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SAMPLING ANALYSIS PLAN FOR FIELD SAMPLING PLAN AND QUALITY ASSURANCE PROJECT PLAN FOR GROUNDWATER SAMPLING AND ANALYSIS MONITORING PLAN AT SITE 11 OLD CAMDEN COUNTY LANDFILL DRAFT ACTING AS FINAL NSB KINGS BAY GA
8/1/2013
TETRA TECH, INC.

Sampling and Analysis Plan
(Field Sampling Plan and Quality Assurance Project Plan)
for
Groundwater Sampling and Analysis Monitoring Plan
At
Site 11, Old Camden County Landfill

Naval Submarine Base Kings Bay
Kings Bay, Georgia

Naval Facilities Engineering Command Southeast

Contract Number N62470-08-D-1001
Contract Task Order JM35

August 2013

SAP Worksheet #1 -- Title and Approval Page
(UFP-QAPP Manual Section 2.1)

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

AUGUST 2013

Groundwater Sampling and Analysis Monitoring Plan
Site 11, Old Camden County Landfill
Naval Submarine Base Kings Bay
Kings Bay, Georgia

Prepared for:
Naval Facilities Engineering Command
Southeast
NAS Jacksonville Building 903
Jacksonville, Florida 32212-0030

Prepared by:
Tetra Tech, Inc.
234 Mall Boulevard
King of Prussia, Pennsylvania 19406-2954

Prepared under:
Comprehensive Long-term Environmental Action Navy
(CLEAN) Contract Number N62470-08-D-1001
Contract Task Order JM35

SAP Worksheet #1 -- Approval Page
(UFP-QAPP Manual Section 2.1)

Document Title: Sampling and Analysis Plan, (Field Sampling Plan and Quality Assurance Project Plan), Revision 2, August 2013, Groundwater Sampling and Analysis Monitoring Plan, Site 11, Old Camden County Landfill, Naval Submarine Base Kings Bay, Kings Bay, Georgia

Lead Organization: Naval Facilities Engineering Command Southeast

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10-1-13

Signature/Date
Tom Johnston, Ph.D
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Lead Organization's Project Manager:

HAYWORTH.DANA.R.1264108450 Digitally signed by HAYWORTH.DANA.R.1264108450 DN: c=US, o=U.S. Government, ou=DoD, ou=PKI, ou=USN, cn=HAYWORTH.DANA.R.1264108450 Date: 2013.09.30 07:08:49 -04'00'

Signature/Date
Dana Hayworth, P.G.
Naval Facilities Engineering Command Southeast

Lead Organization Quality Assurance Officer:

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Signature/Date
Navy Chemist/Quality Assurance Officer
Naval Facilities Engineering Command Atlantic

Approval Signatures:

Signature/Date
Amy Potter
Georgia Department of Natural Resources

EXECUTIVE SUMMARY

Tetra Tech has prepared this Sampling and Analysis Plan (SAP) for the Groundwater Sampling and Analysis Monitoring Plan, Site 11, Old Camden County Landfill, Naval Submarine Base (NSB) Kings Bay, located in Kings Bay, Georgia. This work was completed under Comprehensive Long-term Environmental Action Navy Contract Number N62470-08-D-1001, Contract Task Order (CTO) JM35. This SAP was prepared to address the long-term monitoring (LTM) investigation at NSB Kings Bay. The site addressed in this SAP is already part of the LTM programs under the Hazardous Waste Facility Permit HW-014(S&T)-4.

