure.
- Pertinent lithologic or hydrogeologic information.

If from review of the submitted data the DEP determines that both the elevated Dissolved Oxygen and Turbidity measurements are due to naturally occurring conditions, then only the first four (4) items are required to be submitted in future reports. However, if the DEP cannot determine if the Dissolved Oxygen or Turbidity is elevated due to naturally occurring conditions, then in addition to the first four (4) items, a description of the conditions at the site that caused the affected parameter(s) to be high is required to be submitted in future reports.

3.7 One fully dry purge (not recommended). This criterion applies only if purging was attempted per FS 2212, FS 2213, and section 3.4.1 below, and if it is impossible to balance the pumping rate with the rate of recharge at very low pumping rates (< 100 mL/minute).

3.7.1 If wells have previously and consistently purged dry, when purged according to FS 2212 and FS 2213, and the current depth to groundwater indicates that the well will purge dry during the current sampling event, minimize the amount of water removed from the well by using the same pump to purge and collect the sample:

3.7.1.1 Place the pump or tubing intake within the well screened interval.

3.7.1.2 Use very small diameter Teflon, Polyethylene or PP tubing and the smallest possible pump chamber volume to minimize the total volume of water pumped from the well and to reduce drawdown.

3.7.1.3 Select tubing that is thick enough to minimize oxygen transfer through the tubing walls while pumping.

3.7.1.4 Pump at the lowest possible rate (100 mL/minute or less) to reduce drawdown to a minimum.

3.7.1.5 Purge at least two (2) volumes of the pumping system (pump, tubing and flow cell, if used).

3.7.1.6 Measure pH, Specific Conductance, Temperature, Dissolved Oxygen and Turbidity and begin to collect the samples (see FS 2222).

4. Collect samples immediately after purging is complete.

4.1 The time period between completing the purge and sampling cannot exceed six (6) hours.

4.2 If sample collection does not occur within one (1) hour of purging completion, re-measure the five (5) field parameters Temperature, pH, Specific Conductance, Dissolved Oxygen and Turbidity just prior to collecting the sample.

4.2.1 If the measured values are not within 10 percent of the previous measurements, re-purge the well.

4.2.2 See section 3.4 above when collecting samples from wells that have purged dry.

FS 2213 *Purging Wells Without Plumbing (Monitoring Wells)*

1. TUBING/PUMP PLACEMENT

1.1 Do not lower the pump or intake hose (tubing) to the bottom of the well. Pump or tubing placement procedures will be determined by the purging option selected in FS 2212, section 2 above or FS 2214 below.

1.1.1 Minimizing Purge Volume: If the following conditions can be met, position the intake hose (tubing) or pump in the screened or open borehole interval.

- The same pump must be used for both purging and sampling,
- The well screen or borehole interval must be less than or equal to 10 feet, and
- The well screen or borehole must be fully submerged.

1.1.2 If the position or length of the screened interval or open borehole is unknown or estimated, place the intake hose (tubing) or pump to perform conventional purging in 1.2 below.

1.1.3 Position the pump or intake hose when purging large-diameter deep wells with open boreholes using the procedure in FS 2214 below.

1.2 Conventional Purging: Position the pump or intake tubing in the top one foot of the water column or no deeper than necessary for the type of pump.

1.2.1 If purging with a bailer, see section 4 below.

1.3 Partially Submerged Screened Interval: If the well screen or open borehole is partially submerged, and the pump will be used for both purging and sampling, position the pump or intake hose (tubing) in the portion of the water column within the submerged screened or open borehole interval.

1.3.1 If the position or length of the screened interval or open borehole is unknown or estimated, place the intake hose (tubing) or pump to perform conventional purging in 1.2 above.

1.3.2 Purge large-volume, high-recharge wells as in FS 2214 below.

1.3.3 If purging with a bailer, see section 4 below.

2. NON-DEDICATED (PORTABLE) PUMPS

2.1 Variable Speed Peristaltic Pump

2.1.1 Install a new, 1-foot maximum length of silicone tubing in the peristaltic pump head.

2.1.2 Attach a short section of tubing to the discharge side of the pump-head silicone tubing and into a graduated container.

2.1.3 Attach one end of a length of new or precleaned transport tubing to the intake side of the pump head silicone tubing.

2.1.4 Place the transport tubing in the monitoring well per one of the options in FS 2213, section 1 above.

2.1.5 Measure the depth to groundwater at frequent intervals.

2.1.6 Record these measurements.

2.1.7 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.

2.1.8 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.

2.1.9 If the water table continues to drop during pumping, lower the tubing at the approximate rate of drawdown so that the water is removed from the top of the water column.

2.1.10 Record the purging rate each time the rate changes.

2.1.11 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

2.1.12 Record this measurement.

2.1.13 Decontaminate the pump and tubing between wells (see FC 1000) or only the pump if precleaned tubing is used for each well.

2.2 Variable Speed Centrifugal Pump

2.2.1 Position fuel powered equipment **downwind** and at least 10 feet from the well head. Make sure that the exhaust faces downwind.

2.2.2 Place the decontaminated suction hose so that water is always pumped from the top of the water column.

2.2.3 Equip the suction hose with a foot valve to prevent purge water from re-entering the well.

2.2.4 Measure the depth to groundwater at frequent intervals.

2.2.5 Record these measurements.

2.2.6 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.

2.2.7 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.

2.2.8 If the water table continues to drop during pumping, lower the tubing at the approximate rate of drawdown so that the water is removed from the top of the water column.

2.2.9 Record the purging rate each time the rate changes.

2.2.10 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

2.2.11 Record this measurement.

2.2.12 Decontaminate the pump and tubing between wells (see FC 1000) or only the pump if precleaned tubing is used for each well.

2.3 Variable Speed Electric Submersible Pump

2.3.1 Position fuel powered equipment downwind and at least 10 feet from the well head. Make sure that the exhaust faces downwind.

2.3.2 Carefully position the decontaminated pump per one of the options in FS 2213, section 1 above.

2.3.3 Measure the depth to groundwater at frequent intervals.

2.3.4 Record these measurements.

2.3.5 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.

2.3.6 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.

2.3.7 If the water table continues to drop during pumping, lower the tubing or pump at the approximate rate of drawdown so that the water is removed from the top of the water column.

2.3.8 Record the purging rate each time the rate changes.

2.3.9 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

2.3.10 Record this measurement.

2.3.11 Decontaminate the pump and tubing between wells (see FC 1000) or only the pump if precleaned tubing is used for each well.

2.4 Variable Speed Bladder Pump

2.4.1 Position fuel powered equipment **downwind** and at least 10 feet from the well head. Make sure that the exhaust faces downwind.

2.4.2 Attach the tubing and carefully position the pump per one of the options in FS 2213, section 1 above.

2.4.3 Measure the depth to groundwater at frequent intervals.

2.4.4 Record these measurements.

2.4.5 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.

2.4.6 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal rate with the recharge rate.

2.4.7 If the water table continues to drop during pumping, lower the tubing or pump at the approximate rate of drawdown so that the water is removed from the top of the water column.

2.4.8 Record the purging rate each time the rate changes.

2.4.9 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

2.4.10 Record this measurement.

2.4.11 Decontaminate the pump and tubing between wells (see FC 1000) or only the pump if precleaned tubing is used for each well.

3. DEDICATED PORTABLE PUMPS: Place dedicated pumps per one of the options in FS 2213, section 1 above.

3.1 Variable Speed Electric Submersible Pump

3.1.1 Position fuel powered equipment **downwind** and at least 10 feet from the well head. Make sure that the exhaust faces downwind.

3.1.2 Measure the depth to groundwater at frequent intervals.

3.1.3 Record these measurements.

3.1.4 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.

3.1.5 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal with the recharge rate.

3.1.6 Record the purging rate each time the rate changes.

3.1.7 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

3.1.8 Record this measurement.

3.2 Variable Speed Bladder Pump

3.2.1 Position fuel powered equipment **downwind** and at least 10 feet from the well head. Make sure that the exhaust faces downwind.

3.2.2 Measure the depth to groundwater at frequent intervals.

3.2.3 Record these measurements.

3.2.4 Adjust the purging rate so that it is equivalent to the well recovery rate to minimize drawdown.

3.2.5 If the purging rate exceeds the well recovery rate, reduce the pumping rate to balance the withdrawal with the recharge rate.

3.2.6 Record the purging rate each time the rate changes.

3.2.7 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

3.2.8 Record this measurement.

4. BAILERS: DEP recommends against using bailers for purging except as a last contingency, or if free product is present in the well or suspected to be in the well. However, they may be used if approved by a DEP program, or specified in a permit, contract or DEP order (see Table FS 2200-3 and FS 2211, section 1.3). If in doubt about the appropriateness of using a bailer at a site or during a particular sampling event, contact the appropriate DEP program or project manager.

4.1 Minimize handling the bailer as much as possible.

4.1.1 Remove the bailer from its protective wrapping just before use.

4.1.2 Attach a lanyard of appropriate material (see FS 2201, section 4).

4.1.3 Use the lanyard to move and position the bailer.

4.2 Lower and retrieve the bailer slowly and smoothly.

4.3 Lower the bailer carefully into the well to a depth approximately a foot above the water column.

4.3.1 Do not lower the top of the bailer more than one (1) foot below the top of the water table so that water is removed from the top of the water column. Ensure that the length of the bailer does not exceed the length of the water column.

4.3.2 Allow time for the bailer to fill with aquifer water as it descends into the water column.

4.4 Carefully raise the bailer.

4.4.1 Retrieve the bailer at the same rate of 2 cm/sec until the bottom of the bailer has cleared to top of the water column.

4.5 Measure the purge volume by one of the methods outlined in FS 2212, section 1.

4.5.1 Record the volume of the bailer.

4.6 Continue to carefully lower and retrieve the bailer as described above until the purging completion conditions specified in FS 2212, section 3, have been satisfied.

4.6.1 Remove at least one (1) well volume before collecting measurements of the field parameters. Take each subsequent set of measurements after removing at least one quarter (1/4) well volume between measurements.

FS 2214 *Purging Large-Volume, High-Recharge Wells With Portable Pumps*

If a well originally constructed for high-flow-rate pumping will be sampled as a monitoring well, use these guidelines to develop a purging procedure applicable to the specific details of the well construction. Typical wells constructed for this purpose may be deep, large-diameter wells with a section of open borehole. Evaluate each well on a case-by-case basis and consider any available information on the construction and hydraulic performance of the well.

1. PURGING PROCEDURE

1.1 Place the pump at the top of the open borehole segment of the well.

1.2 Start purging while monitoring stabilization parameters as in FS 2212, section 3 above.

1.3 Purge at least one equipment volume before measuring stabilization parameters.

1.4 If the well is being purged for the first time using these guidelines, monitor stabilization parameters for an extended period until confident that sufficient volume has been pumped from the open borehole to draw fresh formation water into the pump tubing and flow-through container. Use the information obtained from the first-time purging of the well to determine the pumping rate and duration of purging required for future sampling events at the well.

1.5 Purge at least three equipment volumes before evaluating purging completion.

2. PURGING COMPLETION

2.1 Complete the purging of the well when the last three consecutive measurements of the purge stabilization parameters have met the applicable criteria specified in FS 2212, section 3 above.

3. Collect samples from the well using the procedures in FS 2221, section 1 below.

FS 2215. *Purging Wells With Plumbing (production wells or permanently installed pumps equipped with sampling ports or sampling spigots)*

Wells with in-place plumbing are commonly found at municipal water treatment plants, industrial water supplies, private residences, etc. Depending on the sampling objective for collecting samples using installed plumbing, purge the system and collect samples closest to the point of consumption, or, as close to the source well as possible. When purging is required and the purge volume of the plumbing system is not known, purge the system until the purging completion criteria in FS 2212, section 3, have been met.

1. CONTINUOUSLY RUNNING PUMPS

1.1 Select the spigot that is closest to the pump and before any storage tanks (if possible).

1.2 Remove all hoses, aerators and filters (if possible).

1.3 Open the spigot and purge at maximum flow.

1.4 If a storage tank is located between the pump and the spigot, purge the volume of the tank, lines and spigot.

1.5 If the spigot is before any storage tank, purge until sufficient volume is removed to flush the stagnant water from the spigot and the tap line to the spigot.

1.6 Reduce the flow rate to ≤ 500 mL/minute (a 1/8” stream) or approximately 0.1 gal/minute before collecting samples. When sampling for volatile organic compounds, reduce the flow to ≤100 mL/minute before collecting the samples.

2. INTERMITTENTLY RUNNING PUMPS

2.1 Select the spigot that is closest to the pump and before any storage tanks (if possible).

2.2 Remove all hoses, aerators and filters (if possible).

2.3 Open the spigot and purge sufficient volume at a maximum, practical flow rate to flush the spigot and lines and until the purging completion criteria in FS 2212, section 3, have been met.

2.4 If a storage tank is located between the pump and the spigot, purge the volume of the tank, lines and spigot.

2.5 Ensure that the purge stabilization measurement of dissolved oxygen is not biased with aeration of the sample by a high flow rate in the flow-through container.

2.6 Reduce the flow rate to ≤ 500 mL/minute (a 1/8” stream) or approximately 0.1 gal/minute before collecting samples. When sampling for volatile organic compounds, reduce the flow to ≤ 100 mL/minute before collecting the samples.

FS 2216. *Purging Airstrippers and Remedial Treatment Systems*

If collecting samples for groundwater contamination monitoring, follow FS 2215above.

FS 2220. GROUNDWATER SAMPLING TECHNIQUES

1. Purge wells using the techniques outlined in FS 2210.

2. Replace the protective covering around the well if it is soiled or torn after completing the purging operations.

3. EQUIPMENT CONSIDERATIONS

Follow all notes and restrictions as indicated in Table FS 2200-1 and as discussed in FS 2201.

NOTE: The only pumps that are currently approved for use in collecting volatile organic samples through the pump are stainless steel and Teflon variable speed submersible pumps, stainless steel and Teflon or Polyethylene variable speed bladder pumps, and permanently installed PVC bodied pumps (variable speed bladder or submersible pumps) as long as the pump remains in contact with the water in the well at all times.

3.1 Collect the sample into the sample container from the sampling device. **Do not** use intermediate containers.

3.2 In order to avoid contaminating the sample or loss of analytes from the sample:

3.3 Handle the sampling equipment as little as possible.

3.3.1 Minimize the equipment that is exposed to the sample.

3.3.2 Minimize aeration of samples collected for VOC analysis.

3.3.3 Reduce sampling pump flow rates to $\leq$ 100 mL/minute when collecting VOC samples.

3.4 Dedicated Sampling Equipment

3.4.1 Whenever possible, use dedicated equipment because it significantly reduces the chance of cross-contamination.

3.4.2 Dedicated is defined as equipment that is to be used solely for one location for the life of that equipment (e.g., permanently mounted pump).

3.4.3 All material construction and restrictions from Table FS 2200-1 also apply to dedicated equipment. Purchase equipment with the most sensitive analyte of interest in mind.

3.5 Cleaning/Decontamination

3.5.1 Clean or ensure dedicated pumps are clean before installation. They do not need to be cleaned prior to each use but must be cleaned if they are withdrawn for repair or servicing.

3.5.2 Clean or make sure any permanently mounted tubing is clean before installation.

3.5.3 Change or clean tubing when the pump is withdrawn for servicing.

3.5.4 Clean any replaceable or temporary parts as specified in FC 1000.

3.5.5 Collect equipment blanks on dedicated pumping systems when the tubing is cleaned or replaced.

3.5.6 Clean or ensure dedicated bailers are clean before placing them into the well.

3.5.7 Collect an equipment blank on dedicated bailers before introducing them into the water column.

3.5.8 Suspend dedicated bailers above the water column if they are stored in the well.

FS 2221. *Sampling Wells Without Plumbing*

1. SAMPLING WITH PUMPS: Variable speed stainless steel and Teflon submersible pumps and stainless steel, Teflon or Polyethylene bladder pumps, and permanently installed PVC-bodied variable speed submersible or bladder pumps, as long as the pump remains in contact with the water in the well at all times, may be used to sample for all organics. The delivery tubing must be Teflon, Polyethylene or PP. **Extractable organics** may be collected through a peristaltic pump if ≤ 1 foot of silicone tubing is used in the pump head or a vacuum trap is used (see Figure FS 2200-1 for specific configuration). Follow all notes and restrictions as defined in Table FS 2200-1 and discussed in Equipment and Supplies (FS 2201) when using pumps to collect samples.

Do not lower the pump or tubing to the bottom of the well.

1.1 Peristaltic Pump

1.1.1 Volatile Organics Using Manual Fill and Drain Method: Collect volatile organics last. If the pump tubing is placed within the screened interval, the tubing cannot be reinserted into the well, and steps 1.1.1.3 through 1.1.1.6 below are prohibited.

1.1.1.1 Ensure that there is sufficient tubing volume to fill the requisite number of VOC vials.

1.1.1.2 Remove the drop tubing from the inlet side of the pump.

1.1.1.3 Submerse the drop tubing into the water column and allow it fill.

1.1.1.4 Remove the drop tubing from the well.

1.1.1.5 Prevent the water in the tubing from flowing back into the well.

1.1.1.6 Carefully allow the groundwater to drain by gravity into the sample vials. Avoid turbulence. Do not aerate the sample. The flow rate must be ≤ 100 mL/minute.

1.1.1.7 Repeat steps 1.1.1.3 - 1.1.1.6 until enough vials are filled.

1.1.2 Volatile Organics Using the Pump to Fill and Drain the Tubing: Collect volatile organics last. If the pump tubing is placed within the screened interval, the tubing cannot be reinserted into the well, and steps 1.1.2.2 through 1.1.2.8 below are prohibited.

1.1.2.1 Ensure that there is sufficient tubing volume to fill the requisite number of VOC vials.

1.1.2.2 Submerse the drop tubing into the water column.

1.1.2.3 Use the pump to fill the drop tubing.

1.1.2.4 Quickly remove the tubing from the pump.

1.1.2.5 Prevent the water in the tubing from flowing back into the well.

1.1.2.6 Remove the drop tubing from the well and fill the vials using the pump or gravity-drain methods in steps 1.1.2.7 or 1.1.2.8 below.

1.1.2.7 Reverse the flow on the peristaltic pump to deliver the sample into the vials at a slow, steady rate. The flow rate must be ≤ 100 mL/minute.

1.1.2.8 Or, remove the drop tubing from the inlet side of the pump and carefully allow the groundwater to drain into the sample vials. Avoid turbulence. Do not aerate the sample. The flow rate must be ≤ 100 mL/minute.

1.1.2.9 Repeat steps 1.1.2.2 through 1.1.2.8 until enough vials are filled.

1.1.3 Extractable Organics Collected Through Silicone Pump-Head Tubing:

1.1.3.1 Ensure that a 1-foot maximum length of new silicone tubing was installed in the peristaltic pump head assembly before the well was purged if the same pump is being used to purge and sample the well. Otherwise, install a new length of tubing as described above.

1.1.3.2 Collect extractable organic samples directly from the effluent delivery tubing (attached to discharge side of the silicone pump head tubing) into the sample container.

1.1.3.3 If there is a concern that sample analytes are absorbed, adsorbed, leached or otherwise affected or lost by pumping through the silicone pump-head tubing, sample the well using the organic trap assembly in 1.1.4 below.

1.1.4 Extractable Organics Using an Optional Organic Trap Assembly

1.1.4.1 Assemble the components of the pump and trap according to Figure FS 2200-1.

1.1.4.2 The sample container should be the trap bottle.

1.1.4.3 All equipment that contacts the groundwater **before** the sample container must be constructed of Teflon, Polyethylene, PP, stainless steel or glass, including the transport tubing to and from the sample container, the interior liner of the container cap and all fittings. **Do not use a rubber stopper as a cap.**

1.1.4.4 Connect the outflow tubing from the container to the influent side of the peristaltic pump.

1.1.4.5 Prevent the water in the down-hole delivery tubing from flowing back into the well while performing this connection.

1.1.4.6 Turn the pump on and reduce the flow rate to a smooth and even flow.

1.1.4.7 Discard a small portion of the sample to allow an air space.

1.1.4.8 Preserve (if required), label and complete the field notes.

1.1.5 Inorganics

1.1.5.1 Inorganic samples may be collected from the effluent tubing.

1.1.5.2 If samples are collected from the pump, decontaminate all tubing (including the tubing in the head) or change it between wells.

1.1.5.3 Preserve (if required), label and complete field notes.

1.2 Variable Speed Bladder Pump

1.2.1 If sampling for organics the pump body must be constructed of stainless steel and the valves and bladder must be Teflon. All tubing must be Teflon, Polyethylene, or PP and any cabling must be sealed in Teflon, Polyethylene or PP, or made of stainless steel.

1.2.2 After purging to a smooth even flow, reduce the flow rate.

1.2.3 When sampling for volatile organic compounds, reduce the flow rate to 100 mL/minute or less, if possible.

1.3 Variable Speed Submersible Pump

1.3.1 The housing must be stainless steel.

1.3.2 If sampling for organics, the internal impellers, seals and gaskets must be constructed of stainless steel, Teflon, Polyethylene or PP. The delivery tubing must be Teflon, Polyethylene or PP and the electrical cord must be sealed in Teflon and any cabling must be sealed in Teflon or constructed of stainless steel.

1.3.3 After purging to a smooth even flow, reduce the flow rate.

1.3.4 When sampling for volatile organic compounds, reduce the flow rate to 100 mL/minute or less, if possible.

2. SAMPLING WITH BAILERS: A high degree of skill and coordination are necessary to collect representative samples with a bailer. When properly used, bailers may be used to collect samples for certain analyte groups and under specific conditions (see Table FS 2200-3). They must be of an appropriate type and construction (see FS 2201, section 3), and must be used as outlined below. If in doubt about the appropriateness of using a bailer at a site or during a particular sampling event, contact the appropriate DEP program or project manager.

2.1 General Considerations

2.1.1 Minimize handling the bailer as much as possible.

2.1.1.1 Wear sampling gloves.

2.1.1.2 Remove the bailer from its protective wrapping just before use.

2.1.1.3 Attach a lanyard of appropriate material (see FS 2201, section 4).

2.1.1.4 Use the lanyard to move and position the bailers.

2.1.2 Do not allow the bailer or lanyard to touch the ground.

2.1.3 Rinsing

2.1.3.1 If the bailer is certified precleaned, no rinsing is necessary.

2.1.3.2 If both a pump and a bailer are to be used to collect samples, rinse the exterior and interior of the bailer with sample water from the pump before removing the pump.

2.1.3.3 If the purge pump is not appropriate for collecting samples (e.g., non-inert components), rinse the bailer with by collecting a single bailer of the groundwater to be sampled. Use the technique described in section 2.2, Bailing Technique, below.

2.1.3.4 Discard the water appropriately.

2.1.3.5 **Do not** rinse the bailer if Oil & Grease, TRPHs, etc., (see FS 2006) are to be collected.

2.2 Bailing Technique

2.2.1 Collect all samples that are required to be collected with a pump before collecting samples with the bailer.

2.2.2 Raise and lower the bailer gently to minimize stirring up particulate matter in the well and the water column which can increase sample turbidity.

2.2.3 Lower the bailer carefully into the well to a depth approximately a foot above the water column. Ensure that the length of the bailer does not exceed the length of the water column.

2.2.3.1 When the bailer is in position, lower the bailer into the water column at a rate of 2 cm/sec until the desired depth is reached (see section 2.2.3 above).

2.2.4 Do not lower the top of the bailer more than one (1) foot below the top of the water table so that water is removed from the top of the water column.

2.2.5 Allow time for the bailer to fill with aquifer water as it descends into the water column.

2.2.6 Do not allow the bailer to touch the bottom of the well or particulate matter will be incorporated into the sample.

2.2.6.1 Carefully raise the bailer (see section 2.2.2 above). Retrieve the bailer at the same rate of 2 cm/sec until the bottom of the bailer has cleared to top of the water column.

2.2.7 Lower the bailer to approximately the same depth each time.

2.2.8 Collect the sample.

2.2.8.1 Install a device to control the flow from the bottom of the bailer and discard the first few inches of water. Reduce the flow to $\leq$ 100 mL/minute when collecting VOC samples.

2.2.8.2 Fill the appropriate sample containers by allowing the sample to slowly flow down the side of the container. Minimize aeration of VOC samples.

2.2.8.3 Discard the last few inches of water in the bailer.

2.2.9 Repeat steps 2.2.1 through 2.2.8.3 for additional samples.

2.2.10 Measure the DO, pH, temperature, turbidity and specific conductance after the final sample has been collected.

2.2.10.1 Record all measurements and note the time that sampling was completed.

3. SAMPLING WELLS WITH FLOATING NON-AQUEOUS PHASE LIQUID: DEP does not recommend the sampling of wells with floating non-aqueous phase liquid for trace contaminants. This concerns primarily petroleum related sites, but includes any chemical product (e.g., solvent) that floats on the water table. Sampling is acceptable if the information is to be used for the purpose of remedial design.

Sample data from such wells cannot provide useful information regarding the level of contamination. Furthermore, these wells typically do not provide legitimate data because of permanent chemical contamination from product contact with the well casing for an extended period of time.

DEP does reserve the right to require sampling of these wells, not for levels of trace contaminants, but for confirmation of an appropriate remediation technique. This type of sampling is performed **below** the non-aqueous phase layer (see section 3.2 below).

3.1 Non-Aqueous Phase Liquid Sampling: Non-aqueous phase liquid may be evident in a cased monitoring well or in an open excavation.

3.1.1 Non-aqueous phase liquid is normally sampled for two reasons:

- Documentation for its existence and thickness; and
- Determination of the type of product so that the proper analyses can be performed to determine extent. This is only feasible for relatively recent releases as it may not be possible to identify weathered product.

3.1.2 Disposable plastic (acrylic, clear PVC) bailers are recommended for sampling. Disposable Polyethylene and PP bailers are also acceptable. Other wide mouth vessels may be used for sampling non-aqueous phase liquid in an excavation.

3.1.3 Monitoring Well

3.1.3.1 If a non-aqueous phase liquid is identified in a monitoring well during the water level measurement, measure its thickness in the well. If the thickness of the non-aqueous phase liquid is greater than 0.01 foot or product globules are present, collect a sample using a precleaned disposable bailer.

3.1.3.2 Measure the product thickness to the nearest 0.01 foot after withdrawing the bailer.

3.1.3.3 Pour a portion of the product into a glass sample container.

3.1.3.4 This sample is considered a concentrated waste. Therefore, package the container in protective wrapping to prevent breakage, isolate from other samples, and ice to 4°C.

3.1.4 Excavation

3.1.4.1 If non-aqueous phase liquid is observed in an open excavation, a glass sample container or a precleaned intermediate vessel may be used to collect the sample.

3.1.4.2 Securely tie a lanyard to the container and lower it into the excavation.

3.1.4.3 Gently lower and retrieve the container so that no solid material is released or collected.

3.1.4.4 If sufficient water is available, a bailer can be used.

3.1.4.5 Although not recommended, screened casing can be placed (or augered and placed) in the bottom of the excavation and the product sampled with a bailer.

3.1.4.6 Avoid dangerous situations, such as standing too close to the edge of an excavation, riding in the backhoe bucket, or entering a trench or excavation that may collapse.

3.1.4.7 Follow all applicable OSHA regulations.

3.2 Sampling Below Product

3.2.1 This type of depth-specific sampling to attempt to sample the dissolved constituents in the water column below the product layer is performed only at the request of DEP or its designee.

3.2.2 These data provide information that helps define adequate groundwater treatment. Without these data, incorrect (and sometimes unnecessarily expensive) remediation techniques may be designed for a situation where they are not required.

3.2.3 There are some substantial logistical problems involved with sending a sampler through non-aqueous phase liquid to sample the groundwater below. Although there are some products designed specifically for this type of sampling, they are expensive and the results may not be commensurate with their cost. The use of "self-engineered" equipment or coverings may be the best option.

3.2.4 These data are only to be used for qualitative use and will aid in deciding on an appropriate remediation technique.

3.2.5 Wrapping bailers and tubing in plastic seems to be the most popular technique in getting past the product layer.

3.2.6 Although not recommended, some have wrapped submersible pumps in several layers of plastic and retrieved each layer by a separate lanyard. One suggestion would be to use a rigid piece of stainless steel tubing wrapped in plastic.

3.2.6.1 Once the covered tubing is past the layer, pull up on the plastic, piercing the plastic and exposing the (somewhat) clean tubing inlet.

3.2.6.2 Introduce the wrapped hose slowly to not entrain any more product into the dissolved layer located below.

3.2.6.3 Also, perform this procedure with a peristaltic pump or a vacuum pump linked to a trap bottle. To use this setup, the water table must be no deeper than 15-20 feet, realizing that actual sampling may be occurring several feet below the product layer.

FS 2222. *Sampling Low Permeability Aquifers or Wells That Have Purged Dry*

1. Collect the sample(s) after the well has been purged according to FS 2212, section 3.4. Minimize the amount of water removed from the well by using the same pump to purge and collect the sample. If the well has purged dry, collect samples as soon as sufficient sample water is available.

2. Measure the five (5) field parameters Temperature, pH, Specific Conductance, Dissolved Oxygen and Turbidity at the time of sample collection.

3. Advise the analytical laboratory and the client that the usual amount of sample for analysis may not be available.

FS 2223. *Sampling Wells With In-Place Plumbing*

1. If a storage tank is present, locate a cold water spigot, valve or other sampling point close to the well head between the pump and the storage tank. If there is no sampling location between the pump and the storage tank, locate the spigot, valve or other sampling point closest to the tank.

1.1 Depending on the sampling objective for collecting samples using installed plumbing, purge the system and collect samples closest to the point of consumption, or, as close to the source well as possible.

2. Remove all screens or aerators and reduce the flow rate to no more than 500 mL/minute. If collecting samples for volatile organic compounds, reduce the flow rate to 100 mL/minute or less. Collect the samples directly into the appropriate containers.

FS 2224. *Sampling Airstripper and Remedial Treatment System Sampling*

1. Reduce the flow rate to less than 500 mL/minute and begin sample collection.

2. If collecting samples for volatile organic compounds, reduce the flow rate to 100 mL/minute or less.

3. Collect the samples directly into the appropriate containers.

FS 2225. *Filtering Groundwater Samples*

Filtered groundwater samples can only be collected after approval from the DEP program or project manager. If filtering is approved, the DEP program or permit condition may require both filtered and unfiltered samples to be collected, analyzed and reported.

1. FILTERING GROUNDWATER FOR METALS:

1.1 Unless specified otherwise by the DEP program, use a new, disposable, high capacity, 1-µm in-line filter.

1.2 Use a variable speed peristaltic, bladder or submersible pump with the in-line filter fitted on the outlet end.

1.2.1 Peristaltic pumps, bladder pumps or submersible pumps can be used when water levels are no greater than 20 to 25 feet deep.

1.2.2 Bladder pumps or submersible pumps must be used when water levels are greater than 20 to 25 feet deep.

1.3 Ensure that a 1-foot maximum length of new, silicone tubing was installed in the peristaltic pump head assembly before the well was purged if the same pump is being used to purge and sample the well. Otherwise, install a new length of tubing as described above.

1.4 Ensure that new or precleaned delivery tubing was assembled with the peristaltic pump before the well was purged if the same pump is being used to purge and sample the well. Otherwise, assemble the pump with new or precleaned delivery tubing and the new filter.

1.5 Insert the filter on the high pressure side (i.e., on the delivery side) of the pump.

1.5.1 Flush the filter before attaching to the pump tubing assembly with 30-50 mL of analyte free water or an inert gas (nitrogen) to remove atmospheric oxygen;

1.5.2 Or, with the filter attached to the pump tubing assembly, hold the filter upright with the inlet and outlet in the vertical position and pump water from the aquifer through the filter until all atmospheric oxygen has been removed.

1.6 Collect the filtered samples directly into the sample container from the high-pressure (delivery) side of the pump tubing assembly.

1.6.1 Collect filtered samples by either of the methods in 1.6.1.3 or 1.6.1.4 below if the static water level in the well is too deep for a variable speed peristaltic pump and a variable speed electric submersible pump or variable speed bladder pump is not available.

1.6.1.1 Do not agitate the sample or expose it to atmospheric oxygen.

1.6.1.2 **Do not** pour the sample into any intermediate vessel for subsequent filtration.

1.6.1.3 Collect the sample in a Polyethylene, Teflon or PP bailer that can be pressurized. When the bailer has been retrieved, immediately connect the filter and begin to pressurize the bailer;

1.6.1.4 Or, collect the sample with a bailer and immediately place the intake tube of the peristaltic pump into the full bailer and begin pumping the water through the filter as described in section 1.2 above.

1.7 **Do not** use the following equipment for filtering groundwater samples for metals:

1.7.1 Any pump and apparatus combination in which the filter is on the vacuum (suction) side of the pump.

1.7.2 Any type of syringe or barrel filtration apparatus.

1.7.3 Any filter that is not encased in a one-piece, molded unit.

2. Filtering groundwater for non-metallic analytes

2.1 The following analytes cannot be filtered:

- Oil and Grease
- Total Recoverable Petroleum Hydrocarbons (TRPH)
- FL-PRO
- Volatile Organic Compounds (VOC)
- Microbiological Analytes
- Volatile Inorganic Compounds (e.g., Hydrogen Sulfide)

2.2 Unless specified otherwise by the regulatory program, use a new, disposable, high capacity, 0.45 µm in-line filter.

2.3 Assemble the pump, tubing and filter as in 1.2 – 1.5 above.

2.4 Flush the filter as in 1.5.1 or 1.5.2 above.

2.5 Collect the samples as in 1.6 – 1.6.1.4 above.

Appendix FS 2200

Tables, Figures and Forms

Table FS 2200-1 Equipment for Collecting Groundwater Samples
Table FS 2200-2 Dissolved Oxygen Saturation
Table FS 2200-3 Allowable Uses for Bailers
Figure FS 2200-1 Pump and Trap for Extractable Organics
Figure FS 2200-2 Groundwater Purging Procedure
Form FD 9000-24 Groundwater Sampling Log

Table FS 2200-1
Equipment for Collecting Groundwater Samples

Activity	Equipment Type
Well Purging	Variable speed centrifugal pump Variable speed submersible pump Variable speed bladder pump Variable speed peristaltic pump Bailer with lanyard: Not Recommended
Well Stabilization	pH meter DO meter Conductivity meter Thermometer/Thermistor Turbidimeter Flow-through cell Multi-function meters
Sample Collection	Variable speed peristaltic pump Variable speed submersible pump Variable speed bladder pump Bailer with lanyard (See Table FS 2200-3)
Filtration	Variable speed peristaltic pump Variable speed submersible pump Variable speed bladder pump Pressurized bailer 1.0 µm high capacity molded filter 0.45 µm high capacity molded filter
Groundwater Level	Electronic sensor Chalked tape

Table FS 2200-2
Dissolved Oxygen Saturation

TEMP	D.O.	mg/L	TEMP	D.O.	mg/L	TEMP	D.O.	mg/L	TEMP	D.O.	mg/L
deg C	SAT.	20%	deg C	SAT.	20%	deg C	SAT.	20%	deg C	SAT.	20%
15.0	10.084	2.017	19.0	9.276	1.855	23.0	8.578	1.716	27.0	7.968	1.594
15.1	10.062	2.012	19.1	9.258	1.852	23.1	8.562	1.712	27.1	7.954	1.591
15.2	10.040	2.008	19.2	9.239	1.848	23.2	8.546	1.709	27.2	7.940	1.588
15.3	10.019	2.004	19.3	9.220	1.844	23.3	8.530	1.706	27.3	7.926	1.585
15.4	9.997	1.999	19.4	9.202	1.840	23.4	8.514	1.703	27.4	7.912	1.582
15.5	9.976	1.995	19.5	9.184	1.837	23.5	8.498	1.700	27.5	7.898	1.580
15.6	9.955	1.991	19.6	9.165	1.833	23.6	8.482	1.696	27.6	7.884	1.577
15.7	9.934	1.987	19.7	9.147	1.829	23.7	8.466	1.693	27.7	7.870	1.574
15.8	9.912	1.982	19.8	9.129	1.826	23.8	8.450	1.690	27.8	7.856	1.571
15.9	9.891	1.978	19.9	9.111	1.822	23.9	8.434	1.687	27.9	7.842	1.568
16.0	9.870	1.974	20.0	9.092	1.818	24.0	8.418	1.684	28.0	7.828	1.566
16.1	9.849	1.970	20.1	9.074	1.815	24.1	8.403	1.681	28.1	7.814	1.563
16.2	9.829	1.966	20.2	9.056	1.811	24.2	8.387	1.677	28.2	7.800	1.560
16.3	9.808	1.962	20.3	9.039	1.808	24.3	8.371	1.674	28.3	7.786	1.557
16.4	9.787	1.957	20.4	9.021	1.804	24.4	8.356	1.671	28.4	7.773	1.555
16.5	9.767	1.953	20.5	9.003	1.801	24.5	8.340	1.668	28.5	7.759	1.552
16.6	9.746	1.949	20.6	8.985	1.797	24.6	8.325	1.665	28.6	7.745	1.549
16.7	9.726	1.945	20.7	8.968	1.794	24.7	8.309	1.662	28.7	7.732	1.546
16.8	9.705	1.941	20.8	8.950	1.790	24.8	8.294	1.659	28.8	7.718	1.544
16.9	9.685	1.937	20.9	8.932	1.786	24.9	8.279	1.656	28.9	7.705	1.541
17.0	9.665	1.933	21.0	8.915	1.783	25.0	8.263	1.653	29.0	7.691	1.538
17.1	9.645	1.929	21.1	8.898	1.780	25.1	8.248	1.650	29.1	7.678	1.536
17.2	9.625	1.925	21.2	8.880	1.776	25.2	8.233	1.647	29.2	7.664	1.533
17.3	9.605	1.921	21.3	8.863	1.773	25.3	8.218	1.644	29.3	7.651	1.530
17.4	9.585	1.917	21.4	8.846	1.769	25.4	8.203	1.641	29.4	7.638	1.528
17.5	9.565	1.913	21.5	8.829	1.766	25.5	8.188	1.638	29.5	7.625	1.525
17.6	9.545	1.909	21.6	8.812	1.762	25.6	8.173	1.635	29.6	7.611	1.522
17.7	9.526	1.905	21.7	8.794	1.759	25.7	8.158	1.632	29.7	7.598	1.520
17.8	9.506	1.901	21.8	8.777	1.755	25.8	8.143	1.629	29.8	7.585	1.517
17.9	9.486	1.897	21.9	8.761	1.752	25.9	8.128	1.626	29.9	7.572	1.514
18.0	9.467	1.893	22.0	8.744	1.749	26.0	8.114	1.623	30.0	7.559	1.512
18.1	9.448	1.890	22.1	8.727	1.745	26.1	8.099	1.620	30.1	7.546	1.509
18.2	9.428	1.886	22.2	8.710	1.742	26.2	8.084	1.617	30.2	7.533	1.507
18.3	9.409	1.882	22.3	8.693	1.739	26.3	8.070	1.614	30.3	7.520	1.504
18.4	9.390	1.878	22.4	8.677	1.735	26.4	8.055	1.611	30.4	7.507	1.501
18.5	9.371	1.874	22.5	8.660	1.732	26.5	8.040	1.608	30.5	7.494	1.499
18.6	9.352	1.870	22.6	8.644	1.729	26.6	8.026	1.605	30.6	7.481	1.496
18.7	9.333	1.867	22.7	8.627	1.725	26.7	8.012	1.602	30.7	7.468	1.494
18.8	9.314	1.863	22.8	8.611	1.722	26.8	7.997	1.599	30.8	7.456	1.491
18.9	9.295	1.859	22.9	8.595	1.719	26.9	7.983	1.597	30.9	7.443	1.489

Derived using the formula in Standard Methods for the Examination of Water and Wastewater, Page 4-101, 18th Edition, 1992

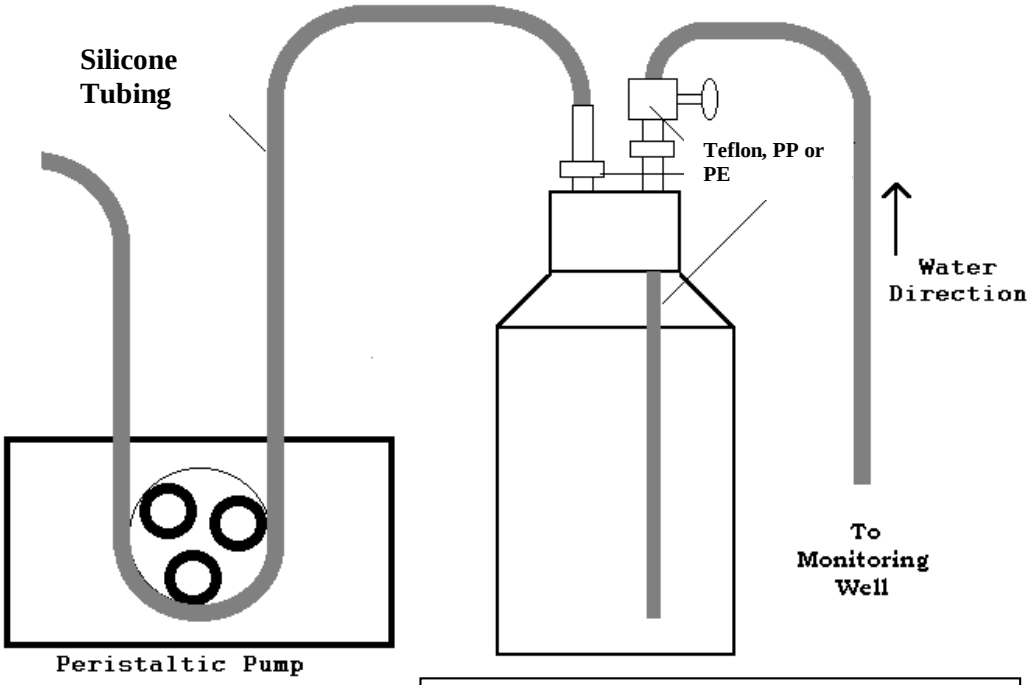
Table FS 2200-3
Allowable Uses for Bailers

• **ANALYTE GROUP(S)**	• **PURGING** (Not Recommended)	• **SAMPLING**	
	Use:	Use:	Not Recommended:
Volatile Organics Extractable Organics Radionuclides, including Radon Metals Volatile Sulfides	If allowed by permit, program, contract or order or If operated by a skilled individual with documented training in proper techniques. Field documentation must demonstrate that the procedure in FS 2213, section 4 was followed without deviation.	If concentrations exceed action levels, the purpose is to monitor effective treatment, and the DEP program allows the use of bailers; or If specified by DEP permit, program, contract or order. or If operated by a skilled individual with documented training in proper techniques and using appropriate equipment. Field documentation must demonstrate that the procedure in FS 2221, section 2 was followed without deviation.	If concentrations are near or below the stated action levels; or If a critical decision (e.g., clean closure) will be made based on the data; or If data are to demonstrate compliance with a permit or order.
Petroleum Hydrocarbons (TRPH) & Oil & Grease	If allowed by permit, program, contract or order or If operated by a skilled individual with documented training in proper techniques. Field documentation must demonstrate that the procedure in FS 2213, section 4 was followed without deviation.	Only if allowed by permit, program, contract or order as samples should be collected into the container without intermediate devices.	Unless allowed by permit, program, contract or order.

• **ANALYTE GROUP(S)**	• **PURGING** (Not Recommended)	• **SAMPLING**	
	Use:	Use:	Not Recommended:
Biologicals Inorganic Non-Metallics Aggregate Organics Microbiological Physical and Aggregate Properties	If allowed by permit, program, contract or order or If operated by a skilled individual with documented training in proper techniques. Field documentation must demonstrate that the procedure in FS 2213, section 4 was followed without deviation.	If all analytes collected from the well can be collected with a bailer; or If collected <u>after</u> collecting all analytes that require the use of a pump.	Before collecting any analytes that must be collected with a pump.
Ultra-Trace Metals	Never	Never	

Figure 2200-1

Pump and Trap for Extractable Organics



The glass sample bottle must be threaded to use a reusable sampling cap lined and installed with fittings made of Teflon, polypropylene or polyethylene, similar to the design shown.

Scenario 1: WELL SCREEN COMPLETELY SUBMERGED

Option 1a: Minimal Purge Volume: Pump or tubing is placed within the middle of the screen interval. The following conditions must be met to use this option:

1. The well screen interval is ≤ 10 feet.
2. Although drawdown may occur in the well when purging is initiated, the drawdown has to stabilize (Aquifer Recovery Rate = Purge Rate).
3. The samples will be obtained with the same equipment that was used to purge the well. Therefore, centrifugal pumps and bailers are not suitable for use in Option 1a.

If one or more of these conditions do not apply, use Option 1b.

Option 1b: Conventional Purge: Pump, tubing, or bailer [1] is placed above the screen at the top of the water column.

[1] DEP does not recommend the use of a bailer for purging; however, if a bailer is used it shall be lowered and raised at the rate of 2 cm/sec in the top of the water column.

Scenario 2: WELL SCREEN PARTIALLY SUBMERGED

Option 2a: A bailer [1] is placed at the top of the water column and is used to purge and sample the well.

Option 2b: Pump or tubing is placed within the middle of the saturated portion of the screen interval.

If the pump or tubing that was used for purging will not be used to obtain the sample, then position the pump or tubing at the top of the water column for purging.

Purging Procedure #1

1. After the drawdown in the well stabilizes, purge at least one equipment volume then collect the first set of stabilization parameters.
2. Thereafter, collect stabilization parameters ≥ 2 to 3 minutes apart.
3. Purge at least three equipment volumes before sampling.

Purging Procedure #2

1. Purge at least one well volume then collect first set of stabilization parameters.
2. Thereafter, collect stabilization parameters ≥ every 1/4 well volume.

Purging Procedure #3

1. Purge at least one well volume then collect first set of stabilization parameters.
2. Thereafter, collect stabilization parameters ≥ 2 to 3 minutes apart.

Purging Completion

If Dissolved Oxygen is ≤ 20% of saturation for the measured temperature and Turbidity is ≤ 20 NTUs, then purging is complete when three consecutive readings of the parameters listed below are within the following ranges:

Temperature ± 0.2 °C
pH ± 0.2 Standard Units
Specific Conductance ± 5.0% of reading

If Dissolved Oxygen (DO) is > 20% of saturation for the measured temperature and/or Turbidity is > 20 NTUs after every attempt has been made to reduce DO and/or turbidity, then purging is complete when three consecutive readings of the parameters listed below are within the following ranges:

Temperature ± 0.2 °C
pH ± 0.2 Standard Units
Specific Conductance ± 5.0% of reading
Dissolved Oxygen ± 0.2 mg/L or readings are within 10% (whichever is greater).
Turbidity ± 5 NTUs or readings are within 10% (whichever is greater).

If the well is expected to purge dry, position the pump or tubing within the screened interval and purge at ≤ 100 mL/minute until two equipment volumes are removed. Use the same pump for purging and sampling.

If the well purges dry at the lowest achievable flow rate (pumping at 100 mL/minute or less), then after a sufficient amount of water recharges in the well, collect the samples.

In either case listed above, before samples are collected, measure (once) pH, temperature, specific conductance, dissolved oxygen, and turbidity.

If one or more parameters do not stabilize after 5 volumes of the screened interval (purging procedure #1) or 5 well volumes (purging procedure #s 2 & 3) are removed, purging may be discontinued at the discretion of the sampling team leader.

FS 4000. SEDIMENT SAMPLING

See also the following Standard Operating Procedures:

- FA 1000 Administrative
- FC 1000 Field Cleaning
- FD 1000 Documentation
- FM 1000 Field Mobilization
- FQ 1000 Quality Control
- FS 1000 General Sampling
- FS 7400 Benthic Macroinvertebate Sampling
- FT 1000 – 2000 Field Testing

1. INTRODUCTION AND SCOPE

Sediments occur in freshwater and marine environments such as streams/rivers, ponds/lakes, canals, ditches, wetlands, lagoons, and estuaries. Recently exposed sediment (due to low water levels) may also be sampled, but exposure to air could affect the characteristics of the sediment (for example, redox) and hence, the interpretation of the results of chemical or other analyses. The following methods are for physical, chemical, and toxicological sampling. See FS 7400 for benthic invertebrate sampling.

1.1. Select sampling locations for sediments depending upon the project objectives. Collect:

1.1.1. Sediment samples as an adjunct to surface water samples;

1.1.2. A series of sediment samples for compositing to determine water or sediment quality in a system;

1.1.3. Sediment samples above and below an outfall to document degradation due to a point source discharge; or

1.1.4. Sediment samples if stressed shore vegetation or visible surface water contamination is evident.

1.2. Decisions related to the selection of sampling locations will not be discussed in this document.

1.3. Collect, preserve and containerize surface water samples prior to collecting sediment samples (see FS 2100).

2. EQUIPMENT AND SUPPLIES

2.1. Refer to Table FS 4000-1 and FS 1000, Tables FS 1000-1, 1000-2 and 1000-3, for selection of sampling equipment and construction.

2.2. For information on the selection of appropriate sample containers, see FS 1000 Table FS 1000-6.

2.3. For information on cleaning requirements for sample containers, equipment and utensils, see FC 1000.

2.4. For information on documentation requirements, see FD 1000.

2.5. For information on preservation and holding time requirements, see FS 1000 Table FS 1000-6.

3. Sample Collection Protocols

Take sediment samples using one of three different types of equipment: scoops, corers and dredges or grab samplers.

3.1. Soil sampling equipment is generally not applicable to sediments because of the low cohesion of the medium.

3.2. When selecting the appropriate sampling equipment, consider sampling location (edge or middle of lagoon), depth of water and sediment, sediment grain size (fineness), water velocity and analytes of interest.

3.3. Direct collection with the appropriate sample container may be appropriate in very low water or where sediment is exposed.

3.4. Use dredges for hard or rocky substrates. They are heavy enough to use in high velocity streams.

3.5. Use coring devices in quiescent waters, unless water depth precludes effective sample collection.

3.6. Scoops or Similar Equipment

3.6.1. Scooping is generally most useful around the margin or shore of the water body or by wading in shallow waters.

3.6.1.1. Stand facing the direction of flow and approach the location from the downstream direction.

3.6.1.2. Take precautions not to disturb the bottom prior to scooping.

3.6.1.3. Scoop the sample in the upstream direction of flow.

3.6.2. For obtaining samples several feet from shore or from a boat, DEP recommends attaching the scoop to an extendible pole.

3.6.3. Transfer sample to the appropriate sample container(s), using a clean non-reactive utensil.

3.6.4. Label, preserve to 4°C with wet ice and complete field notes.

3.7. Corers

3.7.1. Coring devices can be easily fabricated from many materials. Although stainless steel, glass or Teflon must be used for sampling extractable organics, volatile organics and inorganics, aggregate organics, petroleum hydrocarbons and oil & grease, other inexpensive material (e.g., PVC, carbon steel, etc.) may be used for inorganic non-metallics and metals.

3.7.2. Some corers are simple “push tubes,” whereas other more sophisticated models may be finned, gravity driven devices.

3.7.3. A core may be useful for preserving the historical layering of sediments.

3.7.4. Upon descent, water displacement is minimal with core samplers, which minimizes the shock wave produced by other equipment such as dredges.

3.7.5. The corer is an acceptable choice for sampling fine sediments in static waters, especially those containing trace organics and metals.

3.7.6. Corer diameter, grain size and sample consistency will determine if the sample will remain in the corer upon withdrawal.

3.7.7. Sample washout can be a problem and there are several ways to reduce or prevent it.

3.7.7.1. Fit the leading edge of the corer with a nosepiece or core catcher that physically keeps the sample from slipping back out of the corer. The core catcher material must also be compatible with the analytes of interest.

3.7.7.2. A second option is fit the top or back end with a check valve which creates negative pressure on the back of the sample as it is being pulled from the substrate and prevents surface water from washing out the top portion of the sample.

3.7.8. Rotate the corer, if needed, as it is pushed into the sediment.

3.7.8.1. Rotate be around its axis (do not rock the coring device back and forth).

3.7.8.2. Rotation improves penetration and prevents compaction of the sample as it is pushed to the full length of the corer.

3.7.9. Upon withdrawal from the water surface, place a cap on the bottom to prevent the sample from sliding out.

3.7.10. Corers can also be fitted with liners. This is advantageous if a complete core is desired that has not been in contact with the atmosphere. It is also advantageous if the coring device is not constructed of the proper material (e.g., PVC) and one of the analytes requires a sampler of inert construction (glass, stainless steel or Teflon).

3.7.11. As the core is extruded, carefully remove the sample with a clean, non-reactive utensil and transfer into the appropriate sample container(s).

3.7.12. Label, preserve to 4°C with wet ice and complete field notes.

3.8. <u>Dredges or Grab Samplers</u>

3.8.1. The three main types of devices used in freshwater are the Ekman, Peterson and Ponar. Heavier oceanographic dredges are used in marine and estuarine waters.

3.8.2. Refer to Table FS 4000-1 for additional types of dredges. The Peterson and Ponar dredges are suitable for hard or rocky substrates or deep water bodies.

3.8.2.1. The Peterson and Ponar are virtually the same, except that the Ponar has been adapted with a top screen and side plates to prevent sample loss upon ascent. For this reason, the Ponar is the dredge of choice for rocky substrates. These dredges are heavy enough to use in streams with fast currents.

3.8.2.2. Open the jaws and place the cross bar into the proper notch.

3.8.2.3. Lower the dredge to the bottom, making sure it settles flat.

3.8.2.4. When tension is removed from the line, the cross bar will drop, enabling the dredge to close as the line is pulled upward during retrieval.

3.8.2.5. Pull the sampler to the surface. Check to make sure the jaws are fully closed and that no sample was lost while lifting the dredge.

3.8.2.6. Carefully open the jaws, remove the sample with a clean, non-reactive utensil and transfer the sample into the appropriate sample container(s), label, preserve to 4°C with wet ice and complete field notes.

3.8.3. The Ekman is designed for sampling soft substrates (e.g., sand, silt or mud) in areas with little current.

3.8.3.1. Open the spring-loaded jaws and attach the chains to the pegs at the top of the sampler.

3.8.3.2. Lower the dredge to the bottom, making sure it settles flat.

3.8.3.3. Holding the line taut and send down the messenger to close the jaws of the dredge.

3.8.3.4. Pull the sampler to the surface. Check to make sure the jaws are fully closed and that no sample was lost while lifting the dredge.

3.8.3.5. Carefully open the jaws, remove the sample with a clean, non-reactive utensil and transfer the sample into the appropriate sample container(s).

3.8.3.6. Label, preserve to 4°C with wet ice and complete field notes.

4. Procedures for Compositing

4.1. The following is not a complete discussion regarding all available sampling protocols nor the appropriateness or inappropriateness of compositing sediment samples. The appropriateness of compositing sediment samples will depend on the data quality objectives of the project. However, it is sometimes advantageous to composite sediment samples to minimize the number of samples to be analyzed when sampling highly contaminated areas. Obtain permission from the DEP program.

4.1.1. Select sampling points from which to collect each aliquot.

4.1.2. Using the appropriate sampling technique, collect equal aliquots (same sample size) from each location and place in a properly cleaned container.

4.1.3. **Combine the aliquots of the sample directly in the sample container with no pre-mixing**.

4.1.4. Record the amount of each aliquot (volume or weight).

4.1.5. Label container, preserve on wet ice to 4°C and complete field notes.

4.1.6. Notify the laboratory that the sample is an unmixed composite sample, and request that the sample be thoroughly mixed before sample preparation or analysis.

5. Collection of Interstitial or Pore Water Samples

5.1. ASTM identifies interstitial water or pore water as the “water occupying the space between sediment…particles.” It “is often isolated to provide either a matrix for toxicity testing or an indication of the concentration and partitioning of contaminants with a sediment matrix.” See American Society for Testing and Materials, Annual Book of ASTM Standards, Standard Guide for Collection, Storage, Characterization and Manipulation of Sediments for Toxicological Testing and for Selection of Samplers Used to Collect Benthic Invertebrates, Section E 1391-03, Volume 11-05. Collect pore water using available technology that will preserve the integrity of the analytes of interest during collection. Pore water may be extracted in the laboratory from field-collected sediments. Consult the detailed discussion in the ASTM guidance if pore water is to be extracted and analyzed as part of the sampling design. Use of pore water wells (e.g., shallow PVC wells) or pore water equilibrators (e.g., Plexiglas plates with built-in wells or other appropriate construction) is also acceptable.

5.2. Collect adequate amounts of sample in the field to obtain desired quantities of pore water for testing. Sandy sediments retain less water than fine sediments do; thus, the

substrate type will dictate the amount of additional sample needed. In all cases, consult the laboratory conducting the analyses to provide estimates of the amount of sediment necessary to obtain the desired quantity of pore water.

Appendix FS 4000

Tables, Figures and Forms

Table FS 4000-1: Summary of Bottom Sampling Equipment [from ASTM E 1391-94]

TABLE FS 4000-1 Summary of Bottom Sampling Equipment [from ASTM E 1391-94]

Device	Use	Advantages	Disadvantages
Teflon or glass tube	Shallow wadeable waters or deep waters if SCUBA available. Soft or semi-consolidated deposits.	Preserves layering and permits historical study of sediment deposition. Rapid - samples immediately ready for laboratory shipment. Minimal risk of contamination.	Small sample size requires repetitive sampling.
Hand corer with removable teflon or glass liners	Same as above except more consolidated sediments can be obtained.	Handles provide for greater ease of substrate penetration. Above advantages.	Careful handling necessary to prevent spillage. Requires removal of liners before repetitive sampling. Slight risk of metal contamination from barrel and core cutter.
Box corer	Same as above.	Collection of large sample undisturbed, allowing for subsampling.	Hard to handle.
Gravity corers, such as Phleger Corer	Deep lakes and rivers. Semi-consolidated sediments.	Low risk of sample contamination. Maintains sediment integrity relatively well.	Careful handling necessary to avoid sediment spillage. Small sample, require repetitive operation and removal of liners. Time consuming.
Young grab (Teflon or kynar-lined, modified 0.1-m^2 Van Veen)	Lakes and marine areas.	Eliminates metal contamination. Reduced bow wake.	Expensive. Requires winch.
Ekman or box dredge	Soft to semi-soft sediments. Can be used from boat, bridge, or pier in waters of various depths.	Obtains a larger sample than coring tubes. Can be subsampled through box lid.	Possible incomplete jaw closure and sample loss. Possible shock wave, which may disturb the "fines". Metal construction may introduce contaminants. Possible loss of "fines" on retrieval.
PONAR grab sampler Petite PONAR grab sampler	Deep lakes, rivers and estuaries. Useful on sand, silt, or clay.	Most universal grab sampler. Adequate on most substrates. Large sample obtained intact, permitting subsampling.	Shock wave from descent may disturb "fines." Possible incomplete closure of jaws results in sample loss. Possible contamination from metal frame construction. Sample must be further prepared for analysis.
BMH-53 piston corer	Waters of 4 to 6 ft deep when used with extension rod. Soft to semi-consolidated deposits.	Piston provides for greater sample retention.	Cores must be extruded on-site to other containers. Metal barrels introduce risk of metal contamination.
Van Veen dredge	Deep lakes, rivers and estuaries. Useful on sand, silt, or clay.	Adequate on most substrates. Large sample obtained intact, permitting subsampling.	Shock wave from descent may disturb "fines." Possible incomplete closure of jaws results in sample loss. Possible contamination from metal frame construction. Sample must be further prepared for analysis.
BMH-60 grab sampler	Sampling moving waters from a fixed platform.	Streamlined configuration allows sampling where other devices could not achieve proper orientation.	Possible contamination from metal construction. Subsampling difficult. Not effective for sampling fine sediments.
Petersen grab sampler	Deep lakes, rivers and estuaries. Useful on most substrates.	Large sample; can penetrate most substrates.	Heavy. May require winch. No cover lid to permit subsampling. All other disadvantages of Ekman and Ponar.
Shipek grab sampler	Used primarily in marine waters and large inland lakes and reservoirs.	Sample bucket may be opened to permit subsampling. Retains fine- grained sediments effectively.	Possible contamination from metal construction. Heavy. May require winch.
Orange-Peel grab Smith-McIntyre grab	Deep lakes, rivers and estuaries. Useful on most substrates.	Designed for sampling hard substrates.	Loss of fines. Heavy. May require winch. Possible metal contamination.
Scoops Drag Buckets	Various environments, depending on depth and substrate.	Inexpensive, easy to handle.	Loss of fines on retrieval through water column.

Appendix C
Laboratory Accreditation Certificates

Appendix C
Laboratory Accreditation Certificates

LABORATORY ACCREDITATION BUREAU

Certificate of Accreditation

ISO/IEC 17025:2005 ***Certificate Number L2226***

Empirical Laboratories, LLC

621 Mainstream Drive, Suite 270
Nashville, TN 37228

has met the requirements set forth in L-A-B's policies and procedures, all requirements of ISO/IEC 17025:2005 "General Requirements for the competence of Testing and Calibration Laboratories" and the U.S. Department of Defense Environmental Laboratory Accreditation Program (DoD ELAP).*

The accredited lab has demonstrated technical competence to a defined "Scope of Accreditation" and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated 8 January 2009).

Accreditation Granted through: November 30, 2012

R. Douglas Leonard, Jr., Managing Director
Laboratory Accreditation Bureau
Presented the 30th of November 2009

*See the laboratory's Scope of Accreditation for details of the DoD ELAP requirements
Laboratory Accreditation Bureau is found to be in compliance with ISO/IEC 17011:2004 and recognized by ILAC (International Laboratory Accreditation Cooperation) and NACLA (National Cooperation for Laboratory Accreditation).

Scope of Accreditation
For
Empirical Laboratories, LLC

621 Mainstream Drive, Suite 270
Nashville, TN 37228
Marcia K. McGinnity
877-345-1113

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM v4.1) based on the National Environmental Laboratory Accreditation Conference Chapter 5 Quality Systems Standard (NELAC Voted Revision June 5, 2003), accreditation is granted to Empirical Laboratories, LLC to perform the following tests:

Accreditation granted through: **November 30, 2012**

Testing - Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,1-Trichloroethane (1,1,1-TCA)
GC/MS	EPA 8260B	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)
GC/MS	EPA 8260B	1,1,2-Trichloroethane
GC/MS	EPA 8260B	1,1-Dichloroethane (1,1-DCA)
GC/MS	EPA 8260B	1,1-Dichloroethene (1,1-DCE)
GC/MS	EPA 8260B	1,1-Dichloropropene
GC/MS	EPA 8260B	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B	1,2,3-Trichloropropane
GC/MS	EPA 8260B	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 8260B	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260B	1,2-Dichlorobenzene
GC/MS	EPA 8260B	1,2-Dichloroethane (EDC)
GC/MS	EPA 8260B	1,2-Dichloropropane
GC/MS	EPA 8260B	1,3,5-Trimethylbenzene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B	1,3-Dichlorobenzene
GC/MS	EPA 8260B	1,3-Dichloropropane
GC/MS	EPA 8260B	1,4-Dichlorobenzene
GC/MS	EPA 8260B	1,4-Dioxane
GC/MS	EPA 8260B	1-Chlorohexane
GC/MS	EPA 8260B	2,2-Dichloropropane
GC/MS	EPA 8260B	2-Butanone (Methyl ethyl ketone; MEK)
GC/MS	EPA 8260B	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B	2-Chlorotoluene
GC/MS	EPA 8260B	2-Hexanone (Methyl butyl ketone; MBK)
GC/MS	EPA 8260B	4-Chlorotoluene
GC/MS	EPA 8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)
GC/MS	EPA 8260B	Acetone
GC/MS	EPA 8260B	Acetonirile
GC/MS	EPA 8260B	Acrolein
GC/MS	EPA 8260B	Acrylonitrile
GC/MS	EPA 8260B	Allyl chloride
GC/MS	EPA 8260B	Benzene
GC/MS	EPA 8260B	Bromobenzene
GC/MS	EPA 8260B	Bromochloromethane
GC/MS	EPA 8260B	Bromodichloromethane
GC/MS	EPA 8260B	Bromoform
GC/MS	EPA 8260B	Bromomethane
GC/MS	EPA 8260B	Carbon Disulfide
GC/MS	EPA 8260B	Carbon Tetrachloride
GC/MS	EPA 8260B	Chlorobenzene
GC/MS	EPA 8260B	Chloroethane
GC/MS	EPA 8260B	Chloroform
GC/MS	EPA 8260B	Chloromethane
GC/MS	EPA 8260B	Chloroprene
GC/MS	EPA 8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)
GC/MS	EPA 8260B	cis-1,3-Dichloropropene
GC/MS	EPA 8260B	cis-1,4-Dichloro-2-butene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B	Cyclohexane
GC/MS	EPA 8260B	Dibromochloromethane
GC/MS	EPA 8260B	Dibromomethane
GC/MS	EPA 8260B	Dichlorodifluoromethane (CFC-12)
GC/MS	EPA 8260B	Di-isopropyl ether
GC/MS	EPA 8260B	ETBE
GC/MS	EPA 8260B	Ethyl methacrylate
GC/MS	EPA 8260B	Ethylbenzene
GC/MS	EPA 8260B	Hexachlorobutadiene
GC/MS	EPA 8260B	Hexane
GC/MS	EPA 8260B	Iodomethane
GC/MS	EPA 8260B	Isobutyl alcohol
GC/MS	EPA 8260B	Isopropylbenzene (Cumene)
GC/MS	EPA 8260B	Methacrylonitrile
GC/MS	EPA 8260B	Methyl Acetate
GC/MS	EPA 8260B	Methyl methacrylate
GC/MS	EPA 8260B	Methyl Tertiary Butyl Ether (MTBE)
GC/MS	EPA 8260B	Methylcyclohexane
GC/MS	EPA 8260B	Methylene Chloride, or Dichloromethane
GC/MS	EPA 8260B	Naphthalene
GC/MS	EPA 8260B	n-Butylbenzene
GC/MS	EPA 8260B	n-Propylbenzene
GC/MS	EPA 8260B	p-Isopropyltoluene
GC/MS	EPA 8260B	Propionitrile
GC/MS	EPA 8260B	sec-Butylbenzene
GC/MS	EPA 8260B	Styrene
GC/MS	EPA 8260B	t-Butyl alcohol
GC/MS	EPA 8260B	tert-Amyl methyl ether
GC/MS	EPA 8260B	tert-Butylbenzene
GC/MS	EPA 8260B	Tetrachloroethene (PCE; PERC)
GC/MS	EPA 8260B	Tetrahydrofuran
GC/MS	EPA 8260B	Toluene
GC/MS	EPA 8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B	trans-1,3-Dichloropropene
GC/MS	EPA 8260B	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260B	Trichloroethene (TCE)
GC/MS	EPA 8260B	Trichlorofluoromethane (CFC-11)
GC/MS	EPA 8260B	Vinyl acetate
GC/MS	EPA 8260B	Vinyl Chloride (VC)
GC/MS	EPA 8260B	m,p-Xylenes
GC/MS	EPA 8260B	o-Xylene
GC/MS	EPA 8260B	Xylenes (Total)
GC/MS	EPA 8270C/D	1,1'-Biphenyl
GC/MS	EPA 8270C/D	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D	1,2,4-Trichlorobenzene
GC/MS	EPA 8270C/D	1,2-Dichlorobenzene
GC/MS	EPA 8270C/D	1,2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1,3-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dioxane
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D	2,4,6-Trichlorophenol (TCP)
GC/MS	EPA 8270C/D	2,4-Dichlorophenol (DCP)
GC/MS	EPA 8270C/D	2,4-Dimethylphenol
GC/MS	EPA 8270C/D	2,4-Dinitrophenol
GC/MS	EPA 8270C/D	2,4-Dinitrotoluene (DNT)
GC/MS	EPA 8270C/D	2,6-Dichlorophenol
GC/MS	EPA 8270C/D	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol (o-Cresol)
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 8270C/D	2-Nitrophenol (ONP)

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	3,3'-Dichlorobenzidine (DCB)
GC/MS	EPA 8270C/D	3-Methylphenol/4-Methylphenol
GC/MS	EPA 8270C/D	3-Methylphenol
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4,6-Dinitro-2-methylphenol (DNOC)
GC/MS	EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 8270C/D	4-Chlorophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Methylphenol (p-Cresol)
GC/MS	EPA 8270C/D	4-Nitroaniline (PNA)
GC/MS	EPA 8270C/D	4-Nitrophenol (PNP)
GC/MS	EPA 8270C/D	Acenaphthene
GC/MS	EPA 8270C/D	Acenaphthylene
GC/MS	EPA 8270C/D	Acetophenone
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 8270C/D	Benzidine
GC/MS	EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D	Benzoic Acid
GC/MS	EPA 8270C/D	Benzyl alcohol
GC/MS	EPA 8270C/D	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270C/D	bis(2-Chloroethyl)ether (BCEE)
GC/MS	EPA 8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)
GC/MS	EPA 8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)
GC/MS	EPA 8270C/D	Butyl benzyl phthalate (BBP)

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole
GC/MS	EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Dibenz(a,h)anthracene
GC/MS	EPA 8270C/D	Dibenzofuran (DBF)
GC/MS	EPA 8270C/D	Diethyl phthalate (DEP)
GC/MS	EPA 8270C/D	Dimethyl phthalate (DMP)
GC/MS	EPA 8270C/D	Di-n-butyl phthalate (DBP)
GC/MS	EPA 8270C/D	Di-n-octyl phthalate (DNOP)
GC/MS	EPA 8270C/D	Fluoranthene
GC/MS	EPA 8270C/D	Fluorene
GC/MS	EPA 8270C/D	Hexachlorobenzene (HCB)
GC/MS	EPA 8270C/D	Hexachlorobutadiene (HCBD)
GC/MS	EPA 8270C/D	Hexachlorocyclopentadiene (HCCPD)
GC/MS	EPA 8270C/D	Hexachloroethane (HCE)
GC/MS	EPA 8270C/D	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Naphthalene
GC/MS	EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	N-Nitrosodimethylamine
GC/MS	EPA 8270C/D	N-Nitroso-di-n-propylamine (NDPA)
GC/MS	EPA 8270C/D	N-nitrosodiphenylamine (NDPHA)
GC/MS	EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 8270C/D	Phenanthrene
GC/MS	EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/ECD	EPA 8081A/B	4,4'-DDD
GC/ECD	EPA 8081A/B	4,4'-DDE
GC/ECD	EPA 8081A/B	4,4'-DDT
GC/ECD	EPA 8081A/B	Aldrin
GC/ECD	EPA 8081A/B	alpha-BHC (alpha-HCH)
GC/ECD	EPA 8081A/B	alpha-Chlordane

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081A/B	beta-BHC (beta-HCH)
GC/ECD	EPA 8081A/B	delta-BHC (delta-HCH)
GC/ECD	EPA 8081A/B	Dieldrin
GC/ECD	EPA 8081A/B	Endosulfan I
GC/ECD	EPA 8081A/B	Endosulfan II
GC/ECD	EPA 8081A/B	Endosulfan sulfate
GC/ECD	EPA 8081A/B	Endrin
GC/ECD	EPA 8081A/B	Endrin aldehyde
GC/ECD	EPA 8081A/B	Endrin ketone
GC/ECD	EPA 8081A/B	gamma-BHC (Lindane; gamma-HCH)
GC/ECD	EPA 8081A/B	gamma-Chlordane
GC/ECD	EPA 8081A/B	Heptachlor
GC/ECD	EPA 8081A/B	Heptachlor epoxide
GC/ECD	EPA 8081A/B	Methoxychlor
GC/ECD	EPA 8081A/B	Chlordane
GC/ECD	EPA 8081A/B	Toxaphene
GC/ECD	EPA 8082 /A	Aroclor-1016
GC/ECD	EPA 8082 /A	Aroclor-1221
GC/ECD	EPA 8082 /A	Aroclor-1232
GC/ECD	EPA 8082 /A	Aroclor-1242
GC/ECD	EPA 8082 /A	Aroclor-1248
GC/ECD	EPA 8082 /A	Aroclor-1254
GC/ECD	EPA 8082 /A	Aroclor-1260
GC/ECD	EPA 8082 /A	Aroclor-1262
GC/ECD	EPA 8082 /A	Aroclor-1268
GC/ECD	EPA 8151A	2,4,5-T
GC/ECD	EPA 8151A	2,4,5-TP (Silvex)
GC/ECD	EPA 8151A	2,4-D
GC/ECD	EPA 8151A	2,4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichlorprop
GC/ECD	EPA 8151A	Dinoseb

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP (Mecoprop)
HPLC/UV	EPA 8330A/B	1,3,5-Trinitrobenzene
HPLC/UV	EPA 8330A/B	1,3-Dinitrobenzene
HPLC/UV	EPA 8330A/B	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	EPA 8330A/B	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	EPA 8330A/B	2,4-Dinitrotoluene (DNT)
HPLC/UV	EPA 8330A/B	2,6-Dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Amino-4,6-dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Nitrotoluene (ONT)
HPLC/UV	EPA 8330A/B	3,5-Dinitroaniline
HPLC/UV	EPA 8330A/B	3-Nitrotoluene
HPLC/UV	EPA 8330A/B	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330A/B	4-Nitrotoluene (PNT)
HPLC/UV	EPA 8330A/B	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	EPA 8330A/B	Nitrobenzene
HPLC/UV	EPA 8330A/B	Nitroglycerin
HPLC/UV	EPA 8330A/B	Nitroguanidine
HPLC/UV	EPA 8330A/B	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	EPA 8330A/B	3,5-Dinitroaniline
HPLC/UV	EPA 8330A/B	PETN
GC/FID	FLPRO	Petroleum Range Organics
GC/FID	EPA 8015B	TPH DRO
GC/FID	EPA 8015B	TPH GRO
GC/FID	RSK-175	Methane
GC/FID	RSK-175	Ethane
GC/FID	RSK-175	Ethene
GC/ECD	EPA 8011	1,2-Dibromoethane (EDB)
GC/ECD	EPA 8011	1,2-Dibromo-3-chloropropane (DBCP)
HPLC/MS	EPA 6850	Perchlorate
ICP	EPA 6010B/C	Aluminum
ICP	EPA 6010B/C	Antimony
ICP	EPA 6010B/C	Arsenic

Non-Potable Water		
Technology	**Method**	**Analyte**
ICP	EPA 6010B/C	Barium
ICP	EPA 6010B/C	Beryllium
ICP	EPA 6010B/C	Boron
ICP	EPA 6010B/C	Cadmium
ICP	EPA 6010B/C	Calcium
ICP	EPA 6010B/C	Chromium, total
ICP	EPA 6010B/C	Cobalt
ICP	EPA 6010B/C	Copper
ICP	EPA 6010B/C	Iron
ICP	EPA 6010B/C	Lead
ICP	EPA 6010B/C	Magnesium
ICP	EPA 6010B/C	Manganese
CVAA	EPA 7470A	Mercury
ICP	EPA 6010B/C	Molybdenum
ICP	EPA 6010B/C	Nickel
ICP	EPA 6010B/C	Potassium
ICP	EPA 6010B/C	Selenium
ICP	EPA 6010B/C	Silver
ICP	EPA 6010B/C	Sodium
ICP	EPA 6010B/C	Strontium
ICP	EPA 6010B/C	Thallium
ICP	EPA 6010B/C	Tin
ICP	EPA 6010B/C	Titanium
ICP	EPA 6010B/C	Vanadium
ICP	EPA 6010B/C	Zinc
IC	EPA 300.0	Bromide
IC	EPA 300.0	Chloride
IC	EPA 300.0	Fluoride
IC	EPA 300.0	Nitrate
IC	EPA 300.0	Nitrite
IC	EPA 300.0	Sulfate
IC	EPA 9056A	Bromide
IC	EPA 9056A	Chloride

Non-Potable Water		
Technology	**Method**	**Analyte**
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Nitrate
IC	EPA 9056A	Nitrite
IC	EPA 9056A	Sulfate
Titration	SM 2320B 20th/21st edition	Alkalinity
Colorimetric	SM 4500 B, G, 20th/21st edition	Ammonia
Probe	SM 5210B	BOD
Colorimetric	EPA 410.4	COD
UV/Vis	EPA 7196A	Hexavalent Chromium
Colorimetric	EPA 353.2	Nitrocellulose
Colorimetric	EPA 353.2	Nitrate/Nitrite
Gravimetric	EPA 1664A	O&G
Titration	Chap.7, Sect. 7.3.4 Mod.	Reactive Sulfide
Titration	SM 4500 S-2CF, 20th/21st edition	Sulfide
UV/Vis	SM 4500 P B5, E, 20th/21st edition	Total Phosphorus (as P)
UV/Vis	SM 4500 PE, 20th/21st edition	Ortho-Phosphate (as P)
TOC	9060A/SM5310C, 20th/21st edition	Total Organic Carbon
Gravimetric	SM 2540C, 20th/21st edition	TDS
Gravimetric	SM 2540D, 20th/21st edition	TSS
Colorimetric	EPA 9012A/B	Cyanide
Physical	EPA 1010A	Ignitability
Physical	EPA 9095B	Paint Filter
Probe	EPA 9040B/C	pH
Preparation	**Method**	**Type**
Preparation	EPA 1311	TCLP
Preparation	EPA 3005A	Metals digestion
Preparation	EPA 3010A	Metals digestion
Preparation	EPA 3510C	Organics Liquid Extraction
Preparation	EPA 5030A/B	Purge and Trap Water

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B	1,1,1-Trichloroethane (1,1,1-TCA)
GC/MS	EPA 8260B	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B	1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)
GC/MS	EPA 8260B	1,1,2-Trichloroethane
GC/MS	EPA 8260B	1,1-Dichloroethane (1,1-DCA)
GC/MS	EPA 8260B	1,1-Dichloroethene (1,1-DCE)
GC/MS	EPA 8260B	1,1-Dichloropropene
GC/MS	EPA 8260B	1,2,3-Trichlorobenzene
GC/MS	EPA 8260B	1,2,3-Trichloropropane
GC/MS	EPA 8260B	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B	1,2-Dibromo-3-chloropropane (DBCP)
GC/MS	EPA 8260B	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260B	1,2-Dichlorobenzene
GC/MS	EPA 8260B	1,2-Dichloroethane (EDC)
GC/MS	EPA 8260B	1,2-Dichloropropane
GC/MS	EPA 8260B	1,3,5-Trimethylbenzene
GC/MS	EPA 8260B	1,3-Dichlorobenzene
GC/MS	EPA 8260B	1,3-Dichloropropane
GC/MS	EPA 8260B	1,4-Dichlorobenzene
GC/MS	EPA 8260B	1,4-Dioxane
GC/MS	EPA 8260B	2,2-Dichloropropane
GC/MS	EPA 8260B	2-Butanone (Methyl ethyl ketone; MEK)
GC/MS	EPA 8260B	2-Chlorotoluene
GC/MS	EPA 8260B	2-Hexanone (Methyl butyl ketone; MBK)
GC/MS	EPA 8260B	4-Chlorotoluene
GC/MS	EPA 8260B	4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)
GC/MS	EPA 8260B	Acetone
GC/MS	EPA 8260B	Acetonitrile
GC/MS	EPA 8260B	Acrolein
GC/MS	EPA 8260B	Acrylonitrile

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B	Allyl chloride
GC/MS	EPA 8260B	Benzene
GC/MS	EPA 8260B	Bromobenzene
GC/MS	EPA 8260B	Bromochloromethane
GC/MS	EPA 8260B	Bromodichloromethane
GC/MS	EPA 8260B	Bromoform
GC/MS	EPA 8260B	Bromomethane
GC/MS	EPA 8260B	Carbon Disulfide
GC/MS	EPA 8260B	Carbon Tetrachloride
GC/MS	EPA 8260B	Chlorobenzene
GC/MS	EPA 8260B	Chloroethane
GC/MS	EPA 8260B	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B	Chloroform
GC/MS	EPA 8260B	Chloromethane
GC/MS	EPA 8260B	Chloroprene
GC/MS	EPA 8260B	cis-1,2-Dichloroethene (cis-1,2-DCE)
GC/MS	EPA 8260B	cis-1,3-Dichloropropene
GC/MS	EPA 8260B	cis-1,4-Dichloro-2-butene
GC/MS	EPA 8260B	Cyclohexane
GC/MS	EPA 8260B	Dibromochloromethane
GC/MS	EPA 8260B	Dibromomethane
GC/MS	EPA 8260B	Dichlorodifluoromethane (CFC-12)
GC/MS	EPA 8260B	Ethyl methacrylate
GC/MS	EPA 8260B	Ethylbenzene
GC/MS	EPA 8260B	Hexachlorobutadiene
GC/MS	EPA 8260B	Hexane
GC/MS	EPA 8260B	Iodomethane
GC/MS	EPA 8260B	Isobutyl alcohol
GC/MS	EPA 8260B	Isopropylbenzene (Cumene)
GC/MS	EPA 8260B	Methacrylonitrile
GC/MS	EPA 8260B	Methyl Acetate
GC/MS	EPA 8260B	Methyl methacrylate

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B	Methyl Tertiary Butyl Ether (MTBE)
GC/MS	EPA 8260B	Methylcyclohexane
GC/MS	EPA 8260B	Methylene Chloride, or Dichloromethane
GC/MS	EPA 8260B	Naphthalene
GC/MS	EPA 8260B	n-Butylbenzene
GC/MS	EPA 8260B	n-Propylbenzene
GC/MS	EPA 8260B	p-Isopropyltoluene
GC/MS	EPA 8260B	Propionitrile
GC/MS	EPA 8260B	sec-Butylbenzene
GC/MS	EPA 8260B	Styrene
GC/MS	EPA 8260B	tert-Butylbenzene
GC/MS	EPA 8260B	Tetrachloroethene (PCE; PERC)
GC/MS	EPA 8260B	Toluene
GC/MS	EPA 8260B	trans-1,2-Dichloroethene (trans-1,2-DCE)
GC/MS	EPA 8260B	trans-1,3-Dichloropropene
GC/MS	EPA 8260B	trans-1,4-Dichloro-2-butene
GC/MS	EPA 8260B	Trichloroethene (TCE)
GC/MS	EPA 8260B	Trichlorofluoromethane (CFC-11)
GC/MS	EPA 8260B	Vinyl acetate
GC/MS	EPA 8260B	Vinyl Chloride (VC)
GC/MS	EPA 8260B	m,p-Xylenes
GC/MS	EPA 8260B	o-Xylene
GC/MS	EPA 8260B	Xylenes (Total)
GC/MS	EPA 8270C/D	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)
GC/MS	EPA 8270C/D	1,1'-Biphenyl
GC/MS	EPA 8270C/D	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D	1,2,4-Trichlorobenzene
GC/MS	EPA 8270C/D	1,2-Dichlorobenzene
GC/MS	EPA 8270C/D	1,2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1,3-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dichlorobenzene
GC/MS	EPA 8270C/D	1,4-Dioxane

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D	2,4,6-Trichlorophenol (TCP)
GC/MS	EPA 8270C/D	2,4-Dichlorophenol (DCP)
GC/MS	EPA 8270C/D	2,4-Dimethylphenol
GC/MS	EPA 8270C/D	2,4-Dinitrophenol
GC/MS	EPA 8270C/D	2,4-Dinitrotoluene (DNT)
GC/MS	EPA 8270C/D	2,6-Dichlorophenol
GC/MS	EPA 8270C/D	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol (o-Cresol)
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 8270C/D	2-Nitrophenol (ONP)
GC/MS	EPA 8270C/D	3,3'-Dichlorobenzidine (DCB)
GC/MS	EPA 8270C/D	3-Methylphenol/4-Methylphenol
GC/MS	EPA 8270C/D	3-Methylphenol
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4,6-Dinitro-2-methylphenol (DNOC)
GC/MS	EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 8270C/D	4-Chlorophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Methylphenol (p-Cresol)
GC/MS	EPA 8270C/D	4-Nitroaniline (PNA)
GC/MS	EPA 8270C/D	4-Nitrophenol (PNP)
GC/MS	EPA 8270C/D	Acenaphthene
GC/MS	EPA 8270C/D	Acenaphthylene
GC/MS	EPA 8270C/D	Acetophenone
GC/MS	EPA 8270C/D	Aniline

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 8270C/D	Benzidine
GC/MS	EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D	Benzoic Acid
GC/MS	EPA 8270C/D	Benzyl alcohol
GC/MS	EPA 8270C/D	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270C/D	bis(2-Chloroethyl)ether (BCEE)
GC/MS	EPA 8270C/D	bis(2-Ethylhexyl)phthalate (BEHP)
GC/MS	EPA 8270C/D	Butyl benzyl phthalate (BBP)
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole
GC/MS	EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Dibenz(a,h)anthracene
GC/MS	EPA 8270C/D	Dibenzofuran (DBF)
GC/MS	EPA 8270C/D	Diethyl phthalate (DEP)
GC/MS	EPA 8270C/D	Dimethyl phthalate (DMP)
GC/MS	EPA 8270C/D	Di-n-butyl phthalate (DBP)
GC/MS	EPA 8270C/D	Di-n-octyl phthalate (DNOP)
GC/MS	EPA 8270C/D	Fluoranthene
GC/MS	EPA 8270C/D	Fluorene
GC/MS	EPA 8270C/D	Hexachlorobenzene (HCB)
GC/MS	EPA 8270C/D	Hexachlorobutadiene (HCBD)
GC/MS	EPA 8270C/D	Hexachlorocyclopentadiene (HCCPD)
GC/MS	EPA 8270C/D	Hexachloroethane (HCE)
GC/MS	EPA 8270C/D	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D	Isophorone

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Naphthalene
GC/MS	EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	N-Nitrosodimethylamine
GC/MS	EPA 8270C/D	N-Nitroso-di-n-propylamine (NDPA)
GC/MS	EPA 8270C/D	N-nitrosodiphenylamine (NDPHA)
GC/MS	EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 8270C/D	Phenanthrene
GC/MS	EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/ECD	EPA 8081A/B	4,4'-DDD
GC/ECD	EPA 8081A/B	4,4'-DDE
GC/ECD	EPA 8081A/B	4,4'-DDT
GC/ECD	EPA 8081A/B	Aldrin
GC/ECD	EPA 8081A/B	alpha-BHC (alpha-HCH)
GC/ECD	EPA 8081A/B	alpha-Chlordane
GC/ECD	EPA 8081A/B	beta-BHC (beta-HCH)
GC/ECD	EPA 8081A/B	delta-BHC (delta-HCH)
GC/ECD	EPA 8081A/B	Chlordane
GC/ECD	EPA 8081A/B	Dieldrin
GC/ECD	EPA 8081A/B	Endosulfan I
GC/ECD	EPA 8081A/B	Endosulfan II
GC/ECD	EPA 8081A/B	Endosulfan sulfate
GC/ECD	EPA 8081A/B	Endrin
GC/ECD	EPA 8081A/B	Endrin aldehyde
GC/ECD	EPA 8081A/B	Endrin ketone
GC/ECD	EPA 8081A/B	gamma-BHC (Lindane; gamma-HCH)
GC/ECD	EPA 8081A/B	gamma-Chlordane
GC/ECD	EPA 8081A/B	Heptachlor
GC/ECD	EPA 8081A/B	Heptachlor epoxide
GC/ECD	EPA 8081A/B	Methoxychlor
GC/ECD	EPA 8081A/B	Toxaphene

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8082 /A	Aroclor-1016
GC/ECD	EPA 8082 /A	Aroclor-1221
GC/ECD	EPA 8082 /A	Aroclor-1232
GC/ECD	EPA 8082 /A	Aroclor-1242
GC/ECD	EPA 8082 /A	Aroclor-1248
GC/ECD	EPA 8082 /A	Aroclor-1254
GC/ECD	EPA 8082 /A	Aroclor-1260
GC/ECD	EPA 8082 /A	Aroclor-1262
GC/ECD	EPA 8082 /A	Aroclor-1268
HPLC/UV	EPA 8330A	1,3,5-Trinitrobenzene
HPLC/UV	EPA 8330A	1,3-Dinitrobenzene
HPLC/UV	EPA 8330A	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	EPA 8330A	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	EPA 8330A	2,4-Dinitrotoluene (DNT)
HPLC/UV	EPA 8330A	2,6-Dinitrotoluene
HPLC/UV	EPA 8330A	2-Amino-4,6-dinitrotoluene
HPLC/UV	EPA 8330A	2-Nitrotoluene (ONT)
HPLC/UV	EPA 8330A	3-Nitrotoluene
HPLC/UV	EPA 8330A	3,5-Dinitroaniline
HPLC/UV	EPA 8330A	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330A	4-Nitrotoluene (PNT)
HPLC/UV	EPA 8330A	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	EPA 8330A	Nitroglycerin
HPLC/UV	EPA 8330A	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	EPA 8330A	Nitrobenzene
HPLC/UV	EPA 8330A	Nitroguanidine
HPLC/UV	EPA 8330A	PETN
HPLC/UV	EPA 8330B	1,3,5-Trinitrobenzene
HPLC/UV	EPA 8330B	1,3-Dinitrobenzene
HPLC/UV	EPA 8330B	2,4,6-Trinitrophenylmethylnitramine (Tetryl)
HPLC/UV	EPA 8330B	2,4,6-Trinitrotoluene (TNT)
HPLC/UV	EPA 8330B	2,4-Dinitrotoluene (DNT)

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
HPLC/UV	EPA 8330B	2,6-Dinitrotoluene
HPLC/UV	EPA 8330B	2-Amino-4,6-dinitrotoluene
HPLC/UV	EPA 8330B	2-Nitrotoluene (ONT)
HPLC/UV	EPA 8330B	3-Nitrotoluene
HPLC/UV	EPA 8330B	3,5-Dinitroaniline
HPLC/UV	EPA 8330B	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330B	4-Nitrotoluene (PNT)
HPLC/UV	EPA 8330B	Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
HPLC/UV	EPA 8330B	Nitroglycerin
HPLC/UV	EPA 8330B	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
HPLC/UV	EPA 8330B	Nitrobenzene
HPLC/UV	EPA 8330B	Nitroguanidine
HPLC/UV	EPA 8330B	PETN
GC/FID	FLPRO	Petroleum Range Organics
GC/FID	EPA 8015B	TPH DRO
GC/FID	EPA 8015B	TPH GRO
HPLC/MS	EPA 6850	Perchlorate
ICP	EPA 6010B/C	Aluminum
ICP	EPA 6010B/C	Antimony
ICP	EPA 6010B/C	Arsenic
ICP	EPA 6010B/C	Barium
ICP	EPA 6010B/C	Beryllium
ICP	EPA 6010B/C	Boron
ICP	EPA 6010B/C	Cadmium
ICP	EPA 6010B/C	Calcium
ICP	EPA 6010B/C	Chromium, total
ICP	EPA 6010B/C	Cobalt
ICP	EPA 6010B/C	Copper
ICP	EPA 6010B/C	Iron
ICP	EPA 6010B/C	Lead
ICP	EPA 6010B/C	Magnesium
ICP	EPA 6010B/C	Manganese

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
CVAA	EPA 7471A/B	Mercury
ICP	EPA 6010B/C	Molybdenum
ICP	EPA 6010B/C	Nickel
ICP	EPA 6010B/C	Potassium
ICP	EPA 6010B/C	Selenium
ICP	EPA 6010B/C	Silver
ICP	EPA 6010B/C	Sodium
ICP	EPA 6010B/C	Strontium
ICP	EPA 6010B/C	Tin
ICP	EPA 6010B/C	Titanium
ICP	EPA 6010B/C	Thallium
ICP	EPA 6010B/C	Vanadium
ICP	EPA 6010B/C	Zinc
IC	EPA 9056A	Bromide
IC	EPA 9056A	Chloride
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Nitrate
IC	EPA 9056A	Nitrite
IC	EPA 9056A	Sulfate
UV/Vis	EPA 7196A	Hexavalent Chromium
TOC	Lloyd Kahn	Total Organic Carbon
Colorimetric	EPA 353.2	Nitrocellulose
Colorimetric	EPA 9012A/B	Cyanide
Titration	Chap.7, Sect. 7.3.4 Mod.	Reactive Sulfide
Titration	EPA 9034	Sulfide
Probe	EPA 9045C/D	pH
Preparation	**Method**	**Type**
Preparation	EPA 1311	TCLP
Preparation	EPA 1312	SPLP
Preparation	NJ Modified 3060A	Hexavalent Chromium
Preparation	EPA 3050B	Metals Digestion
Preparation	EPA 3546	Organics Microwave Extraction

LABORATORY ACCREDITATION BUREAU

Certificate # L2226

Solid and Chemical Materials		
Technology	**Method**	**Analyte**
Preparation	EPA 3550B/C	Organics Sonication
Preparation	SM 2540B 20th/21st edition	Percent Solids (Percent Moisture)
Preparation	EPA 5035 /A	Purge and Trap Solid

Notes:

1) This laboratory offers commercial testing service.

Approved By:_____ Date: February 27, 2012

R. Douglas Leonard
Chief Technical Officer

Issued: 11/30/09 Revised: 2/9/10 Revised: 3/31/10 Revised: 10/8/10 Revised: 1/25/11 Revised: 4/8/11
Revised: 2/27/12

FLORIDA DEPARTMENT OF
HEALTH

State of Florida
Department of Health, Bureau of Laboratories

This is to certify that

E87646

EMPIRICAL LABORATORIES, LLC.
621 MAINSTREAM DRIVE SUITE 270
NASHVILLE, TN 37228

has complied with Florida Administrative Code 64E-1,
for the examination of Environmental samples in the following categories

NON-POTABLE WATER - EXTRACTABLE ORGANICS, NON-POTABLE WATER - GENERAL CHEMISTRY, NON-POTABLE WATER - METALS, NON-POTABLE WATER - PESTICIDES-HERBICIDES-PCB'S, NON-POTABLE WATER - VOLATILE ORGANICS, SOLID AND CHEMICAL MATERIALS - EXTRACTABLE ORGANICS, SOLID AND CHEMICAL MATERIALS - PESTICIDES-HERBICIDES-PCB'S, SOLID AND CHEMICAL MATERIALS - GENERAL CHEMISTRY, SOLID AND CHEMICAL MATERIALS - METALS, SOLID AND CHEMICAL MATERIALS - VOLATILE ORGANICS

Continued certification is contingent upon successful on-going compliance with the NELAC Standards and FAC Rule 64E-1 regulations. Specific methods and analytes certified are cited on the Laboratory Scope of Accreditation for this laboratory and are on file at the Bureau of Laboratories, P. O. Box 210, Jacksonville, Florida 32231. Clients and customers are urged to verify with this agency the laboratory's certification status in Florida for particular methods and analytes.

Date Issued: July 01, 2012 Expiration Date: June 30, 2013

Max Salfinger, M.D.
Chief, Bureau of Laboratories
Florida Department of Health
DH Form 1697, 7/04
NON-TRANSFERABLE E87646-15-07/01/2012
Supersedes all previously issued certificates

Rick Scott
Governor

FLORIDA DEPARTMENT OF HEALTH

John H. Armstrong, MD
State Surgeon General

Laboratory Scope of Accreditation

Attachment to Certificate #: E87646-15, expiration date June 30, 2013. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E87646 **EPA Lab Code: TN00004** **(615) 345-1115**

E87646
Empirical Laboratories, LLC.
621 Mainstream Drive
Suite 270
Nashville, TN 37228

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
1,1,1,2-Tetrachloroethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,1,1-Trichloroethane	EPA 624	Volatile Organics	NELAP	4/6/2004
1,1,1-Trichloroethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,1,2,2-Tetrachloroethane	EPA 624	Volatile Organics	NELAP	4/6/2004
1,1,2,2-Tetrachloroethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	EPA 8260	Volatile Organics	NELAP	6/16/2011
1,1,2-Trichloroethane	EPA 624	Volatile Organics	NELAP	4/6/2004
1,1,2-Trichloroethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,1-Dichloroethane	EPA 624	Volatile Organics	NELAP	4/6/2004
1,1-Dichloroethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,1-Dichloroethylene	EPA 624	Volatile Organics	NELAP	4/6/2004
1,1-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,2,3-Trichlorobenzene	EPA 8260	Volatile Organics	NELAP	10/5/2006
1,2,3-Trichloropropane	EPA 8260	Volatile Organics	NELAP	10/5/2006
1,2,4,5-Tetrachlorobenzene	EPA 8270	Extractable Organics	NELAP	10/5/2006
1,2,4-Trichlorobenzene	EPA 625	Extractable Organics	NELAP	4/6/2004
1,2,4-Trichlorobenzene	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,2,4-Trichlorobenzene	EPA 8270	Extractable Organics	NELAP	4/6/2004
1,2,4-Trimethylbenzene	EPA 8260	Volatile Organics	NELAP	6/16/2011
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8011	Volatile Organics	NELAP	8/15/2007
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260	Volatile Organics	NELAP	10/5/2006
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 8011	Volatile Organics	NELAP	8/15/2007
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 8260	Volatile Organics	NELAP	10/5/2006
1,2-Dichlorobenzene	EPA 624	Volatile Organics	NELAP	4/6/2004
1,2-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,2-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	4/6/2004
1,2-Dichloroethane	EPA 624	Volatile Organics	NELAP	4/6/2004
1,2-Dichloroethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,2-Dichloropropane	EPA 624	Volatile Organics	NELAP	4/6/2004
1,2-Dichloropropane	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,3,5-Trimethylbenzene	EPA 8260	Volatile Organics	NELAP	6/16/2011
1,3,5-Trinitrobenzene (1,3,5-TNB)	EPA 8270	Extractable Organics	NELAP	10/5/2006
1,3,5-Trinitrobenzene (1,3,5-TNB)	EPA 8330	Extractable Organics	NELAP	4/6/2004
1,3-Dichlorobenzene	EPA 624	Volatile Organics	NELAP	4/6/2004
1,3-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	4/6/2004

Laboratory Scope of Accreditation

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State Laboratory ID: E87646 **EPA Lab Code: TN00004** **(615) 345-1115**

E87646
Empirical Laboratories, LLC.
621 Mainstream Drive
Suite 270
Nashville, TN 37228

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
1,3-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	4/6/2004
1,3-Dichloropropane	EPA 8260	Volatile Organics	NELAP	10/5/2006
1,3-Dinitrobenzene (1,3-DNB)	EPA 8330	Extractable Organics	NELAP	4/6/2004
1,4-Dichlorobenzene	EPA 624	Volatile Organics	NELAP	4/6/2004
1,4-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,4-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	4/6/2004
1,4-Dioxane (1,4-Diethyleneoxide)	EPA 8260	Volatile Organics	NELAP	10/5/2006
1-Methylnaphthalene	EPA 8270	Extractable Organics	NELAP	6/16/2011
2,3,4,6-Tetrachlorophenol	EPA 8270	Extractable Organics	NELAP	10/5/2006
2,4,5-T	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
2,4,5-Trichlorophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
2,4,6-Trichlorophenol	EPA 625	Extractable Organics	NELAP	4/6/2004
2,4,6-Trichlorophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
2,4,6-Trinitrotoluene (2,4,6-TNT)	EPA 8330	Extractable Organics	NELAP	4/6/2004
2,4-D	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
2,4-DB	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	6/16/2011
2,4-Dichlorophenol	EPA 625	Extractable Organics	NELAP	4/6/2004
2,4-Dichlorophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
2,4-Dimethylphenol	EPA 625	Extractable Organics	NELAP	4/6/2004
2,4-Dimethylphenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
2,4-Dinitrophenol	EPA 625	Extractable Organics	NELAP	4/6/2004
2,4-Dinitrophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
2,4-Dinitrotoluene (2,4-DNT)	EPA 625	Extractable Organics	NELAP	4/6/2004
2,4-Dinitrotoluene (2,4-DNT)	EPA 8270	Extractable Organics	NELAP	4/6/2004
2,4-Dinitrotoluene (2,4-DNT)	EPA 8330	Extractable Organics	NELAP	6/16/2011
2,6-Dichlorophenol	EPA 8270	Extractable Organics	NELAP	10/5/2006
2,6-Dinitrotoluene (2,6-DNT)	EPA 625	Extractable Organics	NELAP	4/6/2004
2,6-Dinitrotoluene (2,6-DNT)	EPA 8270	Extractable Organics	NELAP	4/6/2004
2,6-Dinitrotoluene (2,6-DNT)	EPA 8330	Extractable Organics	NELAP	6/16/2011
2-Amino-4,6-dinitrotoluene (2-am-dnt)	EPA 8330	Extractable Organics	NELAP	4/6/2004
2-Butanone (Methyl ethyl ketone, MEK)	EPA 8260	Volatile Organics	NELAP	4/6/2004
2-Chloroethyl vinyl ether	EPA 624	Volatile Organics	NELAP	4/6/2004
2-Chloroethyl vinyl ether	EPA 8260	Volatile Organics	NELAP	6/16/2011
2-Chloronaphthalene	EPA 625	Extractable Organics	NELAP	4/6/2004
2-Chloronaphthalene	EPA 8270	Extractable Organics	NELAP	4/6/2004

Laboratory Scope of Accreditation

Attachment to Certificate #: E87646-15, expiration date June 30, 2013. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E87646 **EPA Lab Code: TN00004** **(615) 345-1115**

E87646
Empirical Laboratories, LLC.
621 Mainstream Drive
Suite 270
Nashville, TN 37228

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
2-Chlorophenol	EPA 625	Extractable Organics	NELAP	4/6/2004
2-Chlorophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
2-Chlorotoluene	EPA 8260	Volatile Organics	NELAP	6/16/2011
2-Hexanone	EPA 8260	Volatile Organics	NELAP	4/6/2004
2-Methyl-4,6-dinitrophenol	EPA 625	Extractable Organics	NELAP	4/6/2004
2-Methyl-4,6-dinitrophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
2-Methylnaphthalene	EPA 8270	Extractable Organics	NELAP	4/6/2004
2-Methylphenol (o-Cresol)	EPA 8270	Extractable Organics	NELAP	4/6/2004
2-Nitroaniline	EPA 8270	Extractable Organics	NELAP	4/6/2004
2-Nitrophenol	EPA 625	Extractable Organics	NELAP	4/6/2004
2-Nitrophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
2-Nitrotoluene	EPA 8330	Extractable Organics	NELAP	4/6/2004
3,3'-Dichlorobenzidine	EPA 625	Extractable Organics	NELAP	4/6/2004
3,3'-Dichlorobenzidine	EPA 8270	Extractable Organics	NELAP	4/6/2004
3-Methylphenol (m-Cresol)	EPA 8270	Extractable Organics	NELAP	4/6/2004
3-Nitroaniline	EPA 8270	Extractable Organics	NELAP	4/6/2004
3-Nitrotoluene	EPA 8330	Extractable Organics	NELAP	4/6/2004
4,4'-DDD	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
4,4'-DDD	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
4,4'-DDE	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
4,4'-DDE	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
4,4'-DDT	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
4,4'-DDT	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
4-Amino-2,6-dinitrotoluene (4-am-dnt)	EPA 8330	Extractable Organics	NELAP	4/6/2004
4-Bromophenyl phenyl ether	EPA 625	Extractable Organics	NELAP	4/6/2004
4-Bromophenyl phenyl ether	EPA 8270	Extractable Organics	NELAP	4/6/2004
4-Chloro-3-methylphenol	EPA 625	Extractable Organics	NELAP	4/6/2004
4-Chloro-3-methylphenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
4-Chloroaniline	EPA 8270	Extractable Organics	NELAP	4/6/2004
4-Chlorophenyl phenylether	EPA 625	Extractable Organics	NELAP	4/6/2004
4-Chlorophenyl phenylether	EPA 8270	Extractable Organics	NELAP	4/6/2004
4-Chlorotoluene	EPA 8260	Volatile Organics	NELAP	6/16/2011
4-Methyl-2-pentanone (MIBK)	EPA 8260	Volatile Organics	NELAP	4/6/2004
4-Methylphenol (p-Cresol)	EPA 8270	Extractable Organics	NELAP	4/6/2004
4-Nitroaniline	EPA 8270	Extractable Organics	NELAP	4/6/2004

Laboratory Scope of Accreditation

Attachment to Certificate #: E87646-15, expiration date June 30, 2013. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E87646 **EPA Lab Code: TN00004** **(615) 345-1115**

E87646
Empirical Laboratories, LLC.
621 Mainstream Drive
Suite 270
Nashville, TN 37228

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
4-Nitrophenol	EPA 625	Extractable Organics	NELAP	4/6/2004
4-Nitrophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
4-Nitrotoluene	EPA 8330	Extractable Organics	NELAP	4/6/2004
Acenaphthene	EPA 625	Extractable Organics	NELAP	4/6/2004
Acenaphthene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Acenaphthylene	EPA 625	Extractable Organics	NELAP	4/6/2004
Acenaphthylene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Acetone	EPA 8260	Volatile Organics	NELAP	4/6/2004
Acetonitrile	EPA 8260	Volatile Organics	NELAP	10/5/2006
Acetophenone	EPA 8270	Extractable Organics	NELAP	10/5/2006
Acrolein (Propenal)	EPA 8260	Volatile Organics	NELAP	4/6/2004
Acrylonitrile	EPA 8260	Volatile Organics	NELAP	4/6/2004
Aldrin	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aldrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Alkalinity as CaCO3	SM 2320 B	General Chemistry	NELAP	3/4/2008
alpha-BHC (alpha-Hexachlorocyclohexane)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
alpha-BHC (alpha-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
alpha-Chlordane	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aluminum	EPA 200.7	Metals	NELAP	4/6/2004
Aluminum	EPA 6010	Metals	NELAP	4/6/2004
Amenable cyanide	SM 4500-CN G	General Chemistry	NELAP	3/4/2008
Ammonia as N	SM 4500-NH3 G	General Chemistry	NELAP	3/4/2008
Aniline	EPA 8270	Extractable Organics	NELAP	10/5/2006
Anthracene	EPA 625	Extractable Organics	NELAP	4/6/2004
Anthracene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Antimony	EPA 200.7	Metals	NELAP	4/6/2004
Antimony	EPA 6010	Metals	NELAP	4/6/2004
Aroclor-1016 (PCB-1016)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1016 (PCB-1016)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1221 (PCB-1221)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1221 (PCB-1221)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1232 (PCB-1232)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1232 (PCB-1232)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1242 (PCB-1242)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1242 (PCB-1242)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	4/6/2004

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Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Aroclor-1248 (PCB-1248)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1248 (PCB-1248)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1254 (PCB-1254)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1254 (PCB-1254)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1260 (PCB-1260)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1260 (PCB-1260)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Arsenic	EPA 200.7	Metals	NELAP	4/6/2004
Arsenic	EPA 6010	Metals	NELAP	4/6/2004
Atrazine	EPA 8270	Pesticides-Herbicides-PCB's	NELAP	6/16/2011
Barium	EPA 200.7	Metals	NELAP	4/6/2004
Barium	EPA 6010	Metals	NELAP	4/6/2004
Benzaldehyde	EPA 8270	Extractable Organics	NELAP	6/16/2011
Benzene	EPA 624	Volatile Organics	NELAP	4/6/2004
Benzene	EPA 8260	Volatile Organics	NELAP	4/6/2004
Benzidine	EPA 625	Extractable Organics	NELAP	4/6/2004
Benzo(a)anthracene	EPA 625	Extractable Organics	NELAP	4/6/2004
Benzo(a)anthracene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Benzo(a)pyrene	EPA 625	Extractable Organics	NELAP	4/6/2004
Benzo(a)pyrene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Benzo(b)fluoranthene	EPA 625	Extractable Organics	NELAP	4/6/2004
Benzo(b)fluoranthene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Benzo(g,h,i)perylene	EPA 625	Extractable Organics	NELAP	4/6/2004
Benzo(g,h,i)perylene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Benzo(k)fluoranthene	EPA 625	Extractable Organics	NELAP	4/6/2004
Benzo(k)fluoranthene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Benzyl alcohol	EPA 8270	Extractable Organics	NELAP	10/5/2006
Beryllium	EPA 200.7	Metals	NELAP	4/6/2004
Beryllium	EPA 6010	Metals	NELAP	4/6/2004
beta-BHC (beta-Hexachlorocyclohexane)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
beta-BHC (beta-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Biochemical oxygen demand	SM 5210 B	General Chemistry	NELAP	3/4/2008
Biphenyl	EPA 8270	Extractable Organics	NELAP	6/16/2011
bis(2-Chloroethoxy)methane	EPA 625	Extractable Organics	NELAP	4/6/2004
bis(2-Chloroethoxy)methane	EPA 8270	Extractable Organics	NELAP	4/6/2004
bis(2-Chloroethyl) ether	EPA 625	Extractable Organics	NELAP	4/6/2004

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Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
bis(2-Chloroethyl) ether	EPA 8270	Extractable Organics	NELAP	4/6/2004
bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane))	EPA 625	Extractable Organics	NELAP	4/6/2004
bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane))	EPA 8270	Extractable Organics	NELAP	4/6/2004
bis(2-Ethylhexyl) phthalate (DEHP)	EPA 625	Extractable Organics	NELAP	4/6/2004
bis(2-Ethylhexyl) phthalate (DEHP)	EPA 8270	Extractable Organics	NELAP	4/6/2004
Boron	EPA 6010	Metals	NELAP	6/16/2011
Bromobenzene	EPA 8260	Volatile Organics	NELAP	6/16/2011
Bromochloromethane	EPA 8260	Volatile Organics	NELAP	10/5/2006
Bromodichloromethane	EPA 624	Volatile Organics	NELAP	4/6/2004
Bromodichloromethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
Bromoform	EPA 624	Volatile Organics	NELAP	4/6/2004
Bromoform	EPA 8260	Volatile Organics	NELAP	4/6/2004
Butyl benzyl phthalate	EPA 625	Extractable Organics	NELAP	4/6/2004
Butyl benzyl phthalate	EPA 8270	Extractable Organics	NELAP	4/6/2004
Cadmium	EPA 200.7	Metals	NELAP	4/6/2004
Cadmium	EPA 6010	Metals	NELAP	4/6/2004
Calcium	EPA 6010	Metals	NELAP	4/6/2004
Caprolactam	EPA 8270	Extractable Organics	NELAP	6/16/2011
Carbazole	EPA 8270	Extractable Organics	NELAP	4/6/2004
Carbon disulfide	EPA 8260	Volatile Organics	NELAP	4/6/2004
Carbon tetrachloride	EPA 624	Volatile Organics	NELAP	4/6/2004
Carbon tetrachloride	EPA 8260	Volatile Organics	NELAP	4/6/2004
Carbonaceous BOD (CBOD)	SM 5210 B	General Chemistry	NELAP	6/16/2011
Chemical oxygen demand	EPA 410.4	General Chemistry	NELAP	4/6/2004
Chlordane (tech.)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Chlordane (tech.)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Chloride	EPA 300.0	General Chemistry	NELAP	4/6/2004
Chloride	EPA 9056	General Chemistry	NELAP	6/16/2011
Chlorobenzene	EPA 624	Volatile Organics	NELAP	4/6/2004
Chlorobenzene	EPA 8260	Volatile Organics	NELAP	4/6/2004
Chloroethane	EPA 624	Volatile Organics	NELAP	4/6/2004
Chloroethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
Chloroform	EPA 624	Volatile Organics	NELAP	4/6/2004
Chloroform	EPA 8260	Volatile Organics	NELAP	4/6/2004

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Empirical Laboratories, LLC.
621 Mainstream Drive
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Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Chromium	EPA 200.7	Metals	NELAP	4/6/2004
Chromium	EPA 6010	Metals	NELAP	4/6/2004
Chromium VI	EPA 7196	General Chemistry	NELAP	4/6/2004
Chromium VI	SM 3500-Cr D (18th/19th Ed.)/UV-VIS	General Chemistry	NELAP	4/6/2004
Chrysene	EPA 625	Extractable Organics	NELAP	4/6/2004
Chrysene	EPA 8270	Extractable Organics	NELAP	4/6/2004
cis-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	4/6/2004
cis-1,3-Dichloropropene	EPA 624	Volatile Organics	NELAP	4/6/2004
cis-1,3-Dichloropropene	EPA 8260	Volatile Organics	NELAP	4/6/2004
Cobalt	EPA 200.7	Metals	NELAP	4/6/2004
Cobalt	EPA 6010	Metals	NELAP	4/6/2004
Conductivity	EPA 120.1	General Chemistry	NELAP	4/6/2004
Copper	EPA 200.7	Metals	NELAP	4/6/2004
Copper	EPA 6010	Metals	NELAP	4/6/2004
Cyclohexane	EPA 8260	Volatile Organics	NELAP	6/16/2011
Dalapon	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
delta-BHC	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
delta-BHC	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Dibenz(a,h)anthracene	EPA 625	Extractable Organics	NELAP	4/6/2004
Dibenz(a,h)anthracene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Dibenzofuran	EPA 8270	Extractable Organics	NELAP	4/6/2004
Dibromochloromethane	EPA 624	Volatile Organics	NELAP	4/6/2004
Dibromochloromethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
Dibromomethane	EPA 8260	Volatile Organics	NELAP	10/5/2006
Dicamba	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Dichlorodifluoromethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
Dichloroprop (Dichlorprop)	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Dieldrin	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Dieldrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Diesel range organics (DRO)	EPA 8015	Extractable Organics	NELAP	4/6/2004
Diethyl phthalate	EPA 625	Extractable Organics	NELAP	4/6/2004
Diethyl phthalate	EPA 8270	Extractable Organics	NELAP	4/6/2004
Dimethyl phthalate	EPA 625	Extractable Organics	NELAP	4/6/2004
Dimethyl phthalate	EPA 8270	Extractable Organics	NELAP	4/6/2004
Di-n-butyl phthalate	EPA 625	Extractable Organics	NELAP	4/6/2004

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Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Di-n-butyl phthalate	EPA 8270	Extractable Organics	NELAP	4/6/2004
Di-n-octyl phthalate	EPA 625	Extractable Organics	NELAP	4/6/2004
Di-n-octyl phthalate	EPA 8270	Extractable Organics	NELAP	4/6/2004
Dinoseb (2-sec-butyl-4,6-dinitrophenol, DNBP)	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Endosulfan I	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Endosulfan I	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Endosulfan II	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Endosulfan II	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Endosulfan sulfate	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Endosulfan sulfate	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Endrin	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Endrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Endrin aldehyde	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Endrin aldehyde	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Endrin ketone	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Ethyl methacrylate	EPA 8260	Volatile Organics	NELAP	10/5/2006
Ethylbenzene	EPA 624	Volatile Organics	NELAP	4/6/2004
Ethylbenzene	EPA 8260	Volatile Organics	NELAP	4/6/2004
Fluoranthene	EPA 625	Extractable Organics	NELAP	4/6/2004
Fluoranthene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Fluorene	EPA 625	Extractable Organics	NELAP	4/6/2004
Fluorene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Fluoride	EPA 300.0	General Chemistry	NELAP	4/6/2004
Fluoride	EPA 9056	General Chemistry	NELAP	6/16/2011
gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
gamma-Chlordane	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Gasoline range organics (GRO)	EPA 8015	Volatile Organics	NELAP	4/6/2004
Hardness (calc.)	EPA 200.7	General Chemistry	NELAP	4/6/2004
Heptachlor	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Heptachlor	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Heptachlor epoxide	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Heptachlor epoxide	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Hexachlorobenzene	EPA 625	Extractable Organics	NELAP	4/6/2004

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Analyte	Method/Tech	Category	Certification Type	Effective Date
Hexachlorobenzene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Hexachlorobutadiene	EPA 625	Extractable Organics	NELAP	4/6/2004
Hexachlorobutadiene	EPA 8260	Volatile Organics	NELAP	4/6/2004
Hexachlorobutadiene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Hexachlorocyclopentadiene	EPA 625	Extractable Organics	NELAP	4/6/2004
Hexachlorocyclopentadiene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Hexachloroethane	EPA 625	Extractable Organics	NELAP	4/6/2004
Hexachloroethane	EPA 8270	Extractable Organics	NELAP	4/6/2004
Ignitability	EPA 1010	General Chemistry	NELAP	4/6/2004
Indeno(1,2,3-cd)pyrene	EPA 625	Extractable Organics	NELAP	4/6/2004
Indeno(1,2,3-cd)pyrene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Iodomethane (Methyl iodide)	EPA 8260	Volatile Organics	NELAP	10/5/2006
Iron	EPA 200.7	Metals	NELAP	4/6/2004
Iron	EPA 6010	Metals	NELAP	4/6/2004
Isobutyl alcohol (2-Methyl-1-propanol)	EPA 8260	Volatile Organics	NELAP	10/5/2006
Isophorone	EPA 625	Extractable Organics	NELAP	4/6/2004
Isophorone	EPA 8270	Extractable Organics	NELAP	4/6/2004
Isopropylbenzene	EPA 8260	Volatile Organics	NELAP	10/5/2006
Kjeldahl nitrogen - total	EPA 351.2	General Chemistry	NELAP	4/6/2004
Lead	EPA 200.7	Metals	NELAP	4/6/2004
Lead	EPA 6010	Metals	NELAP	4/6/2004
Magnesium	EPA 200.7	Metals	NELAP	4/6/2004
Magnesium	EPA 6010	Metals	NELAP	4/6/2004
Manganese	EPA 200.7	Metals	NELAP	4/6/2004
Manganese	EPA 6010	Metals	NELAP	4/6/2004
MCPA	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
MCPP	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Mercury	EPA 245.1	Metals	NELAP	4/6/2004
Mercury	EPA 7470	Metals	NELAP	6/16/2011
Methacrylonitrile	EPA 8260	Volatile Organics	NELAP	10/5/2006
Methoxychlor	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Methyl acetate	EPA 8260	Volatile Organics	NELAP	6/16/2011
Methyl bromide (Bromomethane)	EPA 624	Volatile Organics	NELAP	4/6/2004
Methyl bromide (Bromomethane)	EPA 8260	Volatile Organics	NELAP	4/6/2004
Methyl chloride (Chloromethane)	EPA 624	Volatile Organics	NELAP	4/6/2004

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Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Methyl chloride (Chloromethane)	EPA 8260	Volatile Organics	NELAP	4/6/2004
Methyl methacrylate	EPA 8260	Volatile Organics	NELAP	10/5/2006
Methyl tert-butyl ether (MTBE)	EPA 8260	Volatile Organics	NELAP	4/6/2004
Methylcyclohexane	EPA 8260	Volatile Organics	NELAP	6/16/2011
Methylene chloride	EPA 624	Volatile Organics	NELAP	4/6/2004
Methylene chloride	EPA 8260	Volatile Organics	NELAP	4/6/2004
Molybdenum	EPA 200.7	Metals	NELAP	4/6/2004
Molybdenum	EPA 6010	Metals	NELAP	4/6/2004
Naphthalene	EPA 625	Extractable Organics	NELAP	4/6/2004
Naphthalene	EPA 8260	Volatile Organics	NELAP	4/6/2004
Naphthalene	EPA 8270	Extractable Organics	NELAP	4/6/2004
n-Butylbenzene	EPA 8260	Volatile Organics	NELAP	6/16/2011
Nickel	EPA 200.7	Metals	NELAP	4/6/2004
Nickel	EPA 6010	Metals	NELAP	4/6/2004
Nitrate	EPA 9056	General Chemistry	NELAP	6/16/2011
Nitrate as N	EPA 300.0	General Chemistry	NELAP	4/6/2004
Nitrite	EPA 300.0	General Chemistry	NELAP	6/16/2011
Nitrite	EPA 9056	General Chemistry	NELAP	6/16/2011
Nitrite as N	SM 4500-NO2-B	General Chemistry	NELAP	6/16/2011
Nitrobenzene	EPA 625	Extractable Organics	NELAP	4/6/2004
Nitrobenzene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Nitrobenzene	EPA 8330	Extractable Organics	NELAP	6/16/2011
Nitroglycerin	EPA 8330	Extractable Organics	NELAP	6/16/2011
Nitroglycerin	EPA 8332	Extractable Organics	NELAP	6/16/2011
n-Nitrosodimethylamine	EPA 625	Extractable Organics	NELAP	4/6/2004
n-Nitrosodimethylamine	EPA 8270	Extractable Organics	NELAP	6/16/2011
n-Nitrosodi-n-propylamine	EPA 625	Extractable Organics	NELAP	4/6/2004
n-Nitrosodi-n-propylamine	EPA 8270	Extractable Organics	NELAP	4/6/2004
n-Nitrosodiphenylamine	EPA 625	Extractable Organics	NELAP	4/6/2004
n-Nitrosodiphenylamine	EPA 8270	Extractable Organics	NELAP	4/6/2004
n-Propylbenzene	EPA 8260	Volatile Organics	NELAP	6/16/2011
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	EPA 8330	Extractable Organics	NELAP	4/6/2004
Oil & Grease	EPA 1664A	General Chemistry	NELAP	4/6/2004
Orthophosphate as P	SM 4500-P E	General Chemistry	NELAP	3/4/2008
Pentachlorophenol	EPA 625	Extractable Organics	NELAP	4/6/2004

Laboratory Scope of Accreditation

Attachment to Certificate #: E87646-15, expiration date June 30, 2013. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E87646 **EPA Lab Code: TN00004** **(615) 345-1115**

E87646
Empirical Laboratories, LLC.
621 Mainstream Drive
Suite 270
Nashville, TN 37228

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Pentachlorophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
Pentaerythritoltetranitrate (PETN)	EPA 8330	Extractable Organics	NELAP	6/16/2011
pH	EPA 9040	General Chemistry	NELAP	4/6/2004
pH	SM 4500-H+-B	General Chemistry	NELAP	3/4/2008
Phenanthrene	EPA 625	Extractable Organics	NELAP	4/6/2004
Phenanthrene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Phenol	EPA 625	Extractable Organics	NELAP	4/6/2004
Phenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
Phosphorus, total	SM 4500-P E	General Chemistry	NELAP	3/4/2008
p-Isopropyltoluene	EPA 8260	Volatile Organics	NELAP	6/16/2011
Potassium	EPA 6010	Metals	NELAP	4/6/2004
Propionitrile (Ethyl cyanide)	EPA 8260	Volatile Organics	NELAP	10/5/2006
Pyrene	EPA 625	Extractable Organics	NELAP	4/6/2004
Pyrene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Pyridine	EPA 8270	Extractable Organics	NELAP	4/6/2004
RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)	EPA 8330	Extractable Organics	NELAP	4/6/2004
Residue-filterable (TDS)	SM 2540 C	General Chemistry	NELAP	3/4/2008
Residue-nonfilterable (TSS)	SM 2540 D	General Chemistry	NELAP	3/4/2008
Residue-total	SM 2540 B	General Chemistry	NELAP	3/4/2008
sec-Butylbenzene	EPA 8260	Volatile Organics	NELAP	6/16/2011
Selenium	EPA 200.7	Metals	NELAP	4/6/2004
Selenium	EPA 6010	Metals	NELAP	4/6/2004
Silver	EPA 200.7	Metals	NELAP	4/6/2004
Silver	EPA 6010	Metals	NELAP	4/6/2004
Silvex (2,4,5-TP)	EPA 8151	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Sodium	EPA 200.7	Metals	NELAP	4/6/2004
Sodium	EPA 6010	Metals	NELAP	4/6/2004
Styrene	EPA 8260	Volatile Organics	NELAP	4/6/2004
Sulfate	EPA 300.0	General Chemistry	NELAP	4/6/2004
Sulfate	EPA 9056	General Chemistry	NELAP	6/16/2011
Sulfide	SM 4500-S E (18th Ed.)/TITR	General Chemistry	NELAP	3/4/2008
tert-Butylbenzene	EPA 8260	Volatile Organics	NELAP	6/16/2011
Tetrachloroethylene (Perchloroethylene)	EPA 624	Volatile Organics	NELAP	4/6/2004
Tetrachloroethylene (Perchloroethylene)	EPA 8260	Volatile Organics	NELAP	4/6/2004
Tetryl (methyl-2,4,6-trinitrophenylnitramine)	EPA 8330	Extractable Organics	NELAP	4/6/2004

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E87646
Empirical Laboratories, LLC.
621 Mainstream Drive
Suite 270
Nashville, TN 37228

Matrix: Non-Potable Water

Analyte	Method/Tech	Category	Certification Type	Effective Date
Thallium	EPA 200.7	Metals	NELAP	4/6/2004
Thallium	EPA 6010	Metals	NELAP	4/6/2004
Tin	EPA 200.7	Metals	NELAP	4/6/2004
Tin	EPA 6010	Metals	NELAP	4/6/2004
Titanium	EPA 6010	Metals	NELAP	6/16/2011
Toluene	EPA 624	Volatile Organics	NELAP	4/6/2004
Toluene	EPA 8260	Volatile Organics	NELAP	4/6/2004
Total cyanide	EPA 9012	General Chemistry	NELAP	4/6/2004
Total nitrate-nitrite	EPA 353.2	General Chemistry	NELAP	4/6/2004
Total organic carbon	EPA 9060	General Chemistry	NELAP	7/29/2004
Total organic carbon	SM 5310 C	General Chemistry	NELAP	3/4/2008
Total Petroleum Hydrocarbons (TPH)	FL-PRO	Extractable Organics	NELAP	4/6/2004
Total phenolics	EPA 420.1	General Chemistry	NELAP	4/6/2004
Total phenolics	EPA 420.2	General Chemistry	NELAP	4/6/2004
Toxaphene (Chlorinated camphene)	EPA 608	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Toxaphene (Chlorinated camphene)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
trans-1,2-Dichloroethylene	EPA 624	Volatile Organics	NELAP	4/6/2004
trans-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	4/6/2004
trans-1,3-Dichloropropene	EPA 624	Volatile Organics	NELAP	4/6/2004
trans-1,3-Dichloropropene	EPA 8260	Volatile Organics	NELAP	6/16/2011
trans-1,4-Dichloro-2-butene	EPA 8260	Volatile Organics	NELAP	10/5/2006
Trichloroethene (Trichloroethylene)	EPA 624	Volatile Organics	NELAP	4/6/2004
Trichloroethene (Trichloroethylene)	EPA 8260	Volatile Organics	NELAP	4/6/2004
Trichlorofluoromethane	EPA 624	Volatile Organics	NELAP	4/6/2004
Trichlorofluoromethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
Turbidity	EPA 180.1	General Chemistry	NELAP	4/6/2004
Vanadium	EPA 200.7	Metals	NELAP	4/6/2004
Vanadium	EPA 6010	Metals	NELAP	4/6/2004
Vinyl acetate	EPA 8260	Volatile Organics	NELAP	10/5/2006
Vinyl chloride	EPA 624	Volatile Organics	NELAP	4/6/2004
Vinyl chloride	EPA 8260	Volatile Organics	NELAP	4/6/2004
Xylene (total)	EPA 624	Volatile Organics	NELAP	4/6/2004
Xylene (total)	EPA 8260	Volatile Organics	NELAP	4/6/2004
Zinc	EPA 200.7	Metals	NELAP	4/6/2004
Zinc	EPA 6010	Metals	NELAP	4/6/2004

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State Laboratory ID: E87646 **EPA Lab Code: TN00004** **(615) 345-1115**

E87646
Empirical Laboratories, LLC.
621 Mainstream Drive
Suite 270
Nashville, TN 37228

Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
1,1,1,2-Tetrachloroethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,1,1-Trichloroethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,1,2,2-Tetrachloroethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	EPA 8260	Volatile Organics	NELAP	6/16/2011
1,1,2-Trichloroethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,1-Dichloroethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,1-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,2,3-Trichlorobenzene	EPA 8260	Volatile Organics	NELAP	10/5/2006
1,2,3-Trichloropropane	EPA 8260	Volatile Organics	NELAP	10/5/2006
1,2,4,5-Tetrachlorobenzene	EPA 8270	Extractable Organics	NELAP	10/5/2006
1,2,4-Trichlorobenzene	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,2,4-Trichlorobenzene	EPA 8270	Extractable Organics	NELAP	4/6/2004
1,2,4-Trimethylbenzene	EPA 8260	Volatile Organics	NELAP	6/16/2011
1,2-Dibromo-3-chloropropane (DBCP)	EPA 8260	Volatile Organics	NELAP	10/5/2006
1,2-Dibromoethane (EDB, Ethylene dibromide)	EPA 8260	Volatile Organics	NELAP	10/5/2006
1,2-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,2-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	4/6/2004
1,2-Dichloroethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,2-Dichloropropane	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,3,5-Trimethylbenzene	EPA 8260	Volatile Organics	NELAP	6/16/2011
1,3,5-Trinitrobenzene (1,3,5-TNB)	EPA 8270	Extractable Organics	NELAP	10/5/2006
1,3,5-Trinitrobenzene (1,3,5-TNB)	EPA 8330	Extractable Organics	NELAP	4/6/2004
1,3-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,3-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	4/6/2004
1,3-Dichloropropane	EPA 8260	Volatile Organics	NELAP	10/5/2006
1,3-Dinitrobenzene (1,3-DNB)	EPA 8330	Extractable Organics	NELAP	4/6/2004
1,4-Dichlorobenzene	EPA 8260	Volatile Organics	NELAP	4/6/2004
1,4-Dichlorobenzene	EPA 8270	Extractable Organics	NELAP	4/6/2004
1,4-Dioxane (1,4-Diethyleneoxide)	EPA 8260	Volatile Organics	NELAP	10/5/2006
1-Methylnaphthalene	EPA 8270	Extractable Organics	NELAP	6/16/2011
2,3,4,6-Tetrachlorophenol	EPA 8270	Extractable Organics	NELAP	10/5/2006
2,4,5-Trichlorophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
2,4,6-Trichlorophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
2,4,6-Trinitrotoluene (2,4,6-TNT)	EPA 8330	Extractable Organics	NELAP	4/6/2004
2,4-Dichlorophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004

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State Laboratory ID: E87646 **EPA Lab Code: TN00004** **(615) 345-1115**

E87646
Empirical Laboratories, LLC.
621 Mainstream Drive
Suite 270
Nashville, TN 37228

Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
2,4-Dimethylphenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
2,4-Dinitrophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
2,4-Dinitrotoluene (2,4-DNT)	EPA 8270	Extractable Organics	NELAP	4/6/2004
2,4-Dinitrotoluene (2,4-DNT)	EPA 8330	Extractable Organics	NELAP	4/6/2004
2,6-Dichlorophenol	EPA 8270	Extractable Organics	NELAP	10/5/2006
2,6-Dinitrotoluene (2,6-DNT)	EPA 8270	Extractable Organics	NELAP	4/6/2004
2,6-Dinitrotoluene (2,6-DNT)	EPA 8330	Extractable Organics	NELAP	4/6/2004
2-Amino-4,6-dinitrotoluene (2-am-dnt)	EPA 8330	Extractable Organics	NELAP	4/6/2004
2-Butanone (Methyl ethyl ketone, MEK)	EPA 8260	Volatile Organics	NELAP	4/6/2004
2-Chloroethyl vinyl ether	EPA 8260	Volatile Organics	NELAP	6/16/2011
2-Chloronaphthalene	EPA 8270	Extractable Organics	NELAP	4/6/2004
2-Chlorophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
2-Chlorotoluene	EPA 8260	Volatile Organics	NELAP	6/16/2011
2-Hexanone	EPA 8260	Volatile Organics	NELAP	4/6/2004
2-Methyl-4,6-dinitrophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
2-Methylnaphthalene	EPA 8270	Extractable Organics	NELAP	4/6/2004
2-Methylphenol (o-Cresol)	EPA 8270	Extractable Organics	NELAP	4/6/2004
2-Nitroaniline	EPA 8270	Extractable Organics	NELAP	4/6/2004
2-Nitrophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
2-Nitrotoluene	EPA 8330	Extractable Organics	NELAP	4/6/2004
3,3'-Dichlorobenzidine	EPA 8270	Extractable Organics	NELAP	4/6/2004
3-Methylphenol (m-Cresol)	EPA 8270	Extractable Organics	NELAP	4/6/2004
3-Nitroaniline	EPA 8270	Extractable Organics	NELAP	4/6/2004
3-Nitrotoluene	EPA 8330	Extractable Organics	NELAP	4/6/2004
4,4'-DDD	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
4,4'-DDE	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
4,4'-DDT	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
4-Amino-2,6-dinitrotoluene (4-am-dnt)	EPA 8330	Extractable Organics	NELAP	4/6/2004
4-Bromophenyl phenyl ether	EPA 8270	Extractable Organics	NELAP	4/6/2004
4-Chloro-3-methylphenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
4-Chloroaniline	EPA 8270	Extractable Organics	NELAP	4/6/2004
4-Chlorophenyl phenylether	EPA 8270	Extractable Organics	NELAP	4/6/2004
4-Chlorotoluene	EPA 8260	Volatile Organics	NELAP	6/16/2011
4-Methyl-2-pentanone (MIBK)	EPA 8260	Volatile Organics	NELAP	4/6/2004
4-Methylphenol (p-Cresol)	EPA 8270	Extractable Organics	NELAP	4/6/2004

Laboratory Scope of Accreditation

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E87646
Empirical Laboratories, LLC.
621 Mainstream Drive
Suite 270
Nashville, TN 37228

Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
4-Nitroaniline	EPA 8270	Extractable Organics	NELAP	4/6/2004
4-Nitrophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
4-Nitrotoluene	EPA 8330	Extractable Organics	NELAP	4/6/2004
Acenaphthene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Acenaphthylene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Acetone	EPA 8260	Volatile Organics	NELAP	4/6/2004
Acetonitrile	EPA 8260	Volatile Organics	NELAP	10/5/2006
Acetophenone	EPA 8270	Extractable Organics	NELAP	10/5/2006
Acrolein (Propenal)	EPA 8260	Volatile Organics	NELAP	4/6/2004
Acrylonitrile	EPA 8260	Volatile Organics	NELAP	4/6/2004
Aldrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
alpha-BHC (alpha-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
alpha-Chlordane	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aluminum	EPA 6010	Metals	NELAP	4/6/2004
Aniline	EPA 8270	Extractable Organics	NELAP	10/5/2006
Anthracene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Antimony	EPA 6010	Metals	NELAP	4/6/2004
Aroclor-1016 (PCB-1016)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1221 (PCB-1221)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1232 (PCB-1232)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1242 (PCB-1242)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1248 (PCB-1248)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1254 (PCB-1254)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Aroclor-1260 (PCB-1260)	EPA 8082	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Arsenic	EPA 6010	Metals	NELAP	4/6/2004
Atrazine	EPA 8270	Extractable Organics	NELAP	6/16/2011
Barium	EPA 6010	Metals	NELAP	4/6/2004
Benzaldehyde	EPA 8270	Extractable Organics	NELAP	6/16/2011
Benzene	EPA 8260	Volatile Organics	NELAP	4/6/2004
Benzo(a)anthracene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Benzo(a)pyrene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Benzo(b)fluoranthene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Benzo(g,h,i)perylene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Benzo(k)fluoranthene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Benzyl alcohol	EPA 8270	Extractable Organics	NELAP	10/5/2006

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E87646
Empirical Laboratories, LLC.
621 Mainstream Drive
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Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
Beryllium	EPA 6010	Metals	NELAP	4/6/2004
beta-BHC (beta-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Biphenyl	EPA 8270	Extractable Organics	NELAP	6/16/2011
bis(2-Chloroethoxy)methane	EPA 8270	Extractable Organics	NELAP	4/6/2004
bis(2-Chloroethyl) ether	EPA 8270	Extractable Organics	NELAP	4/6/2004
bis(2-Chloroisopropyl) ether (2,2'-Oxybis(1-chloropropane))	EPA 8270	Extractable Organics	NELAP	4/6/2004
bis(2-Ethylhexyl) phthalate (DEHP)	EPA 8270	Extractable Organics	NELAP	4/6/2004
Bromobenzene	EPA 8260	Volatile Organics	NELAP	6/16/2011
Bromochloromethane	EPA 8260	Volatile Organics	NELAP	10/5/2006
Bromodichloromethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
Bromoform	EPA 8260	Volatile Organics	NELAP	4/6/2004
Butyl benzyl phthalate	EPA 8270	Extractable Organics	NELAP	4/6/2004
Cadmium	EPA 6010	Metals	NELAP	4/6/2004
Calcium	EPA 6010	Metals	NELAP	4/6/2004
Caprolactam	EPA 8270	Extractable Organics	NELAP	6/16/2011
Carbazole	EPA 8270	Extractable Organics	NELAP	4/6/2004
Carbon disulfide	EPA 8260	Volatile Organics	NELAP	4/6/2004
Carbon tetrachloride	EPA 8260	Volatile Organics	NELAP	4/6/2004
Chlordane (tech.)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Chloride	EPA 9056	General Chemistry	NELAP	4/6/2004
Chlorobenzene	EPA 8260	Volatile Organics	NELAP	4/6/2004
Chloroethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
Chloroform	EPA 8260	Volatile Organics	NELAP	4/6/2004
Chromium	EPA 6010	Metals	NELAP	4/6/2004
Chromium VI	EPA 7196	Metals,General Chemistry	NELAP	4/6/2004
Chrysene	EPA 8270	Extractable Organics	NELAP	4/6/2004
cis-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	4/6/2004
cis-1,3-Dichloropropene	EPA 8260	Volatile Organics	NELAP	4/6/2004
Cobalt	EPA 6010	Metals	NELAP	4/6/2004
Copper	EPA 6010	Metals	NELAP	4/6/2004
Cyclohexane	EPA 8260	Volatile Organics	NELAP	6/16/2011
delta-BHC	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Dibenz(a,h)anthracene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Dibenzofuran	EPA 8270	Extractable Organics	NELAP	4/6/2004
Dibromochloromethane	EPA 8260	Volatile Organics	NELAP	4/6/2004

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Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
Dibromomethane	EPA 8260	Volatile Organics	NELAP	10/5/2006
Dichlorodifluoromethane	EPA 8260	Volatile Organics	NELAP	4/6/2004
Dieldrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Diesel range organics (DRO)	EPA 8015	Extractable Organics	NELAP	4/6/2004
Diethyl phthalate	EPA 8270	Extractable Organics	NELAP	4/6/2004
Dimethyl phthalate	EPA 8270	Extractable Organics	NELAP	4/6/2004
Di-n-butyl phthalate	EPA 8270	Extractable Organics	NELAP	4/6/2004
Di-n-octyl phthalate	EPA 8270	Extractable Organics	NELAP	4/6/2004
Endosulfan I	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Endosulfan II	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Endosulfan sulfate	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Endrin	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Endrin aldehyde	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Endrin ketone	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Ethyl methacrylate	EPA 8260	Volatile Organics	NELAP	10/5/2006
Ethylbenzene	EPA 8260	Volatile Organics	NELAP	4/6/2004
Fluoranthene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Fluorene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Fluoride	EPA 9056	General Chemistry	NELAP	4/6/2004
gamma-BHC (Lindane, gamma-Hexachlorocyclohexane)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
gamma-Chlordane	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Gasoline range organics (GRO)	EPA 8015	Extractable Organics	NELAP	4/6/2004
Heptachlor	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Heptachlor epoxide	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Hexachlorobenzene	EPA 8270	Extractable Organics,Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Hexachlorobutadiene	EPA 8260	Volatile Organics	NELAP	4/6/2004
Hexachlorobutadiene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Hexachlorocyclopentadiene	EPA 8270	Extractable Organics,Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Hexachloroethane	EPA 8270	Extractable Organics	NELAP	4/6/2004
Ignitability	EPA 1010	General Chemistry	NELAP	4/6/2004
Indeno(1,2,3-cd)pyrene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Iodomethane (Methyl iodide)	EPA 8260	Volatile Organics	NELAP	10/5/2006
Iron	EPA 6010	Metals	NELAP	4/6/2004

Laboratory Scope of Accreditation

Attachment to Certificate #: E87646-15, expiration date June 30, 2013. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: E87646 **EPA Lab Code: TN00004** **(615) 345-1115**

E87646
Empirical Laboratories, LLC.
621 Mainstream Drive
Suite 270
Nashville, TN 37228

Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
Isobutyl alcohol (2-Methyl-1-propanol)	EPA 8260	Volatile Organics	NELAP	10/5/2006
Isophorone	EPA 8270	Extractable Organics	NELAP	4/6/2004
Isopropylbenzene	EPA 8260	Volatile Organics	NELAP	10/5/2006
Lead	EPA 6010	Metals	NELAP	4/6/2004
Magnesium	EPA 6010	Metals	NELAP	4/6/2004
Manganese	EPA 6010	Metals	NELAP	4/6/2004
Mercury	EPA 7471	Metals	NELAP	4/6/2004
Methacrylonitrile	EPA 8260	Volatile Organics	NELAP	10/5/2006
Methoxychlor	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Methyl acetate	EPA 8260	Volatile Organics	NELAP	6/16/2011
Methyl bromide (Bromomethane)	EPA 8260	Volatile Organics	NELAP	4/6/2004
Methyl chloride (Chloromethane)	EPA 8260	Volatile Organics	NELAP	4/6/2004
Methyl methacrylate	EPA 8260	Volatile Organics	NELAP	10/5/2006
Methyl tert-butyl ether (MTBE)	EPA 8260	Volatile Organics	NELAP	4/6/2004
Methylcyclohexane	EPA 8260	Volatile Organics	NELAP	6/16/2011
Methylene chloride	EPA 8260	Volatile Organics	NELAP	4/6/2004
Molybdenum	EPA 6010	Metals	NELAP	4/6/2004
Naphthalene	EPA 8260	Volatile Organics	NELAP	4/6/2004
Naphthalene	EPA 8270	Extractable Organics	NELAP	4/6/2004
n-Butylbenzene	EPA 8260	Volatile Organics	NELAP	6/16/2011
Nickel	EPA 6010	Metals	NELAP	4/6/2004
Nitrate	EPA 9056	General Chemistry	NELAP	4/6/2004
Nitrite	EPA 9056	General Chemistry	NELAP	6/16/2011
Nitrobenzene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Nitrobenzene	EPA 8330	Extractable Organics	NELAP	4/6/2004
Nitroglycerin	EPA 8330	Extractable Organics	NELAP	6/16/2011
Nitroglycerin	EPA 8332	Extractable Organics	NELAP	6/16/2011
n-Nitrosodimethylamine	EPA 8270	Extractable Organics	NELAP	6/16/2011
n-Nitrosodi-n-propylamine	EPA 8270	Extractable Organics	NELAP	4/6/2004
n-Nitrosodiphenylamine	EPA 8270	Extractable Organics	NELAP	4/6/2004
n-Propylbenzene	EPA 8260	Volatile Organics	NELAP	6/16/2011
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)	EPA 8330	Extractable Organics	NELAP	4/6/2004
Oil & Grease	EPA 1664A	General Chemistry	NELAP	6/16/2011
Paint Filter Liquids Test	EPA 9095	General Chemistry	NELAP	4/6/2004
Pentachlorophenol	EPA 8270	Extractable Organics	NELAP	4/6/2004

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State Laboratory ID: E87646 **EPA Lab Code: TN00004** **(615) 345-1115**

E87646
Empirical Laboratories, LLC.
621 Mainstream Drive
Suite 270
Nashville, TN 37228

Matrix: Solid and Chemical Materials

Analyte	Method/Tech	Category	Certification Type	Effective Date
Pentaerythritoltetranitrate (PETN)	EPA 8330	Extractable Organics	NELAP	6/16/2011
Perchlorate	EPA 6850	General Chemistry	NELAP	7/1/2009
pH	EPA 9040	General Chemistry	NELAP	4/6/2004
pH	EPA 9045	General Chemistry	NELAP	4/6/2004
Phenanthrene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Phenol	EPA 8270	Extractable Organics	NELAP	4/6/2004
p-Isopropyltoluene	EPA 8260	Volatile Organics	NELAP	6/16/2011
Potassium	EPA 6010	Metals	NELAP	4/6/2004
Propionitrile (Ethyl cyanide)	EPA 8260	Volatile Organics	NELAP	10/5/2006
Pyrene	EPA 8270	Extractable Organics	NELAP	4/6/2004
Pyridine	EPA 8270	Extractable Organics	NELAP	4/6/2004
RDX (hexahydro-1,3,5-trinitro-1,3,5-triazine)	EPA 8330	Extractable Organics	NELAP	4/6/2004
sec-Butylbenzene	EPA 8260	Volatile Organics	NELAP	6/16/2011
Selenium	EPA 6010	Metals	NELAP	4/6/2004
Silver	EPA 6010	Metals	NELAP	4/6/2004
Sodium	EPA 6010	Metals	NELAP	4/6/2004
Styrene	EPA 8260	Volatile Organics	NELAP	4/6/2004
Sulfate	EPA 9056	General Chemistry	NELAP	4/6/2004
Synthetic Precipitation Leaching Procedure	EPA 1312	General Chemistry	NELAP	4/6/2004
tert-Butylbenzene	EPA 8260	Volatile Organics	NELAP	6/16/2011
Tetrachloroethylene (Perchloroethylene)	EPA 8260	Volatile Organics	NELAP	4/6/2004
Tetryl (methyl-2,4,6-trinitrophenylnitramine)	EPA 8330	Extractable Organics	NELAP	4/6/2004
Thallium	EPA 6010	Metals	NELAP	4/6/2004
Tin	EPA 6010	Metals	NELAP	4/6/2004
Toluene	EPA 8260	Volatile Organics	NELAP	4/6/2004
Total cyanide	EPA 9012	General Chemistry	NELAP	4/6/2004
Total organic carbon	EPA 9060	General Chemistry	NELAP	7/29/2004
Total Petroleum Hydrocarbons (TPH)	FL-PRO	Extractable Organics	NELAP	4/6/2004
Toxaphene (Chlorinated camphene)	EPA 8081	Pesticides-Herbicides-PCB's	NELAP	4/6/2004
Toxicity Characteristic Leaching Procedure	EPA 1311	General Chemistry	NELAP	4/6/2004
trans-1,2-Dichloroethylene	EPA 8260	Volatile Organics	NELAP	4/6/2004
trans-1,3-Dichloropropene	EPA 8260	Volatile Organics	NELAP	4/6/2004
trans-1,4-Dichloro-2-butene	EPA 8260	Volatile Organics	NELAP	10/5/2006
Trichloroethene (Trichloroethylene)	EPA 8260	Volatile Organics	NELAP	4/6/2004
Trichlorofluoromethane	EPA 8260	Volatile Organics	NELAP	4/6/2004

Laboratory Scope of Accreditation

Attachment to Certificate #: E87646-15, expiration date June 30, 2013. This listing of accredited analytes should be used only when associated with a valid certificate.

State Laboratory ID: **E87646** **EPA Lab Code:** **TN00004** **(615) 345-1115**

E87646
Empirical Laboratories, LLC.
621 Mainstream Drive
Suite 270
Nashville, TN 37228

Matrix: **Solid and Chemical Materials**

Analyte	Method/Tech	Category	Certification Type	Effective Date
Vanadium	EPA 6010	Metals	NELAP	4/6/2004
Vinyl acetate	EPA 8260	Volatile Organics	NELAP	10/5/2006
Vinyl chloride	EPA 8260	Volatile Organics	NELAP	4/6/2004
Xylene (total)	EPA 8260	Volatile Organics	NELAP	4/6/2004
Zinc	EPA 6010	Metals	NELAP	4/6/2004

Appendix D
Laboratory Standard Operating Procedures

EMPIRICAL LABORATORIES, LLC
STANDARD OPERATING PROCEDURE

ORGANICS: SOP 202 **REVISION #: 24** **EFFECTIVE DATE: 20110913**

GC/MS VOLATILES BY EPA METHOD E624 & SW846 METHOD 8260B INCLUDING APPENDIX IX COMPOUNDS

APPROVALS:

Lab Director: _____ Date: 9.13.11

Data Quality Manager: _____ Date: 9-13-11

Section Supervisor: _____ Date: 9.13.11

Changes Summary

Revision 24, 09/13/11

- This SOP is an update from Revision 23 dated 09/09/10.
- Section 9 has been updated with column and concentrator information.
- Section 10 has been updated with current standards mixtures.
- Section 13.1 has been updated to reflect calibration curve for analytes and surrogates.
- References to QSM 4.1 have been updated to QSM 4.2.

Revision 23, 09/09/10

- This SOP is an update from Revision 22 dated 09/30/09.
- Tables 1 and 2 have been updated with appropriate reference updates.
- Tables 5-7 have been added.

Revision 22, 9/30/09

- The SOP is an update from Revision 21 dated 09/11/08
- The SOP is formatted to include all 22-elements required per the NELAC standards
- The laboratory's revision of all technical SOPs now includes a Table of Contents that provides the map of the technical information contained within the SOP.
- Additional requirements, based upon the DoD QSM 4.2, have been integrated into the routine sample flow; however, if the requirement is different from routine sample flow, then the requirement is outlined and documented as such to be followed only when DoD samples are analyzed.

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1. Identification of the Test Method

1.1 This SOP is compliant with methods – EPA Method 624 and SW-846 Method 8260B

2. Applicable Matrix or Matrices

2.1 This SOP is applicable to – The analysis of volatile organic compounds in a variety of matrices including but not limited to soils, sediments, ground and surface waters, aqueous sludge, oily wastes, etc.

3. Detection Limit: See **Table 1** of this SOP.

4. Scope of Application, Including components to be Analyzed

4.1 This SOP is based primarily on SW-846 Method 8260B. Methods SW-846 Method 8000B; *Federal Register* Method 624; and CLP Method for Volatiles have also been used in the development of this SOP. The analyses by these various methods are clearly defined in the respective regulatory manuals. A good understanding of these different methods is essential to the performance of each method. Each parameter that is analyzed and reported under the scope of this SOP is listed in **Table 1** of this SOP. When applicable, surrogate and Internal Standard Analytes are listed and indicated as such within this table.

5. Summary of the Test Method

5.1 After sample preparation, the sample is introduced into the GC/MS generally using purge and trap but sometimes using direct injection (see SW-846 Methods 5030B, 5035 and 3585 for preparation). In purge and trap, the analytes are stripped from the sample using helium and trapped on an adsorbent tube. The tube is heated while being backflushed with helium to carry the analytes to the GC/MS system. The analytes are separated in the gas chromatograph by a combination of the temperature program and the capillary column. The analytes are then detected by the mass spectrometer. Analytes are identified by comparing the mass spectra of known standards with the mass spectra of the sample. Analytes are quantitated relative to known standards using the internal standard method.

6. Definitions

6.1 Laboratory Quality System SOP QS08 **"**Technical / Operational Definitions, Minimum Essential Quality Control Elements, and Laboratory Calibration Procedures" provides information on the commonly used definitions.

7. Interferences

7.1 Section 3.0 of SW-846 Method 8260B details interferences and potential problems which may be encountered when dealing with volatile analyses.

8. Safety

8.1 Laboratory SOP QS13 “Safety Program & Chemical Hygiene Plan” discusses the safety program that is to be followed labwide.

9. Equipment & Supplies

9.1 GC : HP 5890 or 6890, temperature programmable, suitable for split or splitless injection.

9.2 Column: HP-VOC, 30 meter x 0.2 mm I.D. 1.12 µm film thickness silicon coated fused silica capillary column or equivalent.

9.3 M.S.: HP 5971, 5972 or 5973 capable of scanning 35 to 500 amu every one second or less, using 70 volts electron energy in electron impact ionization mode. The MS is capable of producing a mass spectrum for p-Bromofluorobenzene, BFB, which meets all tuning criteria for EPA methods [when 1 µL (50 ng) of the GC/MS tuning standard is introduced to the GC.]

9.4 Purge and Trap Unit

9.4.1 Concentrators: Tekmar/Dohrmann 3000/3100 Sample Concentrator equipped with Supelco trap number 2-4920-U VOCARB 3000, or equivalent, providing good delivery for all target compounds.

9.4.2 Autosamplers: Varian Archon 51 position programmable autosampler with 5ml to 25ml water and heated soil capability.

9.5 Acquisition Software: HP chemstation system interfaced to the GC/MS. The system acquires and stores data throughout the chromatographic programs.

9.6 Data Processing Software: TargetDB on Windows NT data system interfaced to the HP Chemstation. The system accepts and stores acquired data. It plots by extracted ion current profile (EICP). The system is also capable of integrating the abundances of any EICP between specified time or scan-number limits. NBS75K mass spectral library is installed.

9.7 Microsyringes – 1.0, 5.0,10, 25, 50, 100, 250, 500 and 1000 µL.

9.8 Syringes – 5, 25 and 50 mL, gas-tight with Luer end.

9.9 Balance - analytical, 0.0001 g; top-loading, 0.01 g.

9.10 Disposable pasteur pipets.

9.11 Volumetric flasks, Class A - 2 mL, 5 mL, 10 mL, 50 mL, 100 mL and 250 mL with ground-glass stoppers.

9.12 Spatula - stainless steel.

9.13 Glass scintillation vials - 20mL with screw caps.

9.14 Nitrile Gloves

9.15 pH paper (measures pH from 0-14).

10. Reagents and Standards

10.1 The laboratory's LIMS system allows for complete documentation and for the traceability of reagents and standards used within the laboratory. The following information relates to the specific reagents and standards used for the performance of the method:

10.2 Organic-free reagent water - obtained from the charcoal filter system in the VOA laboratory.

10.3 Methanol - Purge and trap grade (EM-Omnisolv EM-0482-6 or equivalent)

10.4 Methanol - suitable for use in gas chromatography (B&J Omnisolv MX0484- 1, or equivalent)

10.5 Sodium bisulfate, $NaHSO_4$ – ACS reagent grade, or equivalent. Available from Aldrich (Part No. 30,782-3).

10.6 Stock standards are purchased in mixtures from reputable vendors. The date they are received is noted on the label. The date they are opened is noted on the label and recorded in the LIMS system along with their lot number and vendor and given a sequential number. Each standard label is completed with the standard number, name, preparation date, expiration date, solvent and analyst initials. Stock standards, when opened, have an expiration date of 6 months, **except for gas standards for South Carolina samples which have a one week expiration date**. All stocks and standards are stored in the freezer at a temperature of -15°C $\pm$ 5°C or less from the date they are received/prepared. The freezer temperature is monitored daily with a calibrated thermometer (annual calibration for liquid in glass and quarterly calibration for digital) and recorded with calibration correction in the VOA refrigerator/freezer logbook. Minimum and maximum temperatures are recorded after weekends/holidays. Makeup of common standards is detailed below. See standard information in LIMS system for makeup of other standards.

10.6.1 The Bromofluorobenzene (BFB) tuning standard is prepared as follows: Using a 50µL syringe, 40µL of standard (BFB @ 2500ng/µL) is injected into a 2mL volumetric flask containing approximately 1.0mL P&T methanol (Vendor,Lot) and diluted to volume with same making a 50ng/µL standard. After capping and inverting 3 times, the solution is transferred to a labeled 2ml, teflon-lined, screw-capped vial and stored in the freezer at -15°C $\pm$ 5°C or less for up to 6 months **(1 week for South Carolina samples)**. A direct injection of 1µL (or equivalent purge) is used to tune the instrument.

10.6.2 The internal and surrogate standards are prepared as follows: Using the indicated syringe, the indicated amount of standard is injected into a 50 mL volumetric flask containing P&T methanol (Vendor,Lot) and diluted to volume with same making a 150ng/µL standard. After capping and inverting 3 times, the solution is transferred to the Archon standard vial and stored under helium for 1 month or less. Each 8260/624 sample is automatically injected with 1µL of this standard. (The internal standard/surrogate solution may be replaced if the –50%-200% criteria exceeds in the CCV when calculated against the midpoint of the ICAL or previous CCV.)

Standard	Conc. (ng/µL)	Syringe (µL)	Amount (µL)
8260 ISTD Mix	2500	1000	3000
Surr. Mix	2500	1000	3000

10.6.3 Calibration standards are prepared from the vendor stock standards at appropriate concentrations as follows. Occasionally unusual compounds are added to the mix so it is best to check the LIMS for exact standard makeup. Note: for laboratory control spikes (LCS), alternate sources or lot numbers from the main calibration standard are used to make the LCS standard.

10.6.3.1 Primary Standard: Using the indicated syringe, the indicated amount of standard is injected into a 2mL volumetric flask containing approximately 1.0mL P&T methanol (Vendor,Lot) and diluted to volume with same to make a 100-500ng/µL standard. After capping and inverting 3 times, the solution is transferred into 2ml amber vial w/mini-inert valve and stored in the freezer at -15°C ± 5°C for 1 week. A 100µg/L (5mL purge) standard is made using 50µL of this standard to 50mLof reagent water.

Stock Standard(CCV)	Conc (ng/µL)	Syringe(µL)	Amount(µL)	Final Conc (ng/µL)
Custom 2 Mix	2000-40000	250	200	200
Ketones Mix	5000	250	160	400
Liquid mix	2000	250	200	200
Custom mix	2000-10000	250	200	200
Gases **(cat#30042)**	2000	250	200	200
Oxygenates **(CC2098.10)**	2000-10000	250	200	200

Additional compounds may be added such as Appendix IX. Refer to standard ID in LIMS system.

10.6.4 ICV/LCS/Matrix Spike Mix: A second source standard is used to check the validity of the gas and primary calibration standards used in analyzing the calibration curve. Using the indicated syringe, the indicated amount of standard is injected into a 2mL volumetric flask containing approximately 1.0mL P&T methanol (Vendor,Lot) and diluted to volume with same to make a 100-500ng/µL standard. After capping and inverting 3 times, the solution is transferred into 2ml amber vial w/mini-inert valve and stored in the freezer at -15°C ± 5°C for 1 week. A 50µg/L ICV/LCS/Matrix Spike is made using 25µL of this standard to 50mL of reagent water/Sample Matrix.

Stock Standard(ICV/LCS)	Conc (ng/µL)	Syringe(µL)	Amount(µL)	Final Conc (ng/µL)
Custom 2 mix	2000-40000	100	100	100
Oxygenates	2000-10000	100	100	100
Ketones	5000	100	80	200
Liquid mix	2000	100	100	100
Custom Mix	2000-10000	100	100	100
Gases	2000	100	100	100

11. Sample Collection, Preservation, Shipment, and Storage

11.1 Quality Systems SOP QS10 related to Sample Receipt, Handling, & Processing provides details for collection, preservation, shipment, and storage.

11.2 All water samples are stored in the "True" refrigerator in the VOA lab at a temperature of 4°C. All unpreserved soil samples in TerraCore or encores are stored in the freezer in the VOA lab. All soil samples in bulk jars or chemically preserved TerraCore are stored in the soil walk-in refrigerator at a temperature of 4°C. Non-preserved water volatile samples have a holding time of 7 days from date of sampling. Preserved water samples and soil volatile samples have a holding time of 14 days from date of sampling (unless otherwise specified for the project). The temperature is monitored daily with a calibrated thermometer (annual calibration for liquid in glass and quarterly calibration for digital) and recorded with calibration correction in the VOA refrigerator/freezer logbook. The weekend temperature is monitored with a Min/Max thermometer and recorded upon arrival next business day.

12. Quality Control

12.1 Quality Systems SOP QS08 "Technical / Operational Definitions, Minimum Essential Quality Control Elements, and Laboratory Calibration Procedures" outlines details related to laboratory wide protocols on quality control.

12.1 Internal Standards - All samples and QC are spiked with internals. See **Table 2** for acceptance criteria and corrective action.

12.2 Surrogates - All samples and QC are spiked with surrogates. See **Table 2** of this SOP for acceptance criteria and corrective action.

12.3 LCS Sample - An LCS is analyzed every 12 hour tune. To prepare the LCS, a blank is spiked with standards prepared from an alternate vendor or lot number from the calibration standards. Note: the concentration of the LCS will be 20 µg/L when analyzing 624 samples (QC Check Sample). See **Table 2** of this SOP for acceptance criteria and corrective action. **When analyzing samples for South Carolina the limits are 70-130% except for poor purgers which are 60-140%.**

12.4 Method Blanks - A method blank is analyzed every 12 hour tune. See **Table 2** of this SOP for acceptance criteria and corrective action..

12.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Sample - 1 in 20 samples are spiked for an MS/MSD with the LCS standard. See **Table 2** of this SOP for acceptance criteria and corrective action. MS data evaluation must include the consideration of the following factors.

12.5.1 Sample matrix - If the sample is a soil, grab sample or sequentially collected water sample it may affect the %R and RPD of the MS/MSD. A water sample which was taken from the same VOA vial for the original sample and the MS/MSD should have very good RPDs unless there has been a method problem. Corrective action must be taken in the form of reanalysis if a method problem is indicated.

12.5.2 Original sample concentration - If a spiked compound has a problem and the concentration of that compound in the original sample was four or more times

the concentration of the spike, no further corrective action may be necessary other than the generation of a corrective action report to document the problem.

12.5.3 MS vs. MSD - If a spiked compound has a problem in both the MS and MSD, review the LCS and if acceptable no further action may be necessary since it is attributable to matrix effect.

12.5.4 Non-target Interference - The presence of significant non-target interference should be brought to the immediate attention of your supervisor who should discuss the problem with the client/project manager to determine the action to be taken.

13. Calibration and Standardization

13.1 Quality Systems **SOP QS08 "**Technical / Operational Definitions, Minimum Essential Quality Control Elements, and Laboratory Calibration Procedures" related to Calibration Procedures provides laboratory wide protocols for calibration and standardization.

13.2 Chromatographic conditions – Refer to corresponding instrument maintenance log for current gas chromatograph, mass spectrometer, and concentrator conditions.

13.3 System Bakeout - Prior to analysis an instrument blank is analyzed.

NOTE: Further cleaning may be accomplished by backflushing the lines with methanol and then analyzing blanks overnight.

13.4 Tuning - Prior to any calibration or analysis, BFB tuning criteria must be met for a 1.0µL injection of the tuning standard. See **Table 5** of this SOP for acceptance criteria. Tune must be met every 12 hours sample analysis is to be performed **(every 24 hours for *Federal Register* Method 624 except for South Carolina which only allows 12 hours).** The mass spectrum of BFB is acquired as follows: by using the BFB method in Target (which uses three scans with backround subtraction) to process the BFB data file. If the BFB tune does not pass criteria corrective action should be taken

13.5 **Calibration:** Calibration standards are made up in water using the appropriate amount of the methanol standard. See the LIMS for preparation of standards. **Calibration for soils for South Carolina requires that 5mL of sodium bisulfate solution is added to each calibration standard made if the samples will be preserved with sodium bisulfate.** All manual calibration integrations must be approved by the section manager or designated peer reviewer.

13.5.1 Initial Calibration - An initial calibration curve at no less than five (six if using a quadratic curve fit) concentration levels for analytes and surrogates must be analyzed and shown to meet the initial calibration criteria before any sample analysis may be performed. See **Table 2** of this SOP for acceptance criteria and corrective action. The lowest standard must be less than or equal to the reported quantitation limit and the highest standard must not exceed the linear range of the detector. Any manual integrations are documented by inclusion of the integrated signals (**before and after manual integration**)

initialed, dated, and reason with the quantitation report and chromatograms. All manual calibration integrations must be approved by the section manager or designated peer reviewer Any response factors less than 0.050 must be supported by the mass spectrum of the lowest standard. **No quadratic curves for South Carolina.**

CCCs:	1,1-Dichloroethene	Toluene
	Chloroform	Ethylbenzene
	1,2-Dichloropropane	Vinyl chloride

SPCCs:	Chloromethane	0.10
	1,1-Dichloroethane	0.10
	Bromoform	0.10
	Chlorobenzene	0.30
	1,1,2,2-Tetrachloroethane	0.30

13.5.2 Initial Calibration Verification (ICV) - A second source standard is prepared at or near the CCV concentration and calculated against the initial calibration curve, then shown to meet the calibration check criteria before any sample analysis may be performed. See **Table 2** of this SOP for acceptance criteria and corrective action. Any manual integrations are documented by inclusion of the integrated signals (**before and after manual integration**) initialed, dated, and reason with the quantitation report and chromatograms. All manual ICV integrations must be approved by the section manager or designated peer reviewer.

13.5.3 Continuing Calibration Verification (CCV) - A CCV is analyzed every 12 hour tune and calculated against the initial calibration curve, then shown to meet the calibration check criteria before any sample analysis may be performed. See **Table 2** of this SOP for acceptance criteria and corrective action. Any manual integrations are documented by inclusion of the integrated signals (**before and after manual integration**) initialed, dated, and reason with the quantitation report and chromatograms. All manual CCV integrations must be approved by the section manager or designated peer reviewer. **.**

NOTE: Acceptance criteria for method 624 consists of meeting recovery limits found in table 5 of the method for a QC check sample. This QC check sample is made from a separate source or lot number than the calibration standard at a concentration of 20 µg/L.

14. **Procedure**

14.1 LCS - An LCS is analyzed every 12 hour tune.Using standards prepared from an alternate vendor or lot number, blank water is spiked at the 50 µg/L (5mL/soil) or 10 µg/L (25mL) level. See **Table 2** of this SOP for acceptance criteria and corrective action. **Note: the concentration of the LCS will be 20 µg/L when analyzing 624 samples (QC Check Sample).**

14.2 Method Blank - Prior to sample analysis, the system must be shown to be free of contamination through analysis of a method blank. See **Table 2** of this SOP for acceptance criteria and corrective action.

14.3 Sample Analysis - Prior to analysis, the samples are prepared for chromatography using the appropriate sample preparation method (5mL water, 25mL water, low soil, high soil, etc.) See SOP 225 for preparation of a 5035 soil sample. For a 5mL/25mL water sample, use the following procedure:

14.3.1 Load the vial into the Archon autosampler in the expected position.

14.3.2 Program the Archon for the loaded vial range and necessary dilutions, making sure the programmed method is set for the same volume as the purge vessel on the front of the LSC 2000 or 3000/3100 and that the Chemstation sequence matches the Archon sequence. Note: TCLP samples are analyzed at a 10x dilution. One TCLP sample is spiked per batch at receipt of leachates.

14.3.3 After analysis of the sample has been completed, check the pH of the sample using pH paper and verify it to be less than a pH of 2 (recorded on the sequence log). If it is not, record the pH on the sequence log and generate a non-conformance report. The sample report will have to be qualified for preservation if the analysis is being performed more than 7 days after sampling. [Note: TCLP samples do not require a pH check.]

14.4 **Instrument sequence**

An example of a typical instrument sequence log follows:

1-BFB Tune (12:00 am)
2-CCV
3-LCS
4-Method Blank
5-Sample
6-Sample
7-Sample
8-Sample
9-Sample
10-Sample
11-Sample
12-Sample
13-Sample
14-Sample
15-Sample
16-Sample
17-Sample MS
18-Sample MSD
19-BFB (12:00pm - 12 hours since last BFB/CCV)
20-CCV
21-LCS
22-Method Blank
23-Sample
24-Sample

14.5 Data Reduction/Evaluation - Each sample analysis sequence is documented using the computer run log generated on the chemstation. This run log is signed, dated and paginated then placed in a 3 ring binder for that instrument. After the sample has

been analyzed, the data is processed through the TargetDB on Windows NT data system. Quantitative measurements are performed using the calculations found in section 15.2 of this SOP. The following must be checked to determine if the sample will need any reanalysis or dilution. See **Table 2** of this SOP for acceptance criteria and corrective action. Formal data evaluation is detailed in SOP QS05. **See SOP QS07 for guidance on manual integrations.**

14.5.1 Internal Standards - Areas counts and retention times.

14.5.2 Surrogates – Recoveries and retention times.
Federal Register **Method 624 contains no criteria for surrogate recovery.**

Surrogate	**WATER**	**SOIL**
Dibromofluoromethane	85-120	80-125
1,2-Dichloroethane-d4	85-135	75-140
Toluene-d8	85-115	80-120
Bromofluorobenzene	80-120	80-125

14.5.3 Analyte concentration.

14.5.4 Qualitative identification based on spectrum and retention time.

15. Data Analysis and Calculations

15.1 Quality Systems SOP QS09 "General and Commonly used Laboratory Calculations" provides details on general calculations used throughout the laboratory.

15.2 Calculations:

15.2.1 The RF is calculated as follows:

$$RF = \frac{A_s \times C_{is}}{A_{is} \times C_s}$$

where:
A_s = Peak area (or height) of the analyte or surrogate.
A_{is} = Peak area (or height) of the internal standard.
C_s = Concentration of the analyte or surrogate.
C_{is} = Concentration of the internal standard.

15.2.2 Calibration verification involves the calculation of the percent drift (linear) or the percent difference (average) of the instrument response between the initial calibration and each subsequent analysis of the verification standard. Use the equations below to calculate % Drift or % Difference, depending on the calibration procedure used.

$$\% \text{ Drift} = \frac{(\text{Calculated concentration} - \text{Theoretical concentration}) * 100}{\text{Theoretical Concentration}}$$

where the calculated concentration is determined from the initial calibration and the theoretical concentration is the concentration at which the standard was prepared.

$$\% \text{ Difference} = \frac{(\text{CCV RF} - \text{Average RF}) * 100}{\text{Average RF}}$$

where CCV RF is the response factor from the analysis of the verification standard and Average RF is the average response factor from the initial calibration. The % difference or % drift calculated for the calibration verification standard must be within ±20% for each CCC analyte, or for all target analytes if the CCCs are not target analytes, before any sample analyses may take place.

15.2.3 Concentration in water samples is calculated as follows: [Note: Using the units specified here for these terms will result in a concentration in units of ng/mL, which is equivalent to ug/L.]

$$\text{Concentration } (\mu\text{g/L}) = \frac{(A_s)(C_{is})(D)(V_i)}{(A_{is})(\overline{RF})(V_s)(1000)}$$

where:

A_s = Area (or height) of the peak for the analyte in the sample.

A_{is} = Area (or height) of the peak for the internal standard.

C_{is} = Concentration of the internal standard in the volume purged in ug/L.

D = Dilution factor, if the sample was diluted prior to analysis. If no dilution was made, D = 1. The dilution factor is always dimensionless.

V_i = For purge-and-trap analysis, V_i is not applicable and is set at 1.

$\overline{RF}$ = Mean response factor from the initial calibration.

V_s = Volume of the aqueous sample purged (mL). If units of liters are used for this term, multiply the results by 1000.

15.2.4 Concentration in non-aqueous samples is calculated as follows: [Note: Using the units specified here for these terms will result in a concentration in units of ng/g, which is equivalent to ug/kg.]

$$\text{Concentration } (\mu\text{g/kg}) = \frac{(A_s)(C_{is})(D)(V_i)}{(A_{is})(\overline{RF})(W_s)(1000)}$$

where: A_s, A_{is}, C_{is}, D, and $\overline{RF}$ are the same as for aqueous samples.

W_s = Weight of sample extracted (g). Either a dry weight or wet weight may be used, depending upon the specific application of the data. If units of kilograms are used for this term, multiply the results by 1000.

16. **Method Performance**

16.1 Demonstration of Capability (DOC): Each analyst must perform a DOC prior to reporting data. The analyst must prepare (for prep technicians) and analyze (analysts reviewing and reporting data) 4-LCS samples. The data is calculated for accuracy and precision requirements. The DOC form is completed by each analyst and then provided to the supervisor for further processing and approval. See **Table 2** for acceptance criteria.

17. **Pollution Prevention**

17.1 Quantity of chemicals purchased should be based on expected usage during its shelf-life and the disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

18. **Data Assessment and Acceptance Criteria for Quality Control Measures**

18.1 Quality Control SOP QS05, "Data Deviations / Interpretations / Exceptions: Laboratory Non-Conformance / Corrective Action Procedures, Decision Making Guidelines for Evaluating Laboratory Analytical Sample and Quality Control Results", provides details on data assessment and acceptance criteria for Quality Control Measures. **Table 2** of this SOP provides information on QC samples, frequency, and the associated criteria specific to the performance of this method.

19. **Contingencies for Handling out-of-control or unacceptable data**

19.1 Quality Control SOP QS05, "Data Deviations / Interpretations / Exceptions: Laboratory Non-Conformance / Corrective Action Procedures, Decision Making Guidelines for Evaluating Laboratory Analytical Sample and Quality Control Results", provides details on handling out of control data. Table 2 within this SOP also lists corrective actions associated with the failure of the various QC samples employed for the performance of this method.

20. **Waste Management.**

20.1 Laboratory SOP QS14 on Waste Handling discusses general guidelines for the appropriate handling of wastes and the laboratory program on waste management.

21. **References**

21.1 40 CFR, Part 136; Appendix A
21.2 Test Methods for Evaluating Solid Waste, SW-846, Third Edition and updates
21.3 National Environmental Laboratory Accreditation Conference; CH. 5, 2001
21.4 USACE, EM 200-1-3; Appendix 1; Shell, 2/2001
21.5 DOD Quality Systems Manual for Environmental Laboratories version 3, 3/2005
21.6 DOD Quality Systems Manual for Environmental Laboratories version 4.1, 4/2009
21.7 DOD Quality Systems Manual for Environmental Laboratories version 4.2, 10/2010

22. Tables, Diagrams, Flowcharts and Validation Data

22.1 Table 1, all applicable parameters with the applicable DL(MDL)/LOD/LOQ(MRL).
22.2 Table 2, QA/QC summary table
22.3 Table 3, Technical Completeness / Accuracy Checklist
22.4 Table 4, Data Reviewers Checklist(s)
22.5 Table 5, BFB Tuning Criteria
22.6 Table 6, Analyst Checklist
22.7 Table 7, INTERNAL STANDARD ASSOCIATION

Table 1 – DL/LOD/LOQ

Analyte	MDL/DL	LOD	MRL/LOQ	Units
1,1,1,2-Tetrachloroethane	1.25	2.50	5.00	ug/Kg
1,1,1-Trichloroethane (1,1,1-TCA)	1.25	2.50	5.00	ug/Kg
1,1,2,2-Tetrachloroethane	1.25	2.50	5.00	ug/Kg
1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)	2.50	5.00	10.0	ug/Kg
1,1,2-Trichloroethane	1.25	2.50	5.00	ug/Kg
1,1-Dichloroethane (1,1-DCA)	1.25	2.50	5.00	ug/Kg
1,1-Dichloroethene (1,1-DCE)	1.25	2.50	5.00	ug/Kg
1,1-Dichloropropene	1.25	2.50	5.00	ug/Kg
1,2,3-Trichlorobenzene	1.25	2.50	5.00	ug/Kg
1,2,3-Trichloropropane	1.25	2.50	5.00	ug/Kg
1,2,4-Trichlorobenzene	1.25	2.50	5.00	ug/Kg
1,2,4-Trimethylbenzene	1.25	2.50	5.00	ug/Kg
1,2-Dibromo-3-chloropropane (DBCP)	2.50	5.00	10.0	ug/Kg
1,2-Dibromoethane (EDB)	1.25	2.50	5.00	ug/Kg
1,2-Dichlorobenzene	1.25	2.50	5.00	ug/Kg
1,2-Dichloroethane (EDC)	1.25	2.50	5.00	ug/Kg
1,2-Dichloropropane	1.25	2.50	5.00	ug/Kg
1,3,5-Trimethylbenzene	1.25	2.50	5.00	ug/Kg
1,3-Dichlorobenzene	1.25	2.50	5.00	ug/Kg
1,3-Dichloropropane	1.25	2.50	5.00	ug/Kg
1,4-Dichlorobenzene	1.25	2.50	5.00	ug/Kg
2,2-Dichloropropane	1.25	2.50	5.00	ug/Kg
2-Butanone (Methyl ethyl ketone; MEK)	2.50	5.00	10.0	ug/Kg
2-Chlorotoluene	1.25	2.50	5.00	ug/Kg
2-Hexanone (Methyl butyl ketone; MBK)	1.25	2.50	5.00	ug/Kg
4-Chlorotoluene	1.25	2.50	5.00	ug/Kg
4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)	1.25	2.50	5.00	ug/Kg
Acetone	5.00	10.0	20.0	ug/Kg
Acrolein	5.00	10.0	20.0	ug/Kg
Acrylonitrile	5.00	10.0	20.0	ug/Kg
Benzene	1.25	2.50	5.00	ug/Kg
Bromobenzene	1.25	2.50	5.00	ug/Kg
Bromochloromethane	1.25	2.50	5.00	ug/Kg
Bromodichloromethane	1.25	2.50	5.00	ug/Kg
Bromoform	1.25	2.50	5.00	ug/Kg
Bromomethane	2.50	5.00	10.0	ug/Kg
Carbon Disulfide	1.25	2.50	5.00	ug/Kg
Carbon Tetrachloride	1.25	2.50	5.00	ug/Kg
Chlorobenzene	1.25	2.50	5.00	ug/Kg
Chloroethane	2.50	5.00	10.0	ug/Kg
Chloroform	1.25	2.50	5.00	ug/Kg
Chloromethane	2.50	5.00	10.0	ug/Kg
cis-1,2-Dichloroethene (cis-1,2-DCE)	1.25	2.50	5.00	ug/Kg
cis-1,3-Dichloropropene	1.25	2.50	5.00	ug/Kg
Cyclohexane	1.25	2.50	5.00	ug/Kg
Dibromochloromethane	1.25	2.50	5.00	ug/Kg
Dibromomethane	1.25	2.50	5.00	ug/Kg
Dichlorodifluoromethane (CFC-12)	2.50	5.00	10.0	ug/Kg
Ethyl methacrylate	1.25	2.50	5.00	ug/Kg
Ethylbenzene	1.25	2.50	5.00	ug/Kg
Hexachlorobutadiene	1.25	2.50	5.00	ug/Kg
Iodomethane	5.00	10.0	20.0	ug/Kg
Isopropylbenzene (Cumene)	1.25	2.50	5.00	ug/Kg
Methyl Acetate	2.50	5.00	10.0	ug/Kg
Methyl methacrylate	1.25	2.50	5.00	ug/Kg
Methyl Tertiary Butyl Ether (MTBE)	1.25	2.50	5.00	ug/Kg
Methylcyclohexane	1.25	2.50	5.00	ug/Kg
Methylene Chloride, or Dichloromethane	2.50	5.00	10.0	ug/Kg

Analyte	MDL/DL	LOD	MRL/LOQ	Units
Naphthalene	1.25	2.50	5.00	ug/Kg
n-Butylbenzene	1.25	2.50	5.00	ug/Kg
n-Propylbenzene	1.25	2.50	5.00	ug/Kg
p-Isopropyltoluene	1.25	2.50	5.00	ug/Kg
sec-Butylbenzene	1.25	2.50	5.00	ug/Kg
Styrene	1.25	2.50	5.00	ug/Kg
tert-Butylbenzene	1.25	2.50	5.00	ug/Kg
Tetrachloroethene (PCE; PERC)	1.25	2.50	5.00	ug/Kg
Toluene	1.25	2.50	5.00	ug/Kg
trans-1,2-Dichloroethene (trans-1,2-DCE)	1.25	2.50	5.00	ug/Kg
trans-1,3-Dichloropropene	1.25	2.50	5.00	ug/Kg
Trichloroethene (TCE)	1.25	2.50	5.00	ug/Kg
Trichlorofluoromethane (CFC-11)	2.50	5.00	10.0	ug/Kg
Vinyl acetate	2.50	5.00	10.0	ug/Kg
Vinyl Chloride (VC)	2.50	5.00	10.0	ug/Kg
m,p-Xylene	2.50	5.00	10.0	ug/Kg
o-Xylene	1.25	2.50	5.00	ug/Kg
1,1,1,2-Tetrachloroethane	0.25	0.50	1.00	ug/L
1,1,1-Trichloroethane (1,1,1-TCA)	0.25	0.50	1.00	ug/L
1,1,2,2-Tetrachloroethane	0.25	0.50	1.00	ug/L
1,1,2-Trichloro-1,2,2-trifluoroethane (CFC-113; Freon 113)	0.50	1.00	2.00	ug/L
1,1,2-Trichloroethane	0.25	0.50	1.00	ug/L
1,1-Dichloroethane (1,1-DCA)	0.25	0.50	1.00	ug/L
1,1-Dichloroethene (1,1-DCE)	0.25	0.50	1.00	ug/L
1,1-Dichloropropene	0.25	0.50	1.00	ug/L
1,2,3-Trichlorobenzene	0.25	0.50	1.00	ug/L
1,2,3-Trichloropropane	0.50	1.00	2.00	ug/L
1,2,4-Trichlorobenzene	0.25	0.50	1.00	ug/L
1,2,4-Trimethylbenzene	0.25	0.50	1.00	ug/L
1,2-Dibromo-3-chloropropane (DBCP)	0.50	1.00	2.00	ug/L
1,2-Dibromoethane (EDB)	0.25	0.50	1.00	ug/L
1,2-Dichlorobenzene	0.25	0.50	1.00	ug/L
1,2-Dichloroethane (EDC)	0.25	0.50	1.00	ug/L
1,2-Dichloropropane	0.25	0.50	1.00	ug/L
1,3,5-Trimethylbenzene	0.25	0.50	1.00	ug/L
1,3-Dichlorobenzene	0.25	0.50	1.00	ug/L
1,3-Dichloropropane	0.25	0.50	1.00	ug/L
1,4-Dichlorobenzene	0.25	0.50	1.00	ug/L
1-Chlorohexane	0.50	1.00	2.00	ug/L
2,2-Dichloropropane	0.25	0.50	1.00	ug/L
2-Butanone (Methyl ethyl ketone; MEK)	2.50	5.00	10.0	ug/L
2-Chloroethyl vinyl ether	1.25	2.50	5.00	ug/L
2-Chlorotoluene	0.25	0.50	1.00	ug/L
2-Hexanone (Methyl butyl ketone; MBK)	1.25	2.50	5.00	ug/L
4-Chlorotoluene	0.25	0.50	1.00	ug/L
4-Methyl-2-pentanone (Methyl isobutyl ketone; MIBK)	1.25	2.50	5.00	ug/L
Acetone	2.50	5.00	10.0	ug/L
Acrolein	1.25	2.50	5.00	ug/L
Acrylonitrile	2.50	5.00	10.0	ug/L
Benzene	0.25	0.50	1.00	ug/L
Bromobenzene	0.25	0.50	1.00	ug/L
Bromochloromethane	0.25	0.50	1.00	ug/L
Bromodichloromethane	0.25	0.50	1.00	ug/L
Bromoform	0.25	0.50	1.00	ug/L
Bromomethane	0.50	1.00	2.00	ug/L
Carbon Disulfide	0.25	0.50	1.00	ug/L
Carbon Tetrachloride	0.25	0.50	1.00	ug/L
Chlorobenzene	0.25	0.50	1.00	ug/L
Chloroethane	0.50	1.00	2.00	ug/L
Chloroform	0.25	0.50	1.00	ug/L
Chloromethane	0.25	0.50	1.00	ug/L
cis-1,2-Dichloroethene (cis-1,2-DCE)	0.25	0.50	1.00	ug/L

Analyte	MDL/DL	LOD	MRL/LOQ	Units
cis-1,3-Dichloropropene	0.25	0.50	1.00	ug/L
Cyclohexane	0.25	0.50	1.00	ug/L
Dibromochloromethane	0.25	0.50	1.00	ug/L
Dibromomethane	0.25	0.50	1.00	ug/L
Dichlorodifluoromethane (CFC-12)	0.50	1.00	2.00	ug/L
Di-isopropyl ether	0.25	0.50	1.00	ug/L
ETBE	0.25	0.50	1.00	ug/L
Ethyl methacrylate	0.25	0.50	1.00	ug/L
Ethylbenzene	0.25	0.50	1.00	ug/L
Hexachlorobutadiene	0.25	0.50	1.00	ug/L
Iodomethane	0.25	0.50	1.00	ug/L
Isopropylbenzene (Cumene)	0.25	0.50	1.00	ug/L
Methyl Acetate	0.50	1.00	2.00	ug/L
Methyl methacrylate	0.25	0.50	1.00	ug/L
Methyl Tertiary Butyl Ether (MTBE)	0.25	0.50	1.00	ug/L
Methylcyclohexane	0.25	0.50	1.00	ug/L
Methylene Chloride, or Dichloromethane	0.50	1.00	2.00	ug/L
Naphthalene	0.25	0.50	1.00	ug/L
n-Butylbenzene	0.25	0.50	1.00	ug/L
n-Propylbenzene	0.25	0.50	1.00	ug/L
p-Isopropyltoluene	0.25	0.50	1.00	ug/L
sec-Butylbenzene	0.25	0.50	1.00	ug/L
Styrene	0.25	0.50	1.00	ug/L
t-Butyl alcohol	1.25	2.50	5.00	ug/L
tert-Amyl methyl ether	2.50	5.00	10.0	ug/L
tert-Butylbenzene	0.25	0.50	1.00	ug/L
Tetrachloroethene (PCE; PERC)	0.25	0.50	1.00	ug/L
Tetrahydrofuran	1.25	2.50	5.00	ug/L
Toluene	0.25	0.50	1.00	ug/L
trans-1,2-Dichloroethene (trans-1,2-DCE)	0.25	0.50	1.00	ug/L
trans-1,3-Dichloropropene	0.25	0.50	1.00	ug/L
Trichloroethene (TCE)	0.25	0.50	1.00	ug/L
Trichlorofluoromethane (CFC-11)	0.50	1.00	2.00	ug/L
Vinyl acetate	1.25	2.50	5.00	ug/L
Vinyl Chloride (VC)	0.50	1.00	2.00	ug/L
m,p-Xylene	0.50	1.00	2.00	ug/L
o-Xylene	0.25	0.50	1.00	ug/L

Table 2. Organic Analysis by Gas Chromatography/Mass Spectrometry (Method 8260B)					
QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise, method-specific criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria (see Section C.1.f of DoD QSM 4.2).	NA.	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
MDL determination	Initial method demonstration required for some states – not required for DoD	Refer to SOP QS09.			
LOD determination and verification	Prior to initial analysis then quarterly verification.	See Box D-13 of DoD QSM 4.2			
LOQ establishment and verification	Prior to initial analysis then quarterly verification.	See Box D-14 of DoD QSM 4.2			
Tuning	Prior to ICAL and at the beginning of each 12-hour period.	Refer to table 5 of this SOP.	Retune instrument and verify. Rerun affected samples.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be accepted without a valid tune.
Minimum five-point initial calibration (ICAL) for all analytes	ICAL prior to sample analysis.	1. Average response factor (RF) for SPCCs: VOCs ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachlorolethane; ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. 2. RSD for RFs for CCCs: VOCs ≤ 30% and one option below: **Option 1:** RSD for each analyte ≤ 15%; **Option 2:** linear least squares regression r ≥ 0.995; **Option 3**: non-linear regression–coefficient of determination (COD) r2 ≥ 0.99 (6 points shall be used for second order, 7 points shall be used for third order).	Correct problem then repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until ICAL has passed. Calibration may not be forced through the origin for DoD projects.

Table 2. Organic Analysis by Gas Chromatography/Mass Spectrometry (Methods 8260B) (continued)					
QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Second source calibration verification (ICV)	Once after each ICAL.	All project analytes within ± 20% of true value. [± 25% for non-DoD 8260B;]	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.
Retention time window position establishment for each analyte and surrogate	Once per ICAL.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the sequence CCV is used.	NA.	NA.	
Evaluation of relative retention times (RRT)	With each sample.	RRT of each target analyte within ± 0.06 RRT units. Note - retention times may be updated based on the CCV to account for minor performance fluctuations or after routine system maintenance (such as column clipping).	Correct problem, then rerun ICAL.	Flagging criteria are not appropriate.	With each sample, the RRT shall be compared with the most recently updated RRT. If the RRT has changed by more than ±0.06 RRT units since the last update, this indicates a significant change in system performance and the laboratory must take appropriate corrective actions as required by the method and rerun the ICAL to reestablish the retention times.
Continuing calibration verification (CCV)	Daily before sample analysis and every 12 hours of analysis time.	1. Average RF for SPCCs: VOCs ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachlorolethane; ≥ 0.1 for chloromethane, bromoform, and 1,1-dichloroethane. 2. %Difference/Drift for all target compounds and surrogates: VOCs ≤ 20%D (Note: D = difference when using RFs or drift when using least squares regression or non-linear calibration). [± 20% for CCCs only non-DoD 8260B]	DoD project level approval must be obtained for each of the failed analytes or corrective action must be taken. Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply qualifier to all results for the specific analyte(s) in all samples since last acceptable CCV. [For non-DoD 8260B, if CCCs exceed, evaluate all analytes for 20%D and qualify as above]	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed, holding time has been exceeded or client has approved reporting.

Table 2. Organic Analysis by Gas Chromatography/Mass Spectrometry (Methods 8260B) (continued)					
QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Internal standards verification	Every field sample, standard, and QC sample.	Retention time ± 30 seconds from retention time of the midpoint standard in the ICAL or daily CCV; EICP area within -50% to +100% of ICAL midpoint standard or daily CCV.	Inspect mass spectrometer and GC for malfunctions. Reanalysis of samples analyzed while system was malfunctioning is mandatory.	If corrective action fails in field samples, apply qulaifier to analytes associated with the non-compliant IS. Flagging criteria are not appropriate for failed standards.	Sample results are not acceptable without a valid IS verification.
Method blank	One per preparatory batch.	No analytes detected > ½ RL and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants, no analytes detected >RL/LOQ	Correct problem. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
LCS containing all analytes to be reported, including surrogates	One per preparatory batch.	QC acceptance criteria specified by client or DoD (appendix G), if available. Otherwise, use in-house control limits. In-house control limits may not be greater than ± 3 times the standard deviation of the mean LCS recovery.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike (MS)	One per preparatory batch per matrix (see Box D-7).	Use LCS criteria, above.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply qualifier if acceptance criteria are not met.	For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.
Matrix spike duplicate (MSD) or sample duplicate	One per preparatory batch per matrix (see Box D-7).	MSD: For matrix evaluation, use LCS acceptance criteria above. MSD or sample duplicate: RPD ≤ 30% or client specified limit (between MS and MSD or sample and sample duplicate).	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply qualifier if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.

Table 2. Organic Analysis by Gas Chromatography/Mass Spectrometry (Methods 8260B) (continued)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Surrogate spike	All field and QC samples.	**Surrogate** / **WATER** / **SOIL** Dibromofluoromethane / 85-120 / 80-125 1,2-Dichloroethane-d4 / 85-135 / 75-140 Toluene-d8 / 85-115 / 80-120 Bromofluorobenzene / 80-120 / 80-125 QC acceptance criteria specified by DoD (above) or Client. Otherwise, in-house control limits may be used. No limits specified for Method 624.	For QC and field samples, correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	Apply qualifier to all associated analytes if acceptance criteria are not met.	Alternative surrogates are recommended when there is obvious chromatographic interference.
Results reported between DL and LOQ	NA.	NA.	NA.	Apply J-flag to all results between DL and LOQ.	

Table 3, Technical Completeness / Accuracy Checklist

1. Were all the QC check elements analyzed – refer to Table 2 of the SOP
2. Were the QC criteria met
3. In cases of failures, was there an NCR written
4. Were all manual integrations signed
5. Were dilution factors applied correctly
6. Was there supervisory approval for manual integrations on standards and QC samples
7. Was the data uploaded into LIMS via direct upload – if yes, then was a cross check subset of the uploaded values performed
8. If the data was entered into LIMS manually, was a check of all entered values performed
9. Was the red marked data in LIMS checked for accuracy and the corresponding hard copy data documented appropriately
10. Were proper data qualifiers applied to the data in LIMS
11. Was the hard copy package checked for completeness to include all data for the sequence such that the data reviewer could reconstruct sample analyses and validate / approve the data

Table 4, Data Reviewers Checklist (Prior to approving data)

1. Does the hard copy raw data (or electronic raw data) package look complete and include all data points
2. Were QA objectives met and for failures were the appropriate actions taken
3. For direct uploads to LIMS, did a subset cross check match the raw data
4. Did all the manual entries into LIMS match the raw data
5. Were there appropriate signatures and documentation on the raw data
6. Were appropriate LIMS flags used
7. Were manual integrations signed
8. Were manual integrations for calibration and QC samples approved by supervisor
9. Were manual calculations verified

Table 5, Tuning Criteria

m/z	Required Intensity (relative abundance)
50	15 to 40% of m/z 95
75	30 to 60% of m/z 95
95	Base peak, 100% relative abundance
96	5 to 9% of m/z 95
173	Less than 2% of m/z 174
174	Greater than 50% of m/z 95
175	5 to 9% of m/z 174
176	Greater than 95% but less than 101% of m/z 174
177	5 to 9% of m/z 176

Table 6, ANALYST DATA REVIEW CHECKLIST

Sample Number(s):	
Batch Number(s):	
Method:	**8260B/624/8270C/8270D/625 (Circle One)**

QA/QC Item	Yes	No	NA	Second Review	Level
1. Is the BFB/DFTPP tune performed every 12 hours and is the tuning criteria met?					
Are the RRFs and % RSDs within QC limits for appropriate analytes for the initial calibration? Check the retention times for compounds with the same spectra. Check compounds with different conc.(e.g. m/p-xylene, ketones, etc.).					
3. Was the initial calibration curve verified by a second source calibration standard (ICV) and have criteria been met?					
4. Does the Continuing Calibration Standard (CCV) meet the criteria for the CCCs, SPCCs and/or 20%D for all analytes.					
5. Is the Method Blank run at the desired frequency and is its concentration for target analytes less than the MDLs?					
6. Are the LCS, MS, MSD within control limits and run at the desired frequency?					
7. Are all sample holding times met, analytes within calibration range, IS areas and surrogate recoveries within QC limits?					
8. Were the Method Blank, LCS, MS, MSD and samples uploaded to the LIMS and verified (at least one calculation per batch uploaded)?					

Comments on any "No" response:

_____

_____

_____

_____

Primary-Level Review: _____ Date: _____

Second-Level Review: _____ Date: _____

Table 7, Internal Standard Association

Analyte	Internal Standard	Analyte	Internal Standard
1,1,1-Trichloroethane	Fluorobenzene	1,1,1,2-Tetrachloroethane	d5-Chlorobenzene
1,1,2-Trichloro-1,2,2-trifluoroethane	Fluorobenzene	1,1,2-Trichloroethane	d5-Chlorobenzene
1,1-Dichloroethane	Fluorobenzene	1,2,3-Trichloropropane	d5-Chlorobenzene
1,1-Dichloroethene	Fluorobenzene	1,2-Dibromoethane (EDB)	d5-Chlorobenzene
1,1-Dichloropropene	Fluorobenzene	1,3-Dichloropropane	d5-Chlorobenzene
1,2-Dichloroethane	Fluorobenzene	1-Chlorohexane	d5-Chlorobenzene
1,2-Dichloroethane-d4	Fluorobenzene	2-Hexanone	d5-Chlorobenzene
1,2-Dichloroethene (total)	Fluorobenzene	Bromofluorobenzene	d5-Chlorobenzene
1,2-Dichloropropane	Fluorobenzene	Bromoform	d5-Chlorobenzene
1,4-Dioxane	Fluorobenzene	Chlorobenzene	d5-Chlorobenzene
2,2-Dichloropropane	Fluorobenzene	Chlorobenzene-d5	d5-Chlorobenzene
2-Butanone	Fluorobenzene	Dibromochloromethane	d5-Chlorobenzene
2-Chloroethyl vinyl ether	Fluorobenzene	Ethyl Methacrylate	d5-Chlorobenzene
4-Methyl-2-pentanone	Fluorobenzene	Ethylbenzene	d5-Chlorobenzene
Acetaldehyde	Fluorobenzene	m,p-Xylene	d5-Chlorobenzene
Acetone	Fluorobenzene	Methacrylonitrile	d5-Chlorobenzene
Acetonitrile	Fluorobenzene	o-Xylene	d5-Chlorobenzene
Acrolein	Fluorobenzene	Styrene	d5-Chlorobenzene
Acrylonitrile	Fluorobenzene	Tetrachloroethene	d5-Chlorobenzene
Allyl chloride	Fluorobenzene	Toluene	d5-Chlorobenzene
Benzene	Fluorobenzene	Toluene-d8	d5-Chlorobenzene
Bromochloromethane	Fluorobenzene	trans-1,3-Dichloropropene	d5-Chlorobenzene
Bromodichloromethane	Fluorobenzene	Xylenes (total)	d5-Chlorobenzene
Bromomethane	Fluorobenzene	1,1,2,2-Tetrachloroethane	1,4-dichlorobenzene-d4
Carbon disulfide	Fluorobenzene	1,2,3-Trichlorobenzene	1,4-dichlorobenzene-d4
Carbon tetrachloride	Fluorobenzene	1,2,4-Trichlorobenzene	1,4-dichlorobenzene-d4
Chloroethane	Fluorobenzene	1,2,4-Trimethylbenzene	1,4-dichlorobenzene-d4
Chloroform	Fluorobenzene	1,2-Dibromo-3-chloropropane	1,4-dichlorobenzene-d4
Chloromethane	Fluorobenzene	1,2-Dichlorobenzene	1,4-dichlorobenzene-d4
Chloroprene	Fluorobenzene	1,3,5-Trimethylbenzene	1,4-dichlorobenzene-d4
cis-1,2-Dichloroethene	Fluorobenzene	1,3-Dichlorobenzene	1,4-dichlorobenzene-d4
cis-1,3-Dichloropropene	Fluorobenzene	1,4-Dichlorobenzene	1,4-dichlorobenzene-d4
Cyclohexane	Fluorobenzene	1,4-Dichlorobenzene-d4	1,4-dichlorobenzene-d4
Dibromofluoromethane	Fluorobenzene	2-Chlorotoluene	1,4-dichlorobenzene-d4
Dibromomethane	Fluorobenzene	4-Chlorotoluene	1,4-dichlorobenzene-d4
Dichlorodifluoromethane	Fluorobenzene	Bromobenzene	1,4-dichlorobenzene-d4
Diisopropyl Ether	Fluorobenzene	cis-1,4-Dichloro-2-butene	1,4-dichlorobenzene-d4
Ethyl tert-Butyl Ether	Fluorobenzene	Hexachlorobutadiene	1,4-dichlorobenzene-d4
Fluorobenzene	Fluorobenzene	Naphthalene	1,4-dichlorobenzene-d4
Hexane	Fluorobenzene	n-Butylbenzene	1,4-dichlorobenzene-d4
Iodomethane	Fluorobenzene	n-Propylbenzene	1,4-dichlorobenzene-d4
Isobutyl alcohol	Fluorobenzene	p-Isopropyltoluene	1,4-dichlorobenzene-d4
Isopropylbenzene	Fluorobenzene	sec-Butylbenzene	1,4-dichlorobenzene-d4
Methyl Acetate	Fluorobenzene	tert-Butylbenzene	1,4-dichlorobenzene-d4
Methyl Methacrylate	Fluorobenzene	trans-1,4-Dichloro-2-butene	1,4-dichlorobenzene-d4
Methyl t-Butyl Ether	Fluorobenzene		
Methylcyclohexane	Fluorobenzene		
Methylene chloride	Fluorobenzene		
Propionitrile	Fluorobenzene		
t-Butyl alcohol	Fluorobenzene		
Tert-Amyl Methyl Ether	Fluorobenzene		
Tetrahydrofuran	Fluorobenzene		
trans-1,2-Dichloroethene	Fluorobenzene		
Trichloroethene	Fluorobenzene		
Trichlorofluoromethane	Fluorobenzene		
Vinyl acetate	Fluorobenzene		
Vinyl chloride	Fluorobenzene		

EMPIRICAL LABORATORIES, LLC
STANDARD OPERATING PROCEDURE

ORGANICS: SOP 201 REVISION #: 22 EFFECTIVE DATE: 20120820

GC/MS SEMIVOLATILES, Regular and Low-Level, BY EPA METHOD 625 AND SW846 METHOD 8270C/8270D

APPROVALS:

Lab Director: _____ Date: 08/20/2012

Data Quality Manager: _____ Date: 08/20/2012

Section Supervisor: _____ Date: 08/20/2012

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Changes Summary

Revision 22, 08/20/2012

- MSDS location updated.
- Internal standard spike volume corrected from 20ul to 10ul.
- Common contaminant reference in table 2 updated to reflect phthalates.
- Table 3 removed and all tables renumbered accordingly.
- Data Review Checklist updated.
- Internal Standard Association tables updated.
- List of 8270D SPCCs added and referenced in table 2.
- List of poor responding compounds added and referenced in table 2.

Revision 21, 05/16/2011

- The SOP is an update from Revision 20 dated 4/13/2010
- A requirement to record the amount and ID of the internal standard used was added to section 14.3.

Revision 20, 4/13/10

- The SOP is an update from Revision 19 dated 4/11/2010
- The SOP is formatted to simplify the text and place all method/program specifications in the SOP tables.

Revision 19, 4/11/10

- The SOP is an update from Revision 18 dated 9/16/08
- The SOP is formatted to include all 22-elements required per the NELAC standards
- The laboratory's revision of all technical SOPs now includes a Table of Contents that provides the map of the technical information contained within the SOP.
- Additional requirements, based upon the DOD QSM 4.1, have been integrated into the routine sample flow; however, if the requirement is different from routine sample flow, then the requirement is outlined and documented as such to be followed only when DOD samples are analyzed.

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Table of Contents

1. Identification of the Test Method
2. Applicable Matrix or Matrices
3. Detection Limit
4. Scope of Application, Including components to be Analyzed
5. Summary of the Test Method
6. Definitions
7. Interferences
8. Safety
9. Equipment & Supplies
10. Reagents and Standards
11. Sample Collection, Preservation, Shipment, and Storage
12. Quality Control
13. Calibration and Standardization
14. Procedure
15. Data Analysis and Calculations
16. Method Performance
17. Pollution Prevention
18. Data Assessment and Acceptance Criteria for Quality Control Measures
19. Contingencies for Handling out-of-control or unacceptable data
20. Waste Management
21. References
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1.0 Identification of the Test Method

This SOP is based primarily on SW-846 Methods 8000B/8000C/8270C/8270D. Methods *Federal Register* Method 625 and CLP Method for Semi-volatiles have also been used in the development of this SOP.

2.0 Applicable Matrix or Matrices

This SOP is used for the analysis of semi-volatile organic compounds (including low concentration) in a variety of matrices (soils, sediments, waters, etc.).

3.0 Detection Limits – Reporting Limits

See Table 1

4.0 Scope of Application, Including Components to Be Analyzed

4.1 Each parameter that is routinely analyzed and reported under the scope of this SOP is listed in the Appendix of this SOP. This table also lists the associated Detection Limit, Limit of Detection and Reporting Limit (also defined as the Limit of Quanititation).

4.2 Extreme care should be taken when working with pure standard and stock standard solutions of these compounds and all handling of standards should be done in a hood. These compounds have been classified as known or suspected human or mammalian carcinogens.

5.0 Summary of the Test Method

5.1 After sample preparation using the appropriate extraction technique, the sample is introduced into the GC/MS using direct injection. The analytes are separated in the gas chromatograph by a combination of the temperature program, the pressure program and the capillary column. The analytes are then detected by the mass spectrometer. Analytes are identified by comparing the mass spectra of known standards with the mass spectra from the sample. Analytes are quantitated relative to known standards using the internal standard method.

6.0 Definitions –

Laboratory Quality System SOP QS08 **"**Technical / Operational Definitions, Minimum Essential Quality Control Elements, and Laboratory Calibration Procedures" provides information on the commonly used definitions.

7.0 Interferences

7.1 All raw data (samples & QC) must be evaluated for interferences. If contamination occurs, determine whether the source of interference is in the preparation or clean-up of the samples and take corrective action to eliminate the problem.

7.2 Contamination by carryover can occur when samples of high-concentration and low-concentration are analyzed sequentially. To reduce carryover, the sample syringe must be rinsed with solvent between injections. If an unusually high sample is detected, a solvent blank should be analyzed for cross contamination or the subsequent sample should be evaluated for cross-contamination.

8.0 Safety

8.1 Laboratory SOP QS13 "Safety Program & Chemical Hygiene Plan" discusses the safety program that is to be followed lab-wide.

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8.2 Care should be used in handling all samples. Safety glasses must be worn in the lab at all times. The use of gloves and lab coats is highly recommended.

8.3 Research into expected sample content and concentration should be done in order to be prepared for additional safety considerations. Generally, any samples which need special consideration have applicable notes on the sample logs.

8.4 MSDS sheets are available for all reagents and standards which have been purchased. These are located on the bookshelf inside the Data Quality Managers office.

9.0 Equipment & Supplies

a HP 5890/6890/7890GC complete with electronic pressure control and temperature programmable gas chromatograph suitable for split-less injection.

b Column: RTX-5 (or equivalent) 30 m x 0.25 mm I.D. x 0.25 µm film thickness fused silica capillary column.

c HP 5971/5973/5975 mass spectrometer capable of scanning from 35 to 500 amu every second or less, using 70 volts electron energy in electron impact ionization mode. The mass spectrometer is capable of producing a mass spectrum for decafluorotriphenylphosphine, DFTPP, which meets all the tuning criteria of the EPA methods.

d HP 7673/7683 autosampler capable of reproducibility from one injection to another proven by meeting QC and calibration criteria.

e HP GC/MS interface that gives acceptable calibration points at 50 ng per injection for each compound of interest and achieves acceptable tuning performance criteria.

f Acquisition Software: HP Chemstation system is interfaced to the GC/MS. The system acquires and stores data throughout the chromatographic programs.

g Data Processing Software: Target DB on Windows NT server data system is interfaced to the HP Chemstation. The system accepts and stores acquired data. It plots by extracted ion current profile (EICP). The system is also capable of integrating the abundances in any EICP between specified times or scan-number limits.

h Micro syringes – gas tight 5uL and larger.

i Liners – 2mm or 4mm, straight or with glass wool (for split injection).

j Septa 11mm.

k Seals- dual vespel stainless steel or gold plated 0.8mm.

l Vials- 2ml and larger amber.

m Volumetric flasks- 10ml and larger class A with glass stopper.

10.0 Reagents and Standards –

10.1 The laboratory's LIMS system allows for complete documentation and for the traceability of reagents and standards used within the laboratory. All certificates received with standards must be marked with the LIMS ID and forwarded to the administration department for scanning/saving in order to be available for view within LIMS.

10.2 Reagent grade chemicals shall be used in all tests unless otherwise specified. All reagents shall conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society, where such specifications are available. Other grades may be used, provided it is first ascertained that the reagent

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is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

10.3 Methylene chloride (Please read SOP-336 before handling this solvent in our laboratory.) – Trace analysis grade.

10.4 Stock standards are purchased in mixtures from reputable vendors. The date they are received is noted on the label and recorded on the certificate of analysis sheet. The date they are opened is noted on the label and recorded in LIMS. Each standards label is completed with the standard number, name, preparation date, expiration date, solvent and analyst initials. All stocks and standards are stored in the freezer at a temperature of -15°C ± 5°C from the date they are received/prepared. Standards are brought to room temperature before being used to make standards. Sonication is used if precipitation is observed after bringing to room temperature. The refrigerator and freezer temperature are monitored daily with an annually calibrated thermometer and recorded with calibration correction in the Extraction temperature/calibration logbook.

10.5 Individual standard makeup is recorded in LIMS with specific details concerning the standard being used, concentration, amount, solvent and expiration date. All reagents used for preparation and analysis are entered into LIMS. These reagents are added to the batch sheet when the samples are batched to ensure traceability of the reagents used to the associated samples.

11.0 Sample Collection, Preservation, Shipment, and Storage

Section 3.0 and table 3-1 of the Empirical Laboratories' Quality Assurance Manual include details concerning sample preservation, containers and handling of semi-volatile samples and extracts. All water and soil samples are stored in the appropriate walk-in coolers at a temperature of 4°C. All extracts are stored in the Hobart in the Extraction lab at a temperature of 4°C. Water samples have a holding time of 7 days from date of sampling while soil samples have a holding time of 14 days from date of sampling (unless otherwise specified for the project). Extracts have 40 days from date of extraction to be analyzed.

12.0 Quality Control

12.1 Internals - All samples and QC are spiked with internal standards prior to analysis.

12.2 Surrogates - All samples and QC are spiked with surrogates prior to extraction. See **Table 2** for criteria and corrective action.

12.3 LCS Sample - The LCS is extracted 1 per extraction batch of up to 20 samples to provide accuracy results. It is spiked using an alternate source or lot number than the calibration standards. See **Table 2** for criteria and corrective action.

12.4 Method Blanks - The Method Blank is extracted 1 per extraction batch of up to 20 samples. See **Table 2** for criteria and corrective action.

12.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Sample - 1 in 20 samples are spiked for a MS/MSD, if sample is available. If no sample is available, an LCSD must be extracted to provide precision results. See **Table 2** for criteria and corrective action. Some factors that may affect MS/MSD results are:

12.5.1 Sample matrix - If the sample is a soil, grab sample or sequentially collected water sample it may affect the %R and RPD of the MS/MSD. Corrective action must be taken in the form of reanalysis if a method problem is indicated.

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12.5.2 Original sample concentration - If a spiked compound has a problem and the concentration of that compound in the original sample was four or more times the concentration of the spike, no further corrective action may be necessary other than the generation of a corrective action report to document the problem.

12.5.3 MS vs. MSD - If a spiked compound has a similar problem in both the MS and MSD and is not traced to a method problem, no further action may be necessary other than the generation of a non-conformance report to document the problem.

12.5.4 Non-target Interference - The presence of significant non-target interference should be brought to the immediate attention of your supervisor who should discuss the problem with the client/project manager to determine the action to be taken.

12.6 Demonstration of Capability (DOC) – Each new analyst must complete a demonstration of capability by analyzing four LCSs with acceptable precision and accuracy. This also must be done when a new instrument is installed or a significant change to the method has been made.

13.0 Calibration and Standardization

13.1 Quality Systems **SOP QS08** "Technical / Operational Definitions, Minimum Essential Quality Control Elements, and Laboratory Calibration Procedures" related to Calibration Procedures provides laboratory wide protocols for calibration and standardization.

13.2 Initial Calibration - An initial multi-point calibration curve must be analyzed and shown to meet the initial calibration criteria before any sample analyses may be performed. See **Table 2** for criteria and corrective action. The lowest standard must be less than or equal to the reported quantitation limit and the highest standard must not exceed the linear range of the detector. Generally, levels for the curve range from 1.0ug/mL to 100ug/mL for regular SVOCs and 0.1µg/mL to 50µg/mL for low-concentration PAHs.. Any manual integrations are documented by inclusion of the integrated signals (**before and after manual integration**) initialed, reason indicated and dated with the quantitation report and chromatogram. All integrations are second-checked for acceptability by a senior analyst. Refer to SOP-QS07 for guidance.

13.3 Initial Calibration Verification (ICV) - A second source standard at the continuing calibration verification (CCV) level must be analyzed and calculated against the initial calibration curve, then shown to meet the ICV criteria before any sample analyses may be performed. See **Table 2** for criteria and corrective action. For ICV standard preparation, refer to LIMS. Any manual integrations are documented by inclusion of the integrated signals (**before and after manual integration**) initialed, reason indicated and dated with the quantitation report and chromatogram. All integrations are second-checked for acceptability by a senior analyst. Refer to SOP-QS07 for guidance.

13.4 Continuing Calibration Verification (CCV) - Every 12 hours, a CCV must be analyzed and calculated against the initial calibration curve, then shown to meet the calibration check criteria before any sample analyses may be performed. See **Table**

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2 for criteria and corrective action. For ICV standard preparation, refer to LIMS. Any manual integrations are documented by inclusion of the integrated signals (**before and after manual integration**) initialed, reason indicated and dated with the quantitation report and chromatogram. All integrations are second-checked for acceptability by a senior analyst. Refer to SOP-QS07 for guidance.

14.0 Procedure

Prior to analysis the samples are prepared for chromatography using the appropriate sample preparation and clean up methods (generally SW-846 methods 3510, 3520, 3541, 3546 3550, 3580, EPA method 625 or CLP).

14.1 Chromatographic conditions: Refer to corresponding instrument maintenance log for current gas chromatograph and mass spectrometer conditions.

14.2 Tuning - Prior to any calibration or analysis, DFTPP tuning criteria must be met for a 50 ng injection of the tuning standard. The injection port performance compounds (pentachlorophenol, benzidine and 4,4'-DDT) are also injected to verify the performance of the injection port . See **Table 2** for criteria and corrective action.

14.3 Extracts - Prior to analysis, 1.0 mL extracts are prepared by verifying volume and spiking with 10uL of the internal standard solution. Record the amount and ID of internal standard spiked on the sequence log printed from the LIMS.

14.4 Instrument sequence-The instrument sequence log is filled out prior to sample analyses. An example of a typical instrument sequence log follows:

1-SEQ-TUN1 (12:00 am)
2-SEQ-CCV1
3-SEQ-BS1
4-SEQ-BLK1
5-Sample
6-Sample
7-Sample
8-Sample
9-Sample
10-Sample
11-Sample
12-Sample
13-Sample
14-SEQ-MS1
15-SEQ-MSD1
16-SEQ-TUN2 (12:00pm - 12 hours since last DFTPP/CCV)
17-SEQ-CCV2
18-Sample
19-Sample
20-Sample

14.5 Data Reduction/Evaluation - Each sample analysis sequence is documented using the computer run log generated on the Chemstation. This run log is signed, dated and paginated then placed in a 3 ring binder for that instrument. After the sample has been analyzed, the data is processed through Target DB on the Windows NT data system. The following must be checked to determine if the sample will need reanalysis or dilution. Criteria and corrective action are found in Table 2. Formal

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data evaluation is detailed in SOP QS05 and documented using the Analyst Data Review Checklist (see Appendix). Manual integration guidance is found in SOP QS07.

14.5.1 Internal Standard Area Counts and Retention Times
14.6.2 Surrogate Recoveries and Retention Times
14.5.3 Analyte concentration.
14.5.4 Analyte identification based on spectrum and retention time.
14.5.5 Analyte quantitation verification.

15.0 Data Analysis and Calculations

15.1 Quality Systems SOP QS09 "General and Commonly used Laboratory Calculations" provides details on general calculations used throughout the laboratory.

15.2 The RF is calculated as follows:

$$RF = \frac{A_s \times C_{is}}{A_{is} \times C_s}$$

where:
A_s = Peak area (or height) of the analyte or surrogate.
A_{is} = Peak area (or height) of the internal standard.
C_s = Concentration of the analyte or surrogate.
C_{is} = Concentration of the internal standard.

15.2 Calibration verification involves the calculation of the percent drift (linear or quadratic) or the percent difference (average) of the instrument response between the initial calibration and each subsequent analysis of the verification standard. Use the equations below to calculate % Drift or % Difference, depending on the calibration procedure used.

$$\% \text{ Drift} = \frac{(\text{Calculated concentration} - \text{Theoretical concentration}) * 100}{\text{Theoretical Concentration}}$$

where:
Calculated concentration is determined from the initial calibration.
Theoretical concentration is the concentration at which the standard was prepared.

$$\% \text{ Difference} = \frac{(\text{CCV RF} - \text{Average RF}) * 100}{\text{Average RF}}$$

where:
CCV RF is the response factor from the analysis of the verification standard
Average RF is the average of the response factors from the initial calibration.

15.3 Concentration in water samples is calculated as follows: [Note: Using the units specified here for these terms will result in a concentration in units of ng/mL, which is equivalent to µg/L.]

$$\text{Concentration } (\mu g/L) = \frac{(A_s)(C_{is})(D)(V_i)}{(A_{is})(\overline{RF})(V_s)(1000)}$$

where:
A_s = Area (or height) of the peak for the analyte in the sample.
A_{is} = Area (or height) of the peak for the internal standard.

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C_{is} = Concentration of the internal standard in the volume extracted in ug/L.

D = Dilution factor, if the sample was diluted prior to analysis. If no dilution was made, D = 1. The dilution factor is always dimensionless.

V_i = Volume of the extract injected (µL). The nominal injection volume for samples and calibration standards must be the same.

$\overline{RF}$ = Mean response factor from the initial calibration.

V_s = Volume of the aqueous sample extracted (mL). If units of liters are used for this term, multiply the results by 1000.

The 1000 in the denominator represents the number of µL in 1 mL. If the injection (V_i) is expressed in mL, then the 1000 may be omitted.

15.4 Concentration in non-aqueous samples is calculated as follows: [Note: Using the units specified here for these terms will result in a concentration in units of ng/g, which is equivalent to µg/kg.]

$$\text{Concentration } (\mu\text{g/kg}) = \frac{(A_s)(C_{is})(D)(V_i)}{(A_{is})(\overline{RF})(W_s)(1000)}$$

where: A_s,

A_{is}, C_{is}, D, and $\overline{RF}$ are the same as for aqueous samples, and

W_s = Weight of sample extracted (g). Either a dry weight or wet weight may be used, depending upon the specific application of the data. If units of kilograms are used for this term, multiply the results by 1000.

The 1000 in the denominator represents the number of µL in 1 mL. If the injection (V_i) is expressed in mL, then the 1000 may be omitted.

15.3 Any questions left unanswered by this SOP should be clarified by reading the referenced method. If questions still remain unanswered, check with the Section Manager, Technical Director and/or Data Quality Manager.

16.0 Method Performance

See SOP QS08 and Table 2 for criteria and corrective actions associated to the following method performance items:

16.1 Method Detection Limit Study or Detection Limit Determination
16.2 Limit of Detection Verification
16.3 Limit of Quantitation or Reporting Limit Verification
16.4 Demonstration of Capability (DOC)
16.5 PT Studies

17.0 Pollution Prevention

Quantity of chemicals purchased should be based on expected usage during its shelf-life and the disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

18.0 Data Assessment and Acceptance Criteria for Quality Control Measures

Quality Control SOP QS05, "Data Deviations / Interpretations / Exceptions: Laboratory Non-Conformance / Corrective Action Procedures, Decision Making Guidelines for Evaluating Laboratory Analytical Sample and Quality Control Results", provides details on data assessment and acceptance criteria for Quality Control Measures. **Table 2** of this SOP

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provides information on QC samples, frequency, and the associated criteria specific to the performance of this method.

19.0 Contingencies for Handling out-of-control or unacceptable data

Quality Control SOP QS05, "Data Deviations / Interpretations / Exceptions: Laboratory Non-Conformance / Corrective Action Procedures, Decision Making Guidelines for Evaluating Laboratory Analytical Sample and Quality Control Results", provides details on handling out of control data. **Table 2** within this SOP also lists corrective actions associated with the failure of the various QC samples employed for the performance of this method.

20.0 Waste Management

Laboratory SOP QS14 on Waste Handling discusses general guidelines for the appropriate handling of wastes and the laboratory program on waste management.

21.0 References

40 CFR, Part 136; Appendix A
Test Methods for Evaluating Solid Waste, SW-846
National Environmental Laboratory Accreditation Conference; CH. 5, 2003
USACE, EM 200-1-3; Appendix 1; Shell, 2/2001
DOD Quality Systems Manual for Environmental Laboratories,

22.0 Tables, Diagrams, Flowcharts and Validation Data

22.1 Table 1, all applicable parameters with the applicable DL(MDL)/LOD/LOQ(MRL).
22.2 Table 2, QA/QC summary table
22.3 Table 3, Data Reviewers Checklist(s)
22.4 Table 4, 625 QC Limits
22.5 Table 5, Standards Used
22.6 Table 6, 8270 Regular Internal Standards
22.7 Table 7, 8270 Low-level Internal Standards
22.8 Figure 1, Tailing Factor Calculation
22.9 Table 8, DFTPP Tuning Criteria
22.10 Table 9, 8270D SPCC Limits
22.11 Table 10, Poor Responding Analytes

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S/W	TABLE 1, Analyte	MRL/LOQ	LOD	MDL/DL	Units
Solid	1,1'-Biphenyl	333	167	83.3	ug/Kg
Solid	1,2,4,5-Tetrachlorobenzene	333	167	83.3	ug/Kg
Solid	1,2,4-Trichlorobenzene	333	167	83.3	ug/Kg
Solid	1,2-Dichlorobenzene (12DCB)	333	167	83.3	ug/Kg
Solid	1,2-Diphenylhydrazine	333	167	83.3	ug/Kg
Solid	1,3-Dichlorobenzene (13DCB)	333	167	83.3	ug/Kg
Solid	1,4-Dichlorobenzene (14DCB)	333	167	83.3	ug/Kg
Solid	1,4-Dioxane	333	167	83.3	ug/Kg
Solid	1-Methylnaphthalene	333	167	83.3	ug/Kg
Solid	2,3,4,6-Tetrachlorophenol	333	167	83.3	ug/Kg
Solid	2,4,5-Trichlorophenol	333	167	83.3	ug/Kg
Solid	2,4,6-Trichlorophenol (TCP)	333	167	83.3	ug/Kg
Solid	2,4-Dichlorophenol (DCP)	333	167	83.3	ug/Kg
Solid	2,4-Dimethylphenol	1330	667	333	ug/Kg
Solid	2,4-Dinitrophenol	3330	1670	833	ug/Kg
Solid	2,4-Dinitrotoluene (DNT)	333	167	83.3	ug/Kg
Solid	2,6-Dichlorophenol (DCP)	333	167	83.3	ug/Kg
Solid	2,6-Dinitrotoluene	333	167	83.3	ug/Kg
Solid	2.4.6-Tribromophenol (Surrogate)	667	333	167	ug/Kg
Solid	2-Chloronaphthalene	333	167	83.3	ug/Kg
Solid	2-Chlorophenol	333	167	83.3	ug/Kg
Solid	2-Fluorobiphenyl (Surrogate)	333	167	83.3	ug/Kg
Solid	2-Fluorophenol (Surrogate)	667	333	167	ug/Kg
Solid	2-Methylnaphthalene	333	167	83.3	ug/Kg
Solid	2-Methylphenol (o-Cresol)	333	167	83.3	ug/Kg
Solid	2-Nitroaniline	1330	667	333	ug/Kg
Solid	2-Nitrophenol (ONP)	333	167	83.3	ug/Kg
Solid	3,3'-Dichlorobenzidine (DCB)	333	167	83.3	ug/Kg
Solid	3-Methylphenol/4-Methylphenol	333	167	83.3	ug/Kg
Solid	3-Nitroaniline	1330	667	333	ug/Kg
Solid	4,6-Dinitro-2-methylphenol (DNOC)	3330	1670	833	ug/Kg
Solid	4-Bromophenyl phenyl ether	333	167	83.3	ug/Kg
Solid	4-Chloro-3-methylphenol	333	167	83.3	ug/Kg
Solid	4-Chloroaniline	333	167	83.3	ug/Kg
Solid	4-Chlorophenyl phenyl ether	333	167	83.3	ug/Kg
Solid	4-Nitroaniline (PNA)	1330	667	333	ug/Kg
Solid	4-Nitrophenol (PNP)	1330	667	333	ug/Kg
Solid	Acenaphthene	333	167	83.3	ug/Kg
Solid	Acenaphthylene	333	167	83.3	ug/Kg
Solid	Acetophenone	333	167	83.3	ug/Kg
Solid	Aniline	333	167	83.3	ug/Kg
Solid	Anthracene	333	167	83.3	ug/Kg
Solid	Atrazine	333	167	83.3	ug/Kg
Solid	Benzaldehyde	333	167	83.3	ug/Kg
Solid	Benzidine	3330	1670	833	ug/Kg
Solid	Benzo(a)anthracene	333	167	83.3	ug/Kg
Solid	Benzo(a)pyrene	333	167	83.3	ug/Kg
Solid	Benzo(b)fluoranthene	333	167	83.3	ug/Kg
Solid	Benzo(g,h,i)perylene	333	167	83.3	ug/Kg
Solid	Benzo(k)fluoranthene	333	167	83.3	ug/Kg

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S/W	TABLE 1, Analyte	MRL/LOQ	LOD	MDL/DL	Units
Solid	Benzoic Acid	1330	667	333	ug/Kg
Solid	Benzyl alcohol	333	167	83.3	ug/Kg
Solid	bis(2-Chloroethoxy)methane	333	167	83.3	ug/Kg
Solid	bis(2-Chloroethyl)ether (BCEE)	333	167	83.3	ug/Kg
Solid	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)	333	167	83.3	ug/Kg
Solid	bis(2-Ethylhexyl)phthalate (BEHP)	333	167	83.3	ug/Kg
Solid	Butyl benzyl phthalate (BBP)	333	167	83.3	ug/Kg
Solid	Caprolactam	333	167	83.3	ug/Kg
Solid	Carbazole	333	167	83.3	ug/Kg
Solid	Chrysene	333	167	83.3	ug/Kg
Solid	Dibenz(a,h)anthracene	333	167	83.3	ug/Kg
Solid	Dibenzofuran (DBF)	333	167	83.3	ug/Kg
Solid	Diethyl phthalate (DEP)	333	167	83.3	ug/Kg
Solid	Dimethyl phthalate (DMP)	333	167	83.3	ug/Kg
Solid	Di-n-butyl phthalate (DBP)	333	167	83.3	ug/Kg
Solid	Di-n-octyl phthalate (DNOP)	333	167	83.3	ug/Kg
Solid	Fluoranthene	333	167	83.3	ug/Kg
Solid	Fluorene	333	167	83.3	ug/Kg
Solid	Hexachlorobenzene (HCB)	333	167	83.3	ug/Kg
Solid	Hexachlorobutadiene (HCBD)	333	167	83.3	ug/Kg
Solid	Hexachlorocyclopentadiene (HCCPD)	333	167	83.3	ug/Kg
Solid	Hexachloroethane (HCE)	333	167	83.3	ug/Kg
Solid	Indeno(1,2,3-cd)pyrene	333	167	83.3	ug/Kg
Solid	Isophorone	333	167	83.3	ug/Kg
Solid	Naphthalene	333	167	83.3	ug/Kg
Solid	Nitrobenzene	333	167	83.3	ug/Kg
Solid	Nitrobenzene-d5 (Surrogate)	333	167	83.3	ug/Kg
Solid	N-Nitrosodimethylamine	333	167	83.3	ug/Kg
Solid	N-Nitroso-di-n-propylamine (NDPA)	333	167	83.3	ug/Kg
Solid	N-nitrosodiphenylamine (NDPHA)	333	167	83.3	ug/Kg
Solid	Pentachlorophenol	1330	667	333	ug/Kg
Solid	Phenanthrene	333	167	83.3	ug/Kg
Solid	Phenol	333	167	83.3	ug/Kg
Solid	Phenol-d6 (Surrogate)	667	333	167	ug/Kg
Solid	Pyrene	333	167	83.3	ug/Kg
Solid	Pyridine	333	167	83.3	ug/Kg
Solid	Terphenyl-d14 (Surrogate)	333	167	83.3	ug/Kg
Water	1,1'-Biphenyl	5.00	2.50	1.25	ug/L
Water	1,2,4,5-Tetrachlorobenzene	5.00	2.50	1.25	ug/L
Water	1,2,4-Trichlorobenzene	5.00	2.50	1.25	ug/L
Water	1,2-Dichlorobenzene (12DCB)	5.00	2.50	1.25	ug/L
Water	1,2-Diphenylhydrazine	5.00	2.50	1.25	ug/L
Water	1,3-Dichlorobenzene (13DCB)	5.00	2.50	1.25	ug/L
Water	1,4-Dichlorobenzene (14DCB)	5.00	2.50	1.25	ug/L
Water	1,4-Dioxane	5.00	2.50	1.25	ug/L
Water	1-Methylnaphthalene	5.00	2.50	1.25	ug/L
Water	2,3,4,6-Tetrachlorophenol	10.0	5.00	2.50	ug/L
Water	2,4,5-Trichlorophenol	5.00	2.50	1.25	ug/L
Water	2,4,6-Trichlorophenol (TCP)	5.00	2.50	1.25	ug/L
Water	2,4-Dichlorophenol (DCP)	5.00	2.50	1.25	ug/L
Water	2,4-Dimethylphenol	20.0	10.0	5.00	ug/L
Water	2,4-Dinitrophenol	50.0	25.0	8.33	ug/L

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S/W	TABLE 1, Analyte	MRL/LOQ	LOD	MDL/DL	Units
Water	2,4-Dinitrotoluene (DNT)	5.00	2.50	1.25	ug/L
Water	2,6-Dichlorophenol (DCP)	5.00	2.50	1.25	ug/L
Water	2,6-Dinitrotoluene	5.00	2.50	1.25	ug/L
Water	2.4.6-Tribromophenol (Surrogate)	10	5	2.5	ug/L
Water	2-Chloronaphthalene	5.00	2.50	1.25	ug/L
Water	2-Chlorophenol	5.00	2.50	1.25	ug/L
Water	2-Fluorobiphenyl (Surrogate)	5.00	2.50	1.25	ug/L
Water	2-Fluorophenol (Surrogate)	10	5	2.5	ug/L
Water	2-Methylnaphthalene	5.00	2.50	1.25	ug/L
Water	2-Methylphenol (o-Cresol)	5.00	2.50	1.25	ug/L
Water	2-Nitroaniline	20.0	10.0	5.00	ug/L
Water	2-Nitrophenol (ONP)	5.00	2.50	1.25	ug/L
Water	3,3'-Dichlorobenzidine (DCB)	5.00	2.50	1.25	ug/L
Water	3-Methylphenol/4-Methylphenol	5.00	2.50	1.25	ug/L
Water	3-Nitroaniline	20.0	10.0	5.00	ug/L
Water	4,6-Dinitro-2-methylphenol (DNOC)	20.0	10.0	5.00	ug/L
Water	4-Bromophenyl phenyl ether	5.00	2.50	1.25	ug/L
Water	4-Chloro-3-methylphenol	5.00	2.50	1.25	ug/L
Water	4-Chloroaniline	5.00	2.50	1.25	ug/L
Water	4-Chlorophenyl phenyl ether	5.00	2.50	1.25	ug/L
Water	4-Nitroaniline (PNA)	20.0	10.0	5.00	ug/L
Water	4-Nitrophenol (PNP)	20.0	10.0	5.00	ug/L
Water	Acenaphthene	5.00	2.50	1.25	ug/L
Water	Acenaphthylene	5.00	2.50	1.25	ug/L
Water	Acetophenone	5.00	2.50	1.25	ug/L
Water	Aniline	5.00	2.50	1.25	ug/L
Water	Anthracene	5.00	2.50	1.25	ug/L
Water	Atrazine	5.00	2.50	1.25	ug/L
Water	Benzaldehyde	5.00	2.50	1.25	ug/L
Water	Benzidine	100	50.0	25.0	ug/L
Water	Benzo(a)anthracene	5.00	2.50	1.25	ug/L
Water	Benzo(a)pyrene	5.00	2.50	1.25	ug/L
Water	Benzo(b)fluoranthene	5.00	2.50	1.25	ug/L
Water	Benzo(g,h,i)perylene	5.00	2.50	1.25	ug/L
Water	Benzo(k)fluoranthene	5.00	2.50	1.25	ug/L
Water	Benzoic Acid	100	50.0	25.0	ug/L
Water	Benzyl alcohol	5.00	2.50	1.25	ug/L
Water	bis(2-Chloroethoxy)methane	5.00	2.50	1.25	ug/L
Water	bis(2-Chloroethyl)ether (BCEE)	5.00	2.50	1.25	ug/L
Water	Bis(2-chloroisopropyl)ether, or 2,2'-oxybis (1-Chloropropane)	5.00	2.50	1.25	ug/L
Water	bis(2-Ethylhexyl)phthalate (BEHP)	5.00	2.50	1.25	ug/L
Water	Butyl benzyl phthalate (BBP)	5.00	2.50	1.25	ug/L
Water	Caprolactam	5.00	2.50	1.25	ug/L
Water	Carbazole	5.00	2.50	1.25	ug/L
Water	Chrysene	5.00	2.50	1.25	ug/L
Water	Dibenz(a,h)anthracene	5.00	2.50	1.25	ug/L
Water	Dibenzofuran (DBF)	5.00	2.50	1.25	ug/L
Water	Diethyl phthalate (DEP)	5.00	2.50	1.25	ug/L
Water	Dimethyl phthalate (DMP)	5.00	2.50	1.25	ug/L
Water	Di-n-butyl phthalate (DBP)	5.00	2.50	1.25	ug/L
Water	Di-n-octyl phthalate (DNOP)	5.00	2.50	1.25	ug/L
Water	Fluoranthene	5.00	2.50	1.25	ug/L

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S/W	TABLE 1, Analyte	MRL/LOQ	LOD	MDL/DL	Units
Water	Fluorene	5.00	2.50	1.25	ug/L
Water	Hexachlorobenzene (HCB)	5.00	2.50	1.25	ug/L
Water	Hexachlorobutadiene (HCBD)	5.00	2.50	1.25	ug/L
Water	Hexachlorocyclopentadiene (HCCPD)	10.0	5.00	2.50	ug/L
Water	Hexachloroethane (HCE)	5.00	2.50	1.25	ug/L
Water	Indeno(1,2,3-cd)pyrene	5.00	2.50	1.25	ug/L
Water	Isophorone	5.00	2.50	1.25	ug/L
Water	Naphthalene	5.00	2.50	1.25	ug/L
Water	Nitrobenzene	5.00	2.50	1.25	ug/L
Water	Nitrobenzene-d5 (Surrogate)	5	2.5	1.25	ug/L
Water	N-Nitrosodimethylamine	5.00	2.50	1.25	ug/L
Water	N-Nitroso-di-n-propylamine (NDPA)	5.00	2.50	1.25	ug/L
Water	N-nitrosodiphenylamine (NDPHA)	5.00	2.50	1.25	ug/L
Water	Pentachlorophenol	20.0	10.0	5.00	ug/L
Water	Phenanthrene	5.00	2.50	1.25	ug/L
Water	Phenol	5.00	2.50	1.25	ug/L
Water	Phenol-d6 (Surrogate)	10	5	2.5	ug/L
Water	Pyrene	5.00	2.50	1.25	ug/L
Water	Pyridine	10.0	5.00	2.50	ug/L
Water	Terphenyl-d14 (Surrogate)	5	2.5	1.25	ug/L
Solid	1,4-Dioxane	66.7	33.3	16.7	ug/Kg
Solid	1-Methylnaphthalene	6.67	3.33	1.67	ug/Kg
Solid	2-Fluorobiphenyl (Surrogate)	6.67	3.33	1.67	ug/Kg
Solid	2-Methylnaphthalene	6.67	3.33	1.67	ug/Kg
Solid	Acenaphthene	6.67	3.33	1.67	ug/Kg
Solid	Acenaphthylene	6.67	3.33	1.67	ug/Kg
Solid	Anthracene	6.67	3.33	1.67	ug/Kg
Solid	Benzo(a)anthracene	6.67	3.33	1.67	ug/Kg
Solid	Benzo(a)pyrene	6.67	3.33	1.67	ug/Kg
Solid	Benzo(b)fluoranthene	6.67	3.33	1.67	ug/Kg
Solid	Benzo(g,h,i)perylene	6.67	3.33	1.67	ug/Kg
Solid	Benzo(k)fluoranthene	6.67	3.33	1.67	ug/Kg
Solid	Chrysene	6.67	3.33	1.67	ug/Kg
Solid	Dibenz (a,h) anthracene	6.67	3.33	1.67	ug/Kg
Solid	Fluoranthene	6.67	3.33	1.67	ug/Kg
Solid	Fluorene	6.67	3.33	1.67	ug/Kg
Solid	Indeno (1,2,3-cd) pyrene	6.67	3.33	1.67	ug/Kg
Solid	Naphthalene	6.67	3.33	1.67	ug/Kg
Solid	Phenanthrene	6.67	3.33	1.67	ug/Kg
Solid	Pyrene	6.67	3.33	1.67	ug/Kg
Solid	Terphenyl-d14 (Surrogate)	6.67	3.33	1.67	ug/Kg
Water	1,4-Dioxane	1.00	0.500	0.250	ug/L
Water	1-Methylnaphthalene	0.200	0.100	0.0500	ug/L
Water	2-Fluorobiphenyl (Surrogate)	0.200	0.100	0.0500	ug/L
Water	2-Methylnaphthalene	0.200	0.100	0.0500	ug/L
Water	Acenaphthene	0.200	0.100	0.0500	ug/L
Water	Acenaphthylene	0.200	0.100	0.0500	ug/L
Water	Anthracene	0.200	0.100	0.0500	ug/L
Water	Benzo(a)anthracene	0.200	0.100	0.0500	ug/L
Water	Benzo(a)pyrene	0.200	0.100	0.0500	ug/L
Water	Benzo(b)fluoranthene	0.200	0.100	0.0500	ug/L
Water	Benzo(g,h,i)perylene	0.200	0.100	0.0500	ug/L

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S/W	TABLE 1, Analyte	MRL/LOQ	LOD	MDL/DL	Units
Water	Benzo(k)fluoranthene	0.200	0.100	0.0500	ug/L
Water	Chrysene	0.200	0.100	0.0500	ug/L
Water	Dibenz (a,h) anthracene	0.200	0.100	0.0500	ug/L
Water	Fluoranthene	0.200	0.100	0.0500	ug/L
Water	Fluorene	0.200	0.100	0.0500	ug/L
Water	Indeno (1,2,3-cd) pyrene	0.200	0.100	0.0500	ug/L
Water	Naphthalene	0.200	0.100	0.0500	ug/L
Water	Phenanthrene	0.400	0.200	0.100	ug/L
Water	Pyrene	0.200	0.100	0.0500	ug/L
Water	Terphenyl-d14 (Surrogate)	0.200	0.100	0.0500	ug/L
TCLP	2,4,5-Trichlorophenol	0.05	0.025	0.0125	mg/L
TCLP	2,4,6-Trichlorophenol (TCP)	0.05	0.025	0.0125	mg/L
TCLP	2,4-Dinitrotoluene (DNT)	0.05	0.025	0.0125	mg/L
TCLP	2.4.6-Tribromophenol (Surrogate)	10	5	2.5	ug/L
TCLP	2-Fluorobiphenyl (Surrogate)	5.00	2.50	1.25	ug/L
TCLP	2-Fluorophenol (Surrogate)	10	5	2.5	ug/L
TCLP	2-Methylphenol (o-Cresol)	0.05	0.025	0.0125	mg/L
TCLP	3-Methylphenol (m-Cresol)	0.05	0.025	0.0125	mg/L
TCLP	4-Methylphenol (p-Cresol)	0.05	0.025	0.0125	mg/L
TCLP	Hexachlorobenzene (HCB)	0.05	0.025	0.0125	mg/L
TCLP	Hexachlorobutadiene (HCBD)	0.05	0.025	0.0125	mg/L
TCLP	Hexachloroethane (HCE)	0.05	0.025	0.0125	mg/L
TCLP	Nitrobenzene	0.05	0.025	0.0125	mg/L
TCLP	Nitrobenzene-d5 (Surrogate)	5	2.5	1.25	ug/L
TCLP	Pentachlorophenol	0.2	0.1	0.05	mg/L
TCLP	Phenol-d6 (Surrogate)	10	5	2.5	ug/L
TCLP	Pyridine	0.10	0.050	0.025	mg/L
TCLP	Terphenyl-d14 (Surrogate)	5	2.5	1.25	ug/L

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Table 2. Organic Analysis by Gas Chromatography/Mass Spectrometry (Methods 625/8270)					
QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise, method-specific criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria (see Section C.1.f of DoD QSM 4.1).	NA.	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C of DoD QSM 4.1. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
MDL determination	Initial method demonstration then annually required for some states – not required for DoD	Refer to SOP QS09.			
LOD determination and verification	Prior to initial analysis then quarterly verification.	Detection at the LOD			
LOQ establishment and verification	Prior to initial analysis then quarterly verification.	Recoveries within LCS limits at 1x-4x LOQ			
Tuning	Prior to ICAL and at the beginning of each 12-hour period.	Refer to table 7 of this SOP.	Retune instrument and verify. Rerun affected samples.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be accepted without a valid tune.
Breakdown check (DDT Method 8270 only)	At the beginning of each 12-hour period, prior to analysis of samples.	Degradation ≤ 20% for DDT. Benzidine and pentachlorophenol should be present at their normal responses, and should not exceed a tailing factor of 2. [Method 625 – benzidine and pentachlorophenol tailing limits are 3 and 5, respectively, when benzidine or acids are target analytes. Benzidine tailing is specific to benzidine analysis and pentachlorophenol tailing is specific to acid analyte analyses according to 625.]	Correct problem then repeat breakdown checks.	Flagging criteria are not appropriate.	No samples shall be run until degradation ≤ 20%. **Not applied when low concentration PAHs are the only target analytes.**

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Table 2. Organic Analysis by Gas Chromatography/Mass Spectrometry (Methods 625/8270) (continued)					
QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Minimum five-point initial calibration (ICAL) for all analytes	ICAL prior to sample analysis.	**1.** Average response factor (RF) for SPCCs: SVOCs ≥ 0.050 [2,4-dinitrophenol, hexachlorocyclopentadiene, N-Nitrosodi-n-propylamine, 4-nitrophenol] **Note 1:** See table 9 for 8270D SPCC analytes and limits. **Note 2:** ≥ 0.050 for all low-level targets **2.** RSD for RFs for CCCs: SVOCs ≤ 30% and one option below: **Option 1:** RSD for each analyte ≤ 15%; [≤ 20% for non-DoD 8270D; or, ≤35% for non-DoD 625] **Option 2:** linear least squares regression r ≥ 0.995 or $r^2 \geq 0.990$; [r ≥ 0.990 for non-DoD analyses] **Option 3:** non-linear regression–coefficient of determination (COD) $r^2 \geq 0.990$ (6 points shall be used for second order, 7 points shall be used for third order).	Correct problem then repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until ICAL has passed. Calibration may not be forced through the origin for DoD projects.
Second source calibration verification (ICV)	Once after each ICAL.	All project analytes within ± 20% of true value [± 25% for non-DoD 8270C; or, ± 30% for non-DoD 8270D]	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples should be run until calibration has been verified.
Retention time window position establishment for each analyte and surrogate	Once per ICAL.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the sequence CCV is used.	NA.	NA.	

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Table 2. Organic Analysis by Gas Chromatography/Mass Spectrometry (Methods 625/8270) (continued)					
QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Evaluation of relative retention times (RRT)	With each sample.	RRT of each target analyte within ± 0.06 RRT units. Note - retention times may be updated based on the CCV to account for minor performance fluctuations or after routine system maintenance (such as column clipping).	Correct problem, then rerun ICAL.	Flagging criteria are not appropriate.	With each sample, the RRT shall be compared with the most recently updated RRT. If the RRT has changed by more than ±0.06 RRT units since the last update, this indicates a significant change in system performance and the laboratory must take appropriate corrective actions as required by the method and rerun the ICAL to reestablish the retention times.
Continuing calibration verification (CCV)	Daily before sample analysis and every 12 hours of analysis time.	**1.** RF for SPCCs: SVOCs ≥ 0.050 [2,4-dinitrophenol, hexachlorocyclopentadiene, N-Nitrosodi-n-propylamine, 4-nitrophenol] **Note 1:** See table 9 for 8270D SPCC analytes and limits. **Note 2:** ≥ 0.050 for all low-level targets **2.** %Difference/Drift for all target compounds and surrogates: SVOCs ≤ 20%D (Note: D = difference when using RFs or drift when using least squares regression or non-linear calibration). [± 20% for CCCs only non-DoD 8270C]	DoD project level approval must be obtained for each of the failed analytes or corrective action must be taken. Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV.	If reanalysis cannot be performed, data should be qualified and explained in the case narrative. Apply qualifier to all results for the specific analyte(s) in all samples since last acceptable CCV. [For non-DoD 8270C, if CCCs exceed, evaluate all analytes for 20%D and qualify as above]	Problem should be corrected. Results should not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed, holding time has been exceeded or client has approved reporting.
Internal standards verification	Every field sample, standard, and QC sample.	Retention time ± 30 seconds from retention time of the midpoint standard in the ICAL or daily CCV; EICP area within -50% to +100% of ICAL midpoint standard or daily CCV.	Inspect mass spectrometer and GC for malfunctions. Reanalysis of samples analyzed while system was malfunctioning is mandatory.	If corrective action fails in field samples, apply qualifier to analytes associated with the non-compliant IS. Flagging criteria are not appropriate for failed standards.	Sample results are not acceptable without a valid IS verification.

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Table 2. Organic Analysis by Gas Chromatography/Mass Spectrometry (Methods 625/8270) (continued)					
QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Method blank	One per preparatory batch.	No analytes detected > ½ RL/LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For common laboratory contaminants (phthalates), no analytes detected > RL/LOQ.	Correct problem. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
LCS containing all analytes to be reported, including surrogates	One per preparatory batch.	QC acceptance criteria specified by client or DoD (appendix G), if available. AFCEE 4.0.02 limits are applied for low concentration PAHs as they are not addressed by DoD. Otherwise, use in-house control limits. In-house control limits may not be greater than ± 3 times the standard deviation of the mean LCS recovery. Low concentration PAH limits	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike (MS)	One per preparatory batch per matrix	Use LCS criteria, above.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply qualifier if acceptance criteria are not met.	For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.
Matrix spike duplicate (MSD) or sample duplicate	One per preparatory batch per matrix	MSD: For matrix evaluation, use LCS acceptance criteria above. MSD or sample duplicate: RPD ≤ 30% or client specified limit (between MS and MSD or sample and sample duplicate).	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply qualifier if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.

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Table 2. Organic Analysis by Gas Chromatography/Mass Spectrometry (Methods 625/8270) (continued)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Surrogate spike	All field and QC samples.	**Surrogate** / **Water** / **Solid** Nitrobenzene-d5: 40-110 / 35-100 2-Fluorobiphenyl: 50-110 / 45-105 Terphenyl-d14: 50-135 / 30-125 Phenol-d6: 10-115 / 40-100 2-Fluorophenol: 20-110 / 35-105 2,4,6-Tribromophenol: 40-125 / 35-125 QC acceptance criteria specified by DoD (above) or Client. Low-level surrogate limits are 14%-129% soil and 34%-167% water. Otherwise, in-house control limits may be used. No limits specified for Method 625.	For QC and field samples, correct problem then reprep and reanalyze all failed samples for failed surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be necessary.	Apply qualifier to all associated analytes if acceptance criteria are not met. For acid surrogate, qualify acid analytes, for base/neutral surrogates, qualify base/neutral analytes.	
Results reported between DL and LOQ	NA.	NA.	NA.	Apply J-flag to all results between DL and LOQ.	

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Table 3, ANALYST DATA REVIEW CHECKLIST

Sample Number(s):	
Batch Number(s)/Target ID:	
Sequence Number/Calibration Number:	
Method: 8260B/624/6200, 8270C/8270D/625	**NCR#_____**

QA/QC Item	Yes	No	NA	2nd Check
1. Was the autosampler tray verified against the sequence file?	___	___	___	_____
2. Is the BFB/DFTPP tune performed every 12 hours and is the tuning criteria met? For 8270 regular (not low PAH), have tailing and breakdown criteria been met?	___	___	___	_____
3. Are the % RSDs within 20% or 0.995 linear corr or 0.990 quadratic COD for all analytes in the initial calibration? Are SPCC response factor criteria met? Is recalc. of low stds within 50%-150% (preferred). Retention times checked for compounds with the same spectra. Concentrations checked fir compounds with different conc.(eg. m/p-xylene, ketones,etc.).	___	___	___	_____
4. Was the initial calibration curve verified by a second source calibration standard (ICV) and have criteria been met (+/-20% DoD, +/-25% method)? Are SPCC response factor criteria met?	___	___	___	_____
5. Does the Continuing Calibration Standard (CCV) meet the ± 20% difference criteria and IS within 50%-200% of calibration curve midpoint?	___	___	___	_____
6. Is the Method Blank run at the desired frequency and is its concentration for target analytes less than the RL (LOD for DoD except phthalates)?	___	___	___	_____
7. Are the BS, BSD, MS, MSD within control limits and run at the desired frequency?	___	___	___	_____
8. Are all sample holding times met, analytes within calibration range, IS areas within 50%-200% of CCV response and surrogate recoveries within limits?	___	___	___	_____
9. Sample_____shows calculation verified from raw data to final LIMS concentration.	___	___	___	_____
10. Data uploaded to Element with correct analysts reflected?	___	___	___	_____
	___	___	___	_____

Comments on any "No" response:

_____

_____

_____

_____

Data uploaded?

Data Qualified?

Primary-Level Review: _____ Date: _____

Second-Level Review: _____ Date: _____

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Table 4 – 625 QC limits

COMPOUND	SPIKE ADDED (ug/L)	SAMPLE CONCENTRATION (ug/L)	LCS CONCENTRATION (ug/L)	LCS % REC #	QC. LIMITS REC.
Acenaphthene	100.00	0.0000	100.00	100	47-145
Acenaphthylene	100.00	0.0000	100.00	100	33-145
Anthracene	100.00	0.0000	100.00	100	27-133
Benzidine	100.00	0.0000	100.00	100	D-110
Benzo(a)anthracene	100.00	0.0000	100.00	100	33-143
Benzo(b)fluoranthene	100.00	0.0000	100.00	100	24-159
Benzo(k)fluoranthene	100.00	0.0000	100.00	100	11-162
Benzo(g,h,i)perylene	100.00	0.0000	100.00	100	D-219
Benzo(a)pyrene	100.00	0.0000	100.00	100	17-163
bis(2-Chloroethoxy)meth	100.00	0.0000	100.00	100	33-184
bis(2-Chloroethyl)ether	100.00	0.0000	100.00	100	12-158
bis(2-Chloroisopropyl)e	100.00	0.0000	100.00	100	36-166
Bis(2-ethylhexyl)phthal	100.00	0.0000	100.00	100	8-158
4-Bromophenyl-phenyleth	100.00	0.0000	100.00	100	53-127
Butylbenzylphthalate	100.00	0.0000	100.00	100	D-152
4-Chloro-3-methylphenol	100.00	0.0000	100.00	100	22-147
2-Chloronaphthalene	100.00	0.0000	100.00	100	60-118
2-Chlorophenol	100.00	0.0000	100.00	100	23-134
4-Chlorophenyl-phenylet	100.00	0.0000	100.00	100	25-158
Chrysene	100.00	0.0000	100.00	100	17-168
Dibenz(a,h)anthracene	100.00	0.0000	100.00	100	D-227
1,2-Dichlorobenzene	100.00	0.0000	100.00	100	32-129
1,3-Dichlorobenzene	100.00	0.0000	100.00	100	D-172
1,4-Dichlorobenzene	100.00	0.0000	100.00	100	20-124
3,3'-Dichlorobenzidine	100.00	0.0000	100.00	100	D-262
2,4-Dichlorophenol	100.00	0.0000	100.00	100	39-135
Diethylphthalate	100.00	0.0000	100.00	100	D-114
2,4-Dimethylphenol	100.00	0.0000	100.00	100	32-119
Dimethylphthalate	100.00	0.0000	100.00	100	D-112
Di-n-butylphthalate	100.00	0.0000	100.00	100	1-118
4,6-Dinitro-2-methylphe	100.00	0.0000	100.00	100	D-181
2,4-Dinitrophenol	100.00	0.0000	100.00	100	D-191
2,4-Dinitrotoluene	100.00	0.0000	100.00	100	39-139
2,6-Dinitrotoluene	100.00	0.0000	100.00	100	50-158
Di-n-octylphthalate	100.00	0.0000	100.00	100	4-146
Fluoranthene	100.00	0.0000	100.00	100	26-137
Fluorene	100.00	0.0000	100.00	100	59-121
Hexachlorobenzene	100.00	0.0000	100.00	100	D-152
Hexachlorobutadiene	100.00	0.0000	100.00	100	24-116
Hexachlorocyclopentadie	100.00	0.0000	100.00	100	15- 70
Hexachloroethane	100.00	0.0000	100.00	100	40-113
Indeno(1,2,3-cd)pyrene	100.00	0.0000	100.00	100	D-171
Isophorone	100.00	0.0000	100.00	100	21-196
Naphthalene	100.00	0.0000	100.00	100	21-133
Nitrobenzene	100.00	0.0000	100.00	100	35-180
2-Nitrophenol	100.00	0.0000	100.00	100	29-182
4-Nitrophenol	100.00	0.0000	100.00	100	D-132
N-Nitroso-di-methylamin	100.00	0.0000	100.00	100	29- 66
N-Nitrosodiphenylamine	100.00	0.0000	100.00	100	23-100
N-Nitroso-di-n-propylam	100.00	0.0000	100.00	100	D-230
Pentachlorophenol	100.00	0.0000	100.00	100	14-176
Phenanthrene	100.00	0.0000	100.00	100	54-120
Phenol	100.00	0.0000	100.00	100	5-112
Pyrene	100.00	0.0000	100.00	100	52-115
1,2,4-Trichlorobenzene	100.00	0.0000	100.00	100	44-142
2,4,6-Trichlorophenol	100.00	0.0000	100.00	100	37-144

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Table 5 - BNA STANDARDS USED

base/neutral mix (2000ppm)		**acids mix (2000ppm)**
bis(2-Chloroethyl)ether		2,4-Dinitrophenol
bis(2-Chloroisopropyl)ether		2-Methylphenol
1,3-Dichlorobenzene		4-Methylphenol
1,2-Dichlorobenzene		Benzoic acid
1,4-Dichlorobenzene		4,6-Dinitro-2-methylphenol
Hexachloroethane		4-Nitrophenol
N-Nitroso-di-methylamine		2,4,5-Trichlorophenol
N-Nitroso-di-n-propylamine		2,4,6-Trichlorophenol
2,4-Dinitrotoluene		Phenol
2,6-Dinitrotoluene		Pentachlorophenol
Fluorene		2-Nitrophenol
Dimethylphthalate		4-Chloro-3-methylphenol
Hexachlorocyclopentadiene		2,4-Dichlorophenol
Anthracene		2,4-Dimethylphenol
4-Bromophenyl-phenylether		Benzoic acid
Di-n-butylphthalate		
bis(2-Chloroethoxy)methane		
1,2-Diphenylhydrazine		**semivoa misc. mix(2000ppm)**
Fluoranthene		Aniline
Hexachlorobenzene		Benzyl alcohol
N-Nitrosodiphenylamine		Carbazole
Phenanthrene		4-Chloroaniline
Hexachlorobutadiene		Dibenzofuran
Isophorone		2-Methylnaphthalene
Naphthalene		2-Nitroaniline
Nitrobenzene		3-Nitroaniline
1,2,4-Trichlorobenzene		4-Nitroaniline
Acenaphthene		Pyridine
Acenaphthylene		
2-Chloronaphthalene		
4-Chlorophenyl-phenylether		**Benzidine mix (2000ppm)**
Diethylphthalate		Benzidine
Benzo(a)anthracene		3,3'-Dichlorobenzidine
Bis(2-ethylhexyl)phthalate		
Butylbenzylphthalate		
Chrysene		**Individual or misc. mixes (2000/5000/20,000ppm)**
p-(Dimethylamino)azobenzene		Caprolactam
Pyrene		Benzaldehyde
Benzo(b)fluoranthene		Atrazine
Benzo(k)fluoranthene		1,1'-Biphenyl
Benzo(g,h,i)perylene		1,4-Dioxane
Benzo(a)pyrene		1-methylnapthalene
Dibenz(a,h)anthracene		2,6-dichlorophenol
Di-n-octylphthalate		2,3,4,6-tetrachlorophenol
Indeno(1,2,3-cd)pyrene		

BNA internals (2000ppm)		Acid surrogate (7500ppm)
1,4-Dichlorobenzene-d4 (I.S)(1)		2-Fluorophenol (S)
Naphthalene-d8 (I.S)(35)		Phenol-d6 (S)
Acenaphthene-d10 (I.S) (59)		2,4,6-Tribromophenol (S)
Phenanthrene-d10 (I.S) (79)		2,-Chlorophenol-d4 (S)
Chrysene-d12 (I.S) (92))		BN surrogate (5000ppm)
Perylene-d12 (I.S) (101)		Nitrobenzene-d5 (S)
		Terphenyl-d14 (S)
		2-Fluorobiphenyl (S)
		1,2-Dichlorobenzene-d4 (S)

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Table 6 - Analyte (Regular)	ISRef	QIon
1,1-Biphenyl	902	154
1,2,4,5-Tetrachlorobenzene	901	216
1,2,4-Trichlorobenzene	901	180
1,2-Dichlorobenzene	900	146
1,2-Diphenylhydrazine	903	77
1,3-Dichlorobenzene	900	146
1,4-Dichlorobenzene	900	146
1,4-Dichlorobenzene-d4	**900**	152
1,4-Dioxane	900	88
1-Methylnaphthalene	901	141
2,2'-Oxybis-1-chloropropane	900	45
2,3,4,6-Tetrachlorophenol	902	232
2,4,5-Trichlorophenol	902	196
2,4,6-Tribromophenol (surr)	903	330
2,4,6-Trichlorophenol	902	196
2,4-Dichlorophenol	901	162
2,4-Dimethylphenol	901	107
2,4-Dinitrophenol	902	184
2,4-Dinitrotoluene	902	165
2,6-Dichlorophenol	901	162
2,6-Dinitrotoluene	902	165
2-Chloronaphthalene	902	162
2-Chlorophenol	900	128
2-Fluorobiphenyl (surr)	902	172
2-Fluorophenol (surr)	900	112
2-Methylnaphthalene	901	141
2-Methylphenol	900	108
2-Nitroaniline	902	65
2-Nitrophenol	901	139
3,3'-Dichlorobenzidine	904	252
3-Methylphenol	900	108
3-Methylphenol/4-Methylphenol	900	108
3-Nitroaniline	902	138
4,6-Dinitro-2-methylphenol	903	198
4-Bromophenyl-phenylether	903	248
4-Chloro-3-methylphenol	901	107
4-Chloroaniline	901	127
4-Chlorophenyl phenyl ether	902	204
4-Methylphenol	900	108
4-Nitroaniline	902	138
4-Nitrophenol	902	65
Acenaphthene	902	153
Acenaphthene-d10	**902**	164
Acenaphthylene	902	152
Acetophenone	900	105
Aniline	900	93
Anthracene	903	178
Atrazine	903	200

Table 6 - Analyte (Regular)	ISRef	QIon
Benzaldehyde	900	106
Benzidine	904	184
Benzo(a)anthracene	904	228
Benzo(a)pyrene	905	252
Benzo(b)fluoranthene	905	252
Benzo(g,h,i)perylene	905	276
Benzo(k)fluoranthene	905	252
Benzoic acid	901	105
Benzyl alcohol	900	108
Bis(2-chloroethoxy)methane	901	93
Bis(2-chloroethyl)ether	900	93
Bis(2-ethylhexyl)phthalate	904	149
Butylbenzylphthalate	904	149
Caprolactam	901	113
Carbazole	903	167
Chrysene	904	228
Chrysene-d12	**904**	240
Dibenz(a,h)anthracene	905	278
Dibenzofuran	902	168
Diethylphthalate	902	149
Dimethyl phthalate	902	163
Di-n-butylphthalate	903	149
Di-n-octylphthalate	905	149
Fluoranthene	903	202
Fluorene	902	166
Hexachlorobenzene	903	284
Hexachlorobutadiene	901	225
Hexachlorocyclopentadiene	902	237
Hexachloroethane	900	117
Indeno(1,2,3-cd)pyrene	905	276
Isophorone	901	82
Naphthalene	901	128
Naphthalene-d8	**901**	136
Nitrobenzene	901	77
Nitrobenzene-d5 (surr)	901	82
N-Nitrosodimethylamine	900	42
N-Nitroso-di-n-propylamine	900	70
N-Nitrosodiphenylamine	903	169
Pentachlorophenol	903	266
Perylene-d12	**905**	264
Phenanthrene	903	178
Phenanthrene-d10	**903**	188
Phenol	900	94
Phenol-d6 (surr)	900	99
Pyrene	904	202
Pyridine	900	79
Terphenyl-d14 (surr)	904	244

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Table 7 - Analyte (Low)	ISRef	QIon
1,4-Dioxane	903	88
1-Methylnaphthalene	903	141
2,4,6-Tribromophenol (acid surr)	903	330
2-Fluorobiphenyl (surr)	903	172
2-Methylnaphthalene	903	141
Acenaphthene	903	153
Acenaphthylene	903	152
Anthracene	903	178
Benzo(a)anthracene	903	228
Benzo(a)pyrene	905	252
Benzo(b)fluoranthene	905	252
Benzo(g,h,i)perylene	905	276
Benzo(k)fluoranthene	905	252
Bis(2-ethylhexyl)phthalate	905	149
Carbazole	903	167
Chrysene	903	228
Dibenz(a,h)anthracene	905	278
Dibenzofuran	903	168
Di-n-octylphthalate	905	149
Fluoranthene	903	202
Fluorene	903	166
Hexachlorobenzene	903	284
Hexachlorobutadiene	903	225
Hexachlorocyclopentadiene	903	236.8
Hexachloroethane	903	117
Indeno(1,2,3-cd)pyrene	905	276
Isophorone	903	82
Naphthalene	903	128
N-Nitroso-di-n-propylamine	903	70
N-Nitrosodiphenylamine	903	169
Pentachlorophenol	903	266
Perylene-d12	**905**	264
Phenanthrene	903	178
Phenanthrene-d10	**903**	188
Phenol	903	94
Pyrene	903	202
Terphenyl-d14 (surr)	903	244

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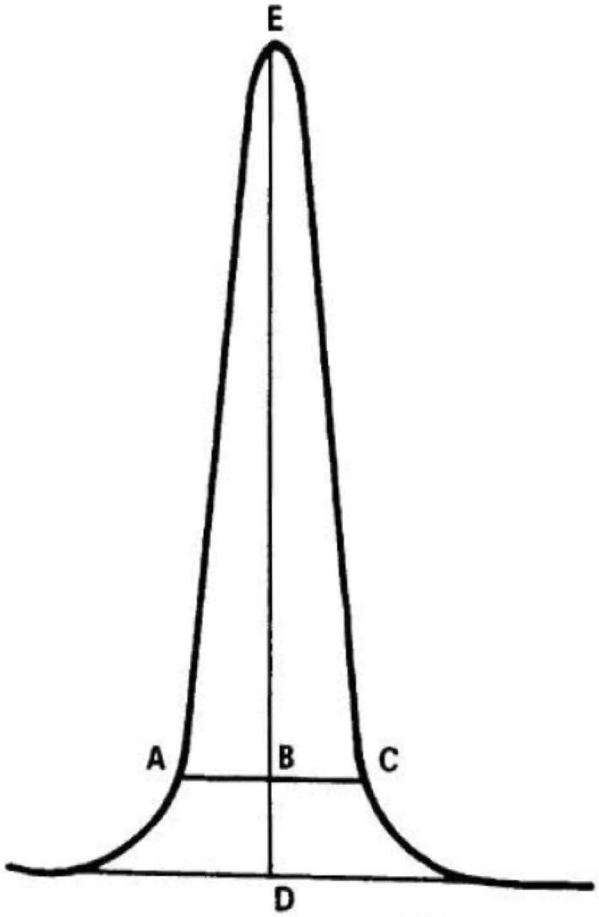
FIGURE 1
TAILING FACTOR CALCULATION



$$\text{TAILING FACTOR} = \frac{BC}{AB}$$

Example calculation: Peak Height = DE = 100 mm
10% Peak Height = BD = 10 mm
Peak Width at 10% Peak Height = AC = 23 mm
AB = 11 mm
BC = 12 mm

Therefore: Tailing Factor $= \frac{12}{11} = 1.1$

Table 8, DFTPP Tuning Criteria

Mass	Ion Abundance Criteria
51	30-60% of mass 198
68	<2% of mass 69
70	<2% of mass 69
127	40-60% of mass 198
197	<1% of mass 198
198	Base peak, 100% relative
199	5-9% of mass 198
275	10-30% of mass 198
365	>1% of mass 198
441	Present, but less than mass 443
442	>40% of mass 198
443	17-23% of mass 442

Note: While 8270D table 3 indicates different criteria, section 11.3.1.2 allows the use of alternate criteria.

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Table 9, 8270D SPCC limits

Analyte	SPCC
1,1-Biphenyl	0.010
1,2,4,5-Tetrachlorobenzene	0.010
1,2,4-Trichlorobenzene	0.010
1,2-Dichlorobenzene	0.010
1,2-Diphenylhydrazine	0.010
1,3-Dichlorobenzene	0.010
1,4-Dichlorobenzene	0.010
1,4-Dichlorobenzene-d4	0.010
1,4-Dioxane	0.010
1-Methylnaphthalene	0.010
2,2'-Oxybis-1-chloropropane	0.010
2,3,4,6-Tetrachlorophenol	0.010
2,4,5-Trichlorophenol	0.200
2,4,6-Tribromophenol	0.010
2,4,6-Trichlorophenol	0.200
2,4-Dichlorophenol	0.200
2,4-Dimethylphenol	0.200
2,4-Dinitrophenol **(8270C 0.050 used)**	*0.010*
2,4-Dinitrotoluene	0.200
2,6-Dichlorophenol	0.010
2,6-Dinitrotoluene	0.200
2-Chloronaphthalene	0.800
2-Chlorophenol	0.800
2-Fluorobiphenyl	0.010
2-Fluorophenol	0.010
2-Methylnaphthalene	0.400
2-Methylphenol	0.700
2-Nitroaniline	0.010
2-Nitrophenol	0.100
3,3'-Dichlorobenzidine	0.010
3-Methylphenol	0.010
3-Methylphenol/4-Methylphenol	0.010
3-Nitroaniline	0.010
4,6-Dinitro-2-methylphenol	0.010
4-Bromophenyl-phenylether	0.100
4-Chloro-3-methylphenol	0.200
4-Chloroaniline	0.010
4-Chlorophenyl phenyl ether	0.400
4-Methylphenol	0.600
4-Nitroaniline	0.010
4-Nitrophenol **(8270C 0.050 used)**	*0.010*
Acenaphthene	0.900
Acenaphthene-d10	0.010
Acenaphthylene	0.900
Acetophenone	0.010
Aniline	0.010
Anthracene	0.700
Atrazine	0.010

Analyte	SPCC
Benzaldehyde	0.010
Benzidine	0.010
Benzo(a)anthracene	0.800
Benzo(a)pyrene	0.700
Benzo(b)fluoranthene	0.700
Benzo(g,h,i)perylene	0.500
Benzo(k)fluoranthene	0.700
Benzoic acid	0.010
Benzyl alcohol	0.010
Bis(2-chloroethoxy)methane	0.300
Bis(2-chloroethyl)ether	0.700
Bis(2-ethylhexyl)phthalate	0.010
Butylbenzylphthalate	0.010
Caprolactam	0.010
Carbazole	0.010
Chrysene	0.700
Chrysene-d12	0.010
Dibenz(a,h)anthracene	0.400
Dibenzofuran	0.800
Diethylphthalate	0.010
Dimethyl phthalate	0.010
Di-n-butylphthalate	0.010
Di-n-octylphthalate	0.010
Fluoranthene	0.600
Fluorene	0.900
Hexachlorobenzene	0.100
Hexachlorobutadiene	0.010
Hexachlorocyclopentadiene	0.050
Hexachloroethane	0.300
Indeno(1,2,3-cd)pyrene	0.500
Isophorone	0.400
Naphthalene	0.700
Naphthalene-d8	0.010
Nitrobenzene	0.200
Nitrobenzene-d5	0.010
N-Nitrosodimethylamine	0.010
N-Nitroso-di-n-propylamine	0.500
N-Nitrosodiphenylamine	0.010
Pentachlorophenol	0.050
Perylene-d12	0.010
Phenanthrene	0.700
Phenanthrene-d10	0.010
Phenol	0.800
Phenol-d6	0.010
Pyrene	0.600
Pyridine	0.010
Terphenyl-d14	0.010

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Table 10, Poor Performing Analytes
1,1-Biphenyl
1,2,4,5-Tetrachlorobenzene
2,2'-Oxybis-1-chloropropane
2,6-Dichlorophenol
2-Nitroaniline
3,3'-Dichlorobenzidine
3-Nitroaniline
4,6-Dinitro-2-methylphenol
4-Chloroaniline
4-Nitroaniline
4-Nitrophenol
Acetophenone
Atrazine
Benzaldehyde
Bis(2-ethylhexyl)phthalate
Butylbenzylphthalate
Caprolactam
Carbazole
Diethylphthalate
Dimethyl phthalate
Di-n-butylphthalate
Di-n-octylphthalate
Hexachlorobutadiene
Hexachlorocyclopentadiene
N-Nitrosodiphenylamine

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EMPIRICAL LABORATORIES, LLC
STANDARD OPERATING PROCEDURE

ORGANICS: SOP 338 **REVISION #: 10** **EFFECTIVE DATE: 20120912**

FLPRO
METHOD FOR DETERMINATION OF PETROLEUM RANGE ORGANICS

APPROVALS:

Lab Director: _____ Date: 09/12/2012

Data Quality Manager: _____ Date: 09/12/2012

Section Supervisor: _____ Date: 09/12/2012

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Changes Summary

Revision 10, 20120912

- Equipment and Supplies were updated to reflect turbovap tubes from Reeves, add filter paper, and add tongue depressors.
- Standards and Reagents were updated to add LIMS record requirements, reflect pre-baked Sodium Sulfate from Jost Chemical, update silica gel reference and remove sodium hydroxide reference.
- Quality Control was updated to add QS08 reference and reflect BSD required when there is not enough sample available for a ms/msd.
- Water extraction procedure was updated to reflect pre-rinse of designated syringes, measurement of sample volume using calibration 1L amber, spike/surrogate added from just above the surface of the sample, 60mLs of methylene chloride for extraction , mechanical shaker time of 5 minutes and 5 minute hold before draining extract.
- Sonication extraction procedure was updated to reflect method 3550, 1mL spike of surrogate and spike solution added from just above the surface of samples, 2nd and 3rd extraction performed with 50mL instead of 60mL, horns rinsed with methylene chloride between samples, remove reference to recording turbovap temperature and pressure on bench sheet, and shake samples after addition of silica gel.
- Procedure for extraction by 3546 microwave was added.

Revision 09, 08/22/2011

- Added surrogate calibration requirement 11/19/2010. Implemented with November 2010 curve.
- Added a reference to SOP QS14 in section 20.1 and removed any reference to out-dated/retired SOPs.

Revision 08, 04/29/2010

- The SOP is a revision of rev07 dated 022410.
- Additional requirements, based upon the DoD QSM 4.1, have been integrated into the routine sample flow; however, if the requirement is different from routine sample flow, then the requirement is outlined and documented as such to be followed only when DoD samples are analyzed.
- Table 2 has been updated to reflect method surrogate limits and in-house action limits for samples.

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PETROLEUM HYDROCARBONS

1. **Test Method**
   1.1. This SOP is based upon method FL PRO.

2. **Applicable Matrix**
   2.1. This SOP is applicable to the determination of the concentration of Petroleum Hydrocarbons in ground water, sediments, and wastes in the alkane range of C-8 to C-40.

3. **Detection Limit**
   3.1. See Table 1 for limits.

4. **Scope and Application**
   4.1. This method is recommended for use by experienced analysts or under the close supervision for such qualified personnel for the determination of the concentration of Petroleum Hydrocarbons in ground water, sediments, and wastes in the alkane range of C-8 to C-40.

5. **Summary of the Test Method**
   5.1. Samples are extracted via separatory funnel, sonication or microwave extraction methods. A 1µL aliquot of the extract is injected into a GC system equipped with a flame ionization detector (FID). Quantification is based on the detector response in comparison to a series of alkane standards.

6. **Definitions**
   6.1. Laboratory Quality System **SOP QS08** "Technical / Operational Definitions, Minimum Essential Quality Control Elements, and Laboratory Calibration Procedures" provides information on the commonly used definitions.
   6.2. Petroleum Hydrocarbons: All chromatographic peaks, both resolved and unresolved, eluting between the peak of n-octane (n-C8) and the peak end after n-tetracontane (n-C40). Quantitation is based on direct comparison of the area within this range to the total area of the Petroleum Hydrocarbon standard as determined from the FID response using baseline – baseline integration.
   6.3. Petroluem Hydrocarbon Standard: A 17-component mix of all even-numbered alkanes from C8 to C40. This standard serves as a quantitation standard and a retention time window defining Petroleum Hydrocarbons.

7. **Interferences**
   7.1. All materials utilized during this analysis and the GC system must be demonstrated to be free from interference. Running frequent instrument blanks and methods blanks along with using pure, GC grade solvents will assist with the monitoring of interference's within the analytical system.
   7.2. Any interference's co-extracted with the samples will vary considerably from source to source. Individual samples may require additional cleanup.

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8. Health and Safety

8.1. Laboratory **SOP QS13** "Safety Program & Chemical Hygiene Plan" discusses the safety program that is to be followed labwide.

8.2. Care should be used in handling all samples. Safety glasses must be worn in the lab at all times. The use of latex gloves and lab coats is highly recommended.

8.3. Research into expected sample content and concentration should be done in order to be prepared for additional safety considerations. Generally, any samples that need special consideration have applicable notes on the sample logs.

8.4. MSDS sheets are available for all reagents and standards that have been purchased. These are located on the bookshelves in the Data Quality Manager's office.

9. Equipment and Supplies

a. Separatory Funnel - 2-Liter with Teflon stopcock
b. Beakers- 250 ml
c. Turbo-Vap evaporation tube - 200 mL tube made by Reeves to fit into Turbo-Vap evaporator
d. Metal or wood rack - capable of holding at a minimum six glass evaporation tubes
e. Turbo-Vap Evaporator - heated and capable of temperature control (±5°C); the bath should be vented into a hood.
f. Vials - 4 mL graduated clear glass, with Teflon-lined screw cap
g. pH indicator paper - close range (0-6.0) and (7.0 - 14.0); wide range (1.0 - 12.0)
h. Syringe - 1000µL
i. Graduated cylinder - Glass, Class A, 1000 mL
j. Pasteur pipette - length 9" and 5-3/4"
k. Pipette bulb
l. Aluminum foil - heavy duty
m. Nitrogen tank - equipped with pressure regulator
n. Ultrasonic Disrupter – capable of 300watts output, set on 10 Full power, pulse mode of 50%
o. A HP GC system, equipped with a flame ionization detector (FID), is used for analyzing extracts for all target analytes.
p. A Restek capillary column (RTX-5, 30m x 0.32mm x 0.25um) is used for analysis.
q. HP Chemstation Datasystem is used for data collection, detecting and storage.
r. Autosampler vials and caps appropriate to the sample tray are used for sample injection.
s. Microsyringes suitable for aliquoting 1.0 µL to 1000 µLs are used for standard preparation and sample dilution.
t. Class A volumetrics ranging from 1.0 ml to 250 mls are used for standard, spike and surrogate preparation.
u. Filter paper
v. Tongue depressors
w. 1L amber calibrated in 10ml increments.

10. Standards and Reagents

The laboratory's LIMS system allows for complete documentation and traceability of reagents and standards used within the laboratory. All certificates received with standards must be marked with the LIMS ID and forwarded to the administration department for scanning/saving in order to be available for review within LIMS. All reagents received or prepared are recorded within the LIMS. These reagents are added to the batch to ensure traceability to the associated samples. All reagents shall be received as or prepared from ACS reagent grade chemicals, minimum.

10.1 Reagents

10.1.1. ASTM Type II Water from Modulab system.

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10.1.2. Sodium Sulfate - Pre-baked Sodium Sulfate in 2.5 Kg. glass jars (Jost Chemical Co. Part number #2796, or equivalent). Alternatively, granular, anhydrous, trace pure 10-60 mesh may be used after placing in a Pyrex pan, heating at 400°C overnight (minimum 4hrs), and cooling then placing in a labeled glass amber jar for storage.

10.1.3. Silica Gel 60-200 mesh (Selecto Scientific, 126644, or equivalent). Stored at room temperature.

10.1.4. Glass Wool – Pre-rinse all glass wool used during the extraction process with Methylene Chloride.

10.1.5. Sulfuric Acid Solution - (1:1), slowly add 500 mL of Sulfuric Acid to 500 mL of reagent water in a 1000 mL pyrex container. This mixture will get very warm. Allow to cool before use.

10.1.6. Extraction Solvent - Methylene Chloride (Dichloromethane) (read SOP-336 before using this solvent in our laboratory)- Omnisolv - suitable for spectrophotometry and gas chromatography (JT Baker, or equivalent).

10.1.7. Carbon Disulfide– (Omnisolv - suitable for spectrophotometry, liquid chromotography and gas chromatography (JT Baker, or equivalent).

10.2. Stock standards - purchased from Restek,Ultra and other certified vendors depending on their availability. Petroleum Hydrocarbons: o-Terphenyl (OTP), 2-Fluorobiphenyl (2FBP), and TPH mix containing C8-C40. For stock standards, the expiration date is 6 months from the date the ampule is opened or the vendor expiration date, whichever comes first.

10.3 Working Standards

10.3.1 Standards made from Neat or from stock standards, and are intended for analytical preparation or analysis. The expiration date for these standards is 6 months from the date of preparation or the expiration of the parent stock, whichever date is first.

10.3.2 Follow analytical judgment when using standards. Evaluate standards on a daily basis versus past standards and instrument performance. A standard may evaporate or breakdown if proper storage processes are not used. Therefore, standards may have to be discarded before expiration dates.

11. Sample Collections, Preservation, Shipment, and Storage

11.1. Quality Systems **SOP QS10** related to Sample Receipt, Handling, & Processing provides details for collection, preservation, shipment, and storage.

11.2. Water samples are preserved with sulfuric acid or Hydrochloric acid to pH <2 and cooled to 4°C. Soils are stored at 4°C. Waters must be extracted within 7 days and soils within 14 days from collection and analyzed within 40 days of extraction. Extracts are kept at 4°C. Observe all safety guidelines when handling samples and extracts.

12.Quality Control

Quality Systems **SOP QS08** "Technical/ Operational Definitions, Minimum Essential Quality Control Elements, and Laboratory Calibration Procedures" outlines details related to laboratory wide protocols on quality control.

12.1 An extraction batch must contain no more than 20 field samples.

12.2 One BLK, BS, MS, and MSD must be extracted in each batch. BSD1 is required if there is not enough sample volume available for MS/MSD.

12.3 Please follow guidelines from Table 2 for meeting QC criteria.

13. Calibration and Standardization

13.1 Quality Systems **SOP QS08** "Technical / Operational Definitions, Minimum Essential Quality Control Elements, and Laboratory Calibration Procedures" related to Calibration Procedures provides laboratory wide protocols for calibration and standardization.

13.2 See section 14.4 of this SOP.

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14. Procedure

14.1 Aqueous Extraction: All waters have a seven-day holding time. Determine the samples necessary to extract from the following sources. Note: never extract samples of unknown origin without discussion with supervisor):

14.1.1 Each day a review backlog from LIMS indicating sample numbers with the respective analysis required

14.1.2 Samples requiring RUSH turn around time may be logged in throughout the day which will require your immediate attention. Log-in personnel and or PM will generally communicate this need.

14.1.3 Periodically check LIMS throughout the day to determine what new samples have arrived. If an analysis is ongoing, extra QC may be avoided by picking up those extractions on the same day.

14.1.4 Batch samples together in the LIMS, and print the bench sheet for the batch. Make sure appropriate number of BLK1, BS1, BSD1, MS1, and MSD1 are listed. From the beginning until the end of the extraction process, continue to fill in pertinent information into the LIMS system.

14.1.5 Wearing lab coat, gloves and safety glasses, get samples from walk-in cooler. Samples must be signed out of the walk-in cooler. Enter the sample numbers, your initials and the date and time removed on the log provided. Inspect as to whether they are in glass amber jars and have a Teflon lid. Find out if any special dilutions are needed for the client. Routine procedures for difficult matrices are listed below.

14.1.6 BAD MATRIX – for example a liquid that is partially sediment, see your supervisor to find out what dilution, if any should be made.

14.1.7 Set up enough separatory funnels to extract the number of samples you have plus any additional spikes and a method blank. A BLK, BS, MS and MSD must be processed with each batch of samples. A BSD may be extracted if sufficient sample volume is not available for MS/MSD.

14.1.8 Place a label on each separatory funnel containing the Lab #. The lab batch code is generated by LIMS. The BLK and BS will be identified by the lab batch code.

14.1.9 Pre-rinse all glassware with Methanol.

14.1.10 Compare the calibrated amber bottle to the sample bottle to determine sample volume. Record this volume and sample ID on the bench sheet.

14.1.11 ACID pH Adjusting: Adjust the pH to between 1.0 and 2.0, using 1:1 H_2SO_4. Add the acid solution to each sample, spike and method blank. Close and shake to insure that pH throughout the sample is changed. Check the pH using pH paper against a drop of sample from the lid. Compare the color to the chart on the pH paper. If the color is not within range add more H_2SO_4 solution in small increments, as required to attain the proper pH. If sample is received without proper acid preservation, pH adjustment details must be recorded in LIMS.

14.1.12 Using the 1000-mL glass graduated cylinder measure 1000 mL of DI water and transfer it to a separatory funnel for each BLK1, BS1 & BSD1. Transfer sample to separatory funnel that corresponds to the lab # on the sample bottle.

14.1.13 Verify the amount of surrogate/spike to add to the sample prior to addition. It can change if a different detection limit is required or the volume of sample being analyzed changes. Set out the surrogate/spike at least ten minutes before use to allow it to warm to room temperature.

Note: Prior to using a designated syringe, rinse the syringe with acetone and methanol.

14.1.14 Add 1 mL of spike to BS, MS & MSD. Add 1mL of surrogate to all samples and QC.

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When measuring spike/surrogate with a syringe, be sure to invert syringe and eliminate air bubble. Add solution just above the surface of the sample. **Someone must verify that the spike and surrogate has been added by initialing the extraction sheet.**

14.1.15 Rinse the sample bottle with 60 mls of Methylene Chloride. Transfer this rinsate into the separatory funnel labeled with the associated sample ID. Add 60 mL of Methylene Chloride to BLK, BS and BSD.

14.1.16 Seal and shake the separatory funnel **vigorously** for 2 minutes with periodic venting to release excess pressure. Alternatively, Teflon funnels may be used and placed in the shaker apparatus with the stopcocks slightly open. When this apparatus is used, the shake must be for 5 minutes.

NOTE: Methylene chloride creates excessive pressure very rapidly; therefore, initial venting should be done immediately after the separatory funnel has been sealed and shaken once.

14.1.17 Allow the sample to sit for 5 minutes (more, if necessary) after it has been shaken. It will separate into two layers with the solvent layer on the bottom. If it forms an emulsion (thick, cloudy, viscous, mixture that you cannot see through), attempt to break up the emulsion with a clean Teflon coated metal rod or drain what you believe to be 60mL into a separate centrifuge bottle/beaker with the appropriate laboratory sample ID and "acid fraction emulsion". If the layers are clearly separated, drain the solvent layer into the previously prepared glass beaker labeled with the laboratory sample ID.

NOTE: It is critical that only solvent be drained into the beaker. Make sure the sample is fully separated and carefully drain only solvent into the beaker, leaving 2-5ml in the funnel is acceptable at this step.

14.1.18 Repeat Steps 14.1.16 and 14.1.17 with 60 mLs of methylene chloride using the automatic shaker. Collect the extract from this step into the same beaker.

14.1.19 Transfer the extract to a pre-rinsed turbo vap tube by first passing through a funnel with glass wool and baked sodium sulfate all pre-rinsed with methylene chloride. After pouring the extract into the turbo vap tube, rinse the collection beaker 3-5 times with Methylene Chloride and transfer the rinsate to the turbo vap tube. Finally rinse the funnel with an adequate amount of Methylene Chloride using a Teflon squirt bottle. This ensures optimum transfer of all compounds of interest. Now concentrate the extract to 1.0 mL using the turbo vap concentrator.

14.1.20 Turbo-Vap Operation: Adjust the pressure of nitrogen gas tank to 30 psi. Make sure the tank has 200 psi or more on the main valve. The temperature of the bath should be 45±5°C. The pressure target range is 15-20 psi. Place the glass evaporator tube covered with foil in the Turbo-Vap. Be sure to push tube down so the tip slides into the sensor well. Close the lid to start concentration. Check that each position with a tube has an orange light showing. If the orange light is not steady, bubbles may be detected by the sensor and need removal. (See Turbo-Vap manual).

14.1.21 When the beep sounds indicating the end of concentration, the extract will be at approximately 1 mL. Remove the tube from the bath.

14.1.22 Add methylene chloride to dissolve any precipitate. Transfer extract to a graduated 4.0 ml vial, rinsing with methylene chloride. Adjust volume with methylene chloride to 2 ml. Add 0.3 g of silica gel and shake.

14.1.23 Sign the batch into the extraction laboratory Hobart. Refrigerate at 4°C or carry directly to the instrument operator. Remit custody of the batch to the analyst or technician. The extract is now ready to be analyzed.

14.1.24 The extraction is now complete. Clean all glassware used during the extraction and store appropriately. Please refer to the glassware cleaning SOP for additional guidance.

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14.2 **Solid Extraction (Sonication 3550).** All solids have a fourteen-day holding time. Determine the samples necessary to extract from the following sources (Note: never extract samples of unknown origin without discussion with supervisor):

14.2.1 Each day a review backlog from LIMS indicating sample numbers with the respective analysis required

14.2.2 Samples requiring RUSH turn around time may be logged in throughout the day which will require your immediate attention. Log-in personnel and or PM will generally communicate this need.

14.2.3 Periodically check LIMS throughout the day to determine is new samples have arrived. If an analysis is ongoing, extra QC may be avoided by picking up those extractions on the same day.

14.2.4 Batch samples together in the LIMS, and print the bench sheet for the batch. Make sure appropriate number of BLK, BS, MS, and MSD are listed. A BSD must be extracted if sample volume is not available for MS/MSD.

14.2.5 Wearing lab coat, gloves and safety glasses, get samples from refrigerator. Samples must be signed out of the walk-in refrigerator. Enter the sample numbers, your initials and the date and time removed on the log provided. Inspect as to whether they are in glass jar.

14.2.6 Examine the sample for unusual or bad matrix – for example a solid that is partially oil. See your supervisor to find out what dilution, if any should be made.

14.2.7 Get out enough 250mL beakers to extract the number of samples you have plus any additional spikes and a method blank. A BLK1, BS1, and a BSD1 must be processed with each batch of samples. A matrix spike and a duplicate or a matrix spike duplicate must be processed for each extraction batch (up to a maximum of 20 samples). If sufficient sample is not available to perform a batch MS & MSD indicate such on the extraction sheet.

14.2.8 Pre-rinse all glassware with Methanol. Label each 250mL beaker with the Lab ID.

14.2.9 Pre-weigh beakers and tare. Weigh 25g aliquot of the sample to the beaker and record weight to nearest 0.1g in the bench sheet. Add 25g dried Sodium Sulfate powder and stir the mixture well with a tongue depressor to a free-flowing sandy texture. If sample mixture forms large clumps due to moisture in the sample, add more Sodium Sulfate to achieve proper texture (note in the bench sheet).

14.2.10 It is extremely important that waste (when appropriate), soil and sediment samples be mixed thoroughly to ensure that the sample is as representative as possible of the sample media. The most common method of mixing is referred to as quartering. The quartering procedure should be performed as follows:

14.2.10.1 The material in the sample pan (inorganic-plastic/organic-aluminum) should be divided into quarters and each quarter should be mixed individually.

14.2.10.2 Two quarters should then be mixed to form halves.

14.2.10.3 The two halves should be mixed to form a homogenous matrix. This procedure should be repeated several times until the sample is adequately mixed.

NOTE: Samples that are clay type materials should be handled in a different manner. Due to these type sample matrices having an affinity to stick to most anything that touches it, another approach must be followed. Obtain a representative sub-sample aliquot from the center or middle section of the sample container.

14.2.11 Verify the amount of surrogate/spike to add to the sample prior to addition. It can change if a different detection limit is required or the volume of sample being analyzed changes. Set out the surrogate/spike at least ten minutes before use to allow it to warm to room temperature.

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Note: Prior to using a designated syringe, rinse the syringe with acetone and methanol.

14.2.12 Add 1 mL of spike to BS, MS & MSD. Add 1mL of surrogate to all samples and QC.

14.2.13 When measuring spike/surrogate with a syringe, be sure to invert syringe and eliminate air bubble. Add solution just above the surface of the sample. **Someone must verify that the spike and surrogate has been added by initialing the extraction sheet.**

14.2.14 Add 60 mL of Methylene Chloride to each sample and to all batch QC. Sonicate each sample for 3 minutes in Ultrasonic Disruptor (set on 10 Full power – pulse mode) at a pulse rate of 50%.

14.2.15 Decant the Methylene Chloride extract through a funnel with filter paper and baked sodium sulfate all pre-rinsed with methylene chloride, into a rinsed turbo vap tube.

14.2.16 Repeat Steps 14.2.14 and 14.2.14 two more times with 50 mLs of methylene chloride. Collect the extract from this step into the appropriately labeled tube. Be sure to rinse the sonication horns with methylene chloride between samples.

14.2.17 After pouring the final extract into the turbo vap tube, rinse the beaker 3-5 times with Methylene Chloride and transfer the rinsate to the turbo vap tube. Finally rinse the funnel with an adequate amount of Methylene Chloride using a Teflon squirt bottle. This ensures optimum transfer of all compounds of interest. Now concentrate the extract to 1.0 mL using the turbovap concentrator.

14.2.18 Concentration following steps 14.1.20-14.1.24

14.3 Solid Extraction (Microwave 3546)

14.3.1 Each day a review backlog from LIMS indicating sample numbers with the respective analysis required

14.3.2 Samples requiring RUSH turn around time may be logged in throughout the day which will require your immediate attention. Log-in personnel and or PM will generally communicate this need.

14.3.3 Periodically check LIMS throughout the day to determine is new samples have arrived. If an analysis is ongoing, extra QC may be avoided by picking up those extractions on the same day.

14.3.4 Batch samples together in the LIMS, and print the bench sheet for the batch. Make sure appropriate number of BLK, BS, MS, and MSD are listed. A BSD must be extracted if sample volume is not available for MS/MSD.

14.3.5 Wearing lab coat, gloves and safety glasses, get samples from refrigerator. Samples must be signed out of the walk-in refrigerator. Enter the sample numbers, your initials and the date and time removed on the log provided. Inspect as to whether they are in glass jar.

14.3.6 Examine the sample for unusual or bad matrix – for example a solid that is partially oil. See your supervisor to find out what dilution, if any should be made.

14.3.7 Get out enough aluminum pie pans to weigh-out the number of samples you have plus any additional spikes and a method blank. A BLK1, BS1, and a BSD1 must be processed with each batch of samples. A matrix spike and a duplicate or a matrix spike duplicate must be processed for each extraction batch (up to a maximum of 20 samples). If sufficient sample is not available to perform a batch MS & MSD indicate such on the extraction sheet.

14.3.8 Label each pie pan with the Lab ID.

14.3.9 Pre-weigh pie pans and tare. Weigh 15g aliquot of the sample and record weight to nearest 0.1g on the bench sheet. Add 15g dried Sodium Sulfate powder and stir the mixture well with a tongue depressor to a free-flowing sandy texture. If sample mixture forms large clumps due to moisture in the sample, add more Sodium Sulfate to achieve proper texture (note in the bench sheet).

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14.3.10 It is extremely important that waste (when appropriate), soil and sediment samples be mixed thoroughly to ensure that the sample is as representative as possible of the sample media. The most common method of mixing is referred to as quartering. The quartering procedure should be performed as follows:

14.3.10.1 The material in the sample pan (inorganic-plastic/organic-aluminum) should be divided into quarters and each quarter should be mixed individually.

14.3.10.2 Two quarters should then be mixed to form halves.

14.3.10.3 The two halves should be mixed to form a homogenous matrix. This procedure should be repeated several times until the sample is adequately mixed.

NOTE: Samples that are clay type materials should be handled in a different manner. Due to these type sample matrices having an affinity to stick to most anything that touches it, another approach must be followed. Obtain a representative sub-sample aliquot from the center or middle section of the sample container.

14.3.11 Transfer soil/ sodium sulfate mix to microwave tubes.

14.3.12 Verify the amount of surrogate/spike to add to the sample prior to addition. It can change if a different detection limit is required or the volume of sample being analyzed changes. Set out the surrogate/spike at least ten minutes before use to allow it to warm to room temperature.

Note: Prior to using a designated syringe, rinse the syringe with acetone and methanol.

14.3.13 Spike BS, BSD, MS, MSD with 1 mL of spike standard. Add 1 mL surrogate into all QC and samples. (BSD's are only required to be processed with soil set if sample is not available for a MS/MSD.) When measuring spike/surrogate with a syringe, be sure to invert syringe and eliminate air bubble. Add solution just above the surface of the sample. **Someone must verify that the spike and surrogate has been added by initialing the extraction sheet.**

14.3.14 Add 30mLs methylene chloride to microwave tubes. Use the stopper on the tubes and then screw the caps on the tubes. Use the MARSXpress Capping Station to tighten the cap. Invert the sample in tube to be sure all sample is in the MeCl2. Place tubes in the microwave wheel. Select either 800w (less than 16 samples) or 1600w (more than 16 samples) and hit start on microwave.

14.3.15 After the microwave cycle is complete, decant the Methylene Chloride extract through a funnel with filter paper and baked sodium sulfate all pre-rinsed with methylene chloride, into a rinsed turbo vap tube. Rinse the microwave tube 3-5 times with Methylene Chloride and transfer the rinsate to the turbo vap tube. Finally rinse the funnel with an adequate amount of Methylene Chloride using a Teflon squirt bottle. This ensures optimum transfer of all compounds of interest.

14.3.16 Now concentrate the extract to 1.0 mL using the turbovap concentrator following steps 14.1.20-14.1.24.

14.4 GCFID Analysis

14.4.1 Quality Systems **SOP QS09** "General and Commonly used Laboratory Calculations" provides details on general calculations used throughout the laboratory.

14.4.2 Follow guidelines provided in the method for GC-FID conditions and sample volume to be injected for method FL Pro.

14.4.3 It is recommended that a solvent Blank be analyzed at the beginning of every sequence to ensure that the analytical instrument is free of contaminants.

14.4.4 All extracts within a batch are run on the Instrument after meeting calibration criteria as described in Table 2.

14.4.5 Qualitative and quantitative analysis is performed on samples.

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14.4.5.1 Qualitative Analysis for specific carbon ranges or fuel patterns, such as; mineral spirits, kerosene, JP-4 and heavy oils are performed per client request compared to specific standards. (See Table 3)

14.4.5.2 Quantitative Analysis is performed using the following tools:

14.4.5.2.1 Retention times for the range FL PRO C8-C40 are set daily using the mid-level of the calibration (if applicable) or the first CCV of the run by subtracting 0.05min. from the RT of C8 and adding 0.05min. to the RT of C40. FL PRO analysis is performed by running 6 calibration levels of a TPH mix from C-8 through C-40 (17 peaks). A response factor is calculated for each calibration standard (amount sum of 17 peaks/ std amount * 17), then an Average Response factor is calculated for all 6 standards. This Average Response Factor is put in the method for uncalibrated peaks. Percent RSD must be less than or equal to 20%.

14.4.5.2.2 Surrogates o-Terphenyl and 2-fluorobiphenyl are calibrated by adding to each calibration level at increasing concentrations. Initial calibration must pass acceptance criteria in Table 2.

14.4.5.2.3 Analyte concentration must be within the calibration curve range. If the analyte concentration exceeds the calibration curve range, the extract must be diluted & rerun to bring the concentration within the calibration range. Use the calculation in section 15 to report the final results for the sample.

14.4.5.2.4 Target analytes are calculated using the calibration curve and by incorporating any adjustments for inital or final volume and dilutions.

15. Data Analysis and Calculations

15.1 Quality Systems **SOP QS09** "General and Commonly used Laboratory Calculations" provides details on general calculations throughout the laboratory.

15.2 Calculate the calibration factor for each analyte at each concentration as:

$$CF = \frac{\textit{Peak Area (or Height) of the Compound in the Standard}}{\textit{Mass of the Compound Injected (in nanograms)}}$$

The mean CF is calculated as follows:

$$\overline{CF} = \frac{\sum_{i-1}^{n} CFi}{n}$$

15.3 The standard deviation (SD) and the relative standard deviation (RSD) of the calibration factors for each analyte are calculated as follows:

$$SD = \sqrt{\frac{\sum_{i-1}^{n} (CFi - \overline{CF})^2}{n-1}}$$

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$$RSD = \frac{SD}{AvgCF} X\ 100$$

15.4 Calibration verification involves the calculation of the percent drift (linear or quadratic) or the percent difference (average) of the instrument response between the initial calibration and each subsequent analysis of the verification standard. Use the equations below to calculate % Drift or % Difference, depending on the calibration procedure used.

$$\%\ Drift = \frac{(Calculated\ concentration - Theoretical\ concentration)\ x\ 100}{Theoretical\ Concentration}$$

where the calculated concentration is determined from the initial calibration and the theoretical concentration is the concentration at which the standard was prepared.

$$\%\ Difference = \frac{(CCV\ CF - Average\ CF)\ x\ 100}{Average\ CF}$$

15.5 External standard calibration - The concentration of each analyte in the sample may be determined by calculating the amount of standard injected, from the peak response, using the calibration curve. The concentration of a specific analyte is calculated as follows:

Aqueous Samples:

Concentration (µg/L) = $[(A_S)\ (V_t)\ (D)]/\ [(\overline{CF})\ (V_i)\ (D)]$

where:

A_S = Response for the analyte in the sample, units may be in area counts or peak height.

V_t = Total volume of sample, mL.

D = Dilution factor, if dilution was made on the sample prior to analysis. If no dilution was made, D = 1.

$\overline{CF}$ = Mean calibration factor from initial calibration (area/ng)

V_i = Volume of extract injected, µL.

V_S = Volume of aqueous sample , mL.

Using the units specified here for these terms will result in concentration units of ng/mL, which is µg/L.

Nonaqueous Samples:

Concentration (µg/kg) = $[(A_S)\ (V_t)\ (D)]/[(\ CF)\ (V_i)\ (W_s)]$

where:

W_s= Weight of dry sample extracted, g.

A_S, V_t, D, $\overline{CF}$ and V_i have the same definition as for aqueous samples.

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16. Method Performance

16.1 Demonstration of Capability (DOC): Each analyst must perform a DOC prior to reporting data. The analyst must prepare (for prep technicians) and analyze (analysts reviewing and reporting data) 4-BS samples. The data is calculated for accuracy and precision requirements. The DOC form, as listed within section 2.5 of the Quality is completed by each analyst and then provided to the supervisor for further processing and approval.

16.2 See method FL-PRO for method performance.

17. Pollution Prevention

17.1 Quantity of chemicals purchased should be based on expected usage during its shelf life and the disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

18. Data Assessment and Acceptance Criteria for Quality Control Measures

18.1 Quality Control **SOP QS05**, "Data Deviations/Interpretations/Exceptions: Laboratory Non-Conformance/ Corrective Action Procedures, Decision Making Guidelines for Evaluating Laboratory Analytical Sample and Quality Control Results," provides details on data assessment and acceptance criteria for Quality Control Measures.

13.2 Table 2 of this SOP provides information on QC samples, frequency, and the associated criteria specific to the performance of this method.

19. Contingencies for Handling out-of-control or unacceptable data

19.1 Quality Control **SOP QS05**, "Data Deviations / Interpretations / Exceptions: Laboratory Non-Conformance / Corrective Action Procedures, Decision Making Guidelines for Evaluating Laboratory Analytical Sample and Quality Control Results", provides details on handling out of control data.

19.2 Table 2 within this SOP also lists corrective actions associated with the failure of the various QC samples employed for the performance of this method.

20. Waste Management and Pollution Prevention

20.1 Quantity of chemicals purchased should be based on expected usage during it's shelf-life and the disposal cost of unused material. Actual reagent preparation volumes should reflect anticipated usage and reagent stability.

20.2 Quality Systems **SOP QS14** on Waste Handling discusses general guidelines for the appropriate handling of wastes and the laboratory program on waste management

21. References

21.1 Method for Determination of Petroleum Range Organics (Method FL-PRO)

22. Tables, Diagrams, Flowcharts and Validation Data

Table 1 – Analytes, DL, LOD, LOQ/RL, & Low Calibration Standard
Table 2 - Method Quality Control Requirements Summary
Table-3 - Qualitative Analysis Tool

TABLE 1 – Analytes, DL, LOD, LOQ/RL, & Low Calibration Standard

Parameter	DL	LOD	LOQ/RL	Low Cal
FL-PRO (water)	0.17mg/L	0.34mg/L	0.68mg/L	0.17mg/L
FL-PRO (soil)	11.3mg/Kg	22.7mg/Kg	45.3mg/Kg	11.3mg/Kg

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Table 2 - Method Quality Control Requirements Summary			
QC Check	**Minimum Frequency / Requirements**	**Acceptance Criteria**	**Corrective Action for Failures / Data Useability**
Calibration Curve	• Prior to analyzing any samples • A minimum of 5-points for linear fits • A minimum of 6-points for quadratic fits • Low standard at the RL/LOQ level	• Linear correlation coefficient of at least 0.995 ($r^2 \geq 0.990$) • Quadratic squared correlation coefficient of at least 0.99 • Average CF =< 20% RSD • Manual integrations on curve standards must have supervisory approval • Must follow curve processing requirements from SOP QS08	• Re-evaluate curve mix and makeup • Re-run curve • Check instrument for maintenance needs • Re-prep the curve standards Samples cannot be analyzed until there is a passing calibration
ICV	Alternate source standard to be analyzed after every calibration curve	• $\leq$ 25% drift or difference for all analytes	• Re-analyze an ICV from a different source • Re-prep and re-analyze the ICV • Re-calibrate and verify standard preps and sources
CCV	• At the beginning of every sequence • For every 10-client samples and at the end of the sequence • The concentration must be varied from low to mid range	• $\leq$ 25% drift or difference for all analytes	• Evaluate the system for required maintenance • Obtain passing CCV • Reanalyze all samples injected since last passing CCV • Q-qualify if reanalysis is not possible
BLK	One per prep batch	• Must be less than ½ the RL/LOQ or <1/10th any sample concentration or <1/10th the regulatory limit – whichever is greater.	• Re-analyze to confirm the positive value • If MB results are between the LOD and RL/LOQ, assess the data and notify the PM for possible further action • Re-extract affected samples associated with the MB • NCR and final report qualification will be required for affected samples if re-extraction is not possible.

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Table 2 - Method Quality Control Requirements Summary			
QC Check	**Minimum Frequency / Requirements**	**Acceptance Criteria**	**Corrective Action for Failures / Data Useability**
Surrogates	Spike in every field or QC sample and standard	Surrogate / Water / Soil OTP: 82-142 (method) / 62-109 (method) 30-140 (in-house) / 45-135 (in- house) 2-FBP: 50-150 (default) / 50-150 (default) Note: Project limits will be used when specified.	• Batch QC should pass method limits. • Reanalyze to confirm recovery if failing in-house limits. • Re-extract associated samples, if still failing in-house limits. • Q-qualify if re-extraction is not possible or verifies exceedence.
BS	One per prep batch	Water 55-118% Soil 63-143% Note: Project limits will be used when specified.	• Reanalyze to confirm recovery. • Re-extract associated samples, if still failing • Q-qualify if re-extraction is not possible
BSD	One per prep batch, when MS/MSD not included.	Water 55-118% RPD ≤20% Soil 63-143% RPD ≤25% Note: Project limits will be used when specified.	• See BS
MS/MSD	One per prep batch, if sample volume available.	Water 41-110% RPD ≤20% Soil 51-215% RPD ≤25% Note: Project limits will be used when specified.	• Reanalyze to confirm recovery. • Re-extract if failure is judged to be due to extraction/analysis. • J-qualify associated parent sample if reporting from results exceeding limits.
DOC Study	• Initially per analyst prior to reporting data • Annually • Follow specific guidelines from section 16 for the preparation and analysis of DOC samples	• Must meet the criteria of the BS for average recovery • Precision criteria is 20% standard deviation.	• Re-prep and / or • Re-analysis
LOD Verification	Every quarter	• Parameter must be detected with response 3x the noise level	• Re-prep and / or re-analysis • Raise concentration
LOQ Verification	Every quarter	• Bias Requirement: Organics 50-150% • The LOQ value must be greater than the LOD value	• Re-prep and / or re-analysis • Raise concentration
Retention Time Study	• Prior to running samples • With major instrument changes	3 injections over 72 hours – calculate standard deviation of the measured retention times. Windows +/- 3xSD	If <0.05minutes use +/0.05 minutes.

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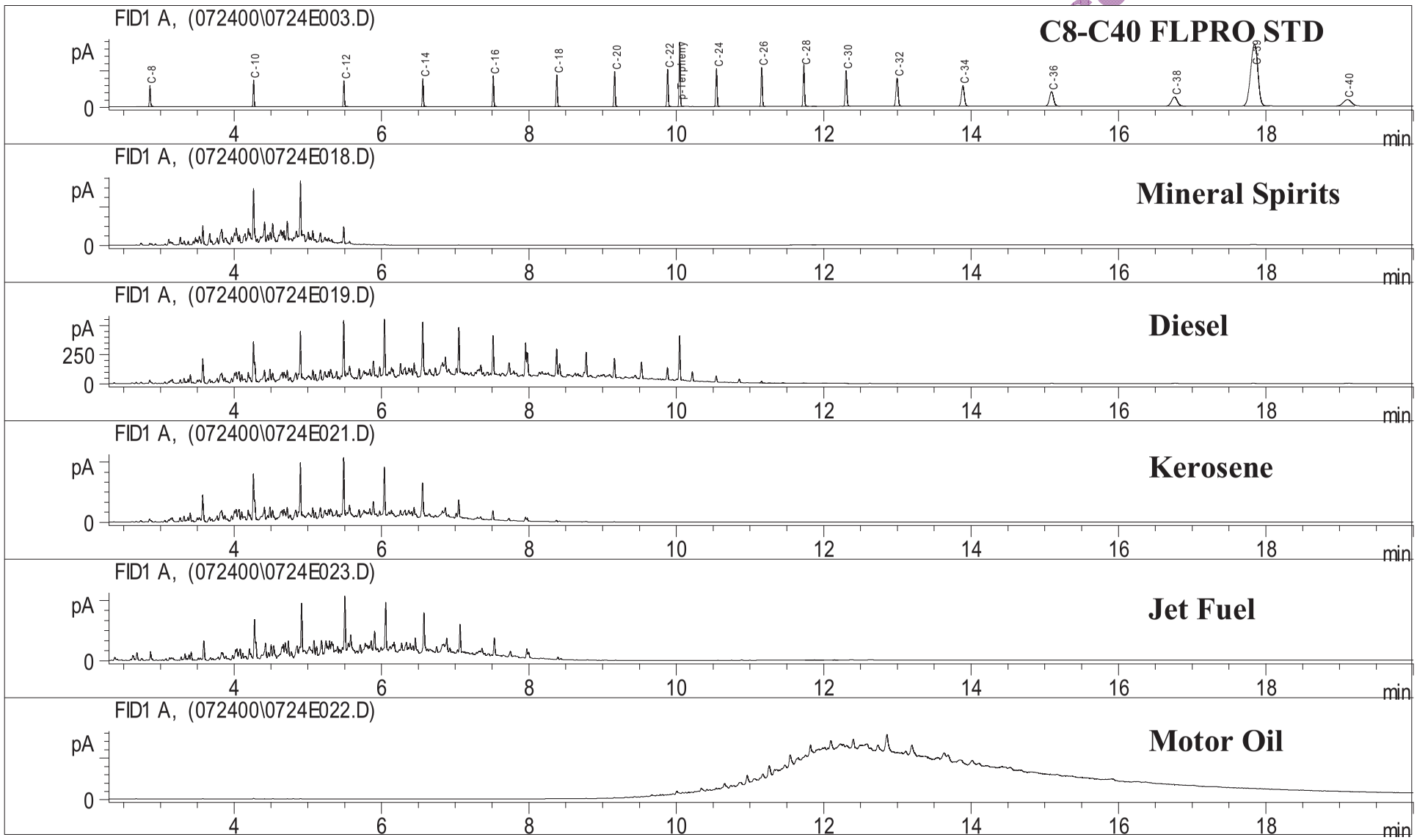
Table-3
Qualitative Analysis Tool