NSB Kings Bay is located in Kings Bay, Georgia (see Figure ES-1). Since the mid-1990s, several Comprehensive Environmental Response, Compensation, and Liability Act of 1980 and Resource Conservation and Recovery Act (RCRA)-based investigations and interim actions have been implemented at Site 11, Old Camden County Landfill. Site 11 is located along the northwestern boundary of NSB Kings Bay, east of the Crooked River Plantation residential subdivision. At some point during landfill operations, tetrachloroethene (PCE) was released in the landfill. Environmental investigations began at Site 11 in 1992 after volatile organic compound (VOC) groundwater contamination (including vinyl chloride, dichloroethene [DCE], cis-1,2-DCE, trichloroethene [TCE], PCE, benzene, toluene, ethylbenzene, m&p-xylene, and o-xylene) was identified during a RCRA Facility Investigation (RFI) conducted by ABB Environmental Services, Inc. (ABB-ES). The horizontal extent of the plume was also reported in a RFI Interim Report conducted by ABB-ES (ABB-ES, 1993). A groundwater extraction and treatment system was designed and installed as an interim measure. The system was operated in three phases from March 1994 to March 1999 at which time the system was shut down. In-situ chemical oxidation treatment was conducted in four phases from August 1998 to January 2002 with hydrogen peroxide and ferrous iron catalyst. Following the third phase of in-situ chemical oxidation, CH2M HILL Constructors, Inc. performed additional source delineation using a membrane interface probe during November 2000 and January 2001. Upon completion of the fourth phase of in-situ chemical oxidation, the pH of the groundwater was adjusted using potassium hydroxide and soybean oil injections to enhance natural attenuation. These injections were conducted from December 2001 to January 2002.

Since 1999, two LTM programs have been conducted at Site 11, including monitoring as required by the RCRA Permit, and performed in accordance with the associated Groundwater Monitoring Plan (GWMP) (Bechtel, 1999a), and monitoring conducted by the United States Geological Survey (USGS) in coordination with the Navy to evaluate the effectiveness of natural attenuation processes in reducing contaminant concentrations (USGS, 2009). The RCRA Permit required that monitoring began in 1999, and the monitoring program was adjusted several times based on the exit strategy provided in the GWMP

and other recommendations from the Georgia Environmental Protection Division (GEPD). The USGS monitoring was conducted from 1999 to 2009 at a number of designated wells. The study confirmed the effectiveness of natural attenuation processes at Site 11 (USGS, 2009). After the completion of the USGS study, these USGS monitoring wells were not sampled in 2010.

In April 2011, the Navy conducted another round of groundwater sampling. The USGS wells and the wells regulated under the site RCRA Permit were sampled during this sampling event. The long-term groundwater monitoring data from 1999 through 2011 were reviewed by Tetra Tech personnel to consolidate and optimize specifics of the two previous monitoring programs and to propose a new comprehensive monitoring program for future monitoring at Site 11. During the regulatory review of the draft optimization report, one existing well located in the source area (KBA-11-36) was sampled (January 2012) per the request of the GEPD to verify contamination was no longer migrating from the source area and that this well is not needed in the optimized monitoring network. A new well was also installed to replace a proposed sentinel well (108 Cottage Court) for which the screened interval could not be verified. Groundwater samples were collected from this newly installed well in March 2012; the results showed no exceedances, verifying that the new well can serve as a sentinel well.

The monitoring data review as part of the Tetra Tech's optimization study (Tetra Tech, 2012) concluded that 1) since 2001, exceedances of the RCRA Permit specified Groundwater Protection Standards (GWPSs) were found only for four chlorinated VOCs (cVOCs): PCE, TCE, cis-1,2-DCE, and vinyl chloride; 2) the plumes of the four cVOCs have shrunk significantly in the past 10 years; and 3) the concentration trends of the four cVOCs are mostly downward or stable. These data review results demonstrated the effectiveness of the corrective actions and natural attenuation in reducing contaminant concentrations and controlling plume migration; therefore, no further active remediation is necessary for the site. Additional chemical injection or installation of new wells within the landfill source area is also not recommended because of the potential to create vertical preferential pathways for contaminants associated with landfill wastes to migrate to groundwater (United States Environmental Protection Agency [USEPA], 1998). The optimization study also recommended that collection of natural attenuation parameters is no longer necessary for the site since the effectiveness of natural attenuation has been conclusively demonstrated at the site based on the optimization study data review and the USGS study (Tetra Tech, 2012).

Based on the optimization evaluation, recommendations were provided in the optimization report for optimizing the monitoring locations, monitoring frequencies, analyte list, and reporting requirements. The optimization report and the associated optimization recommendations were approved by the GEPD in 2012.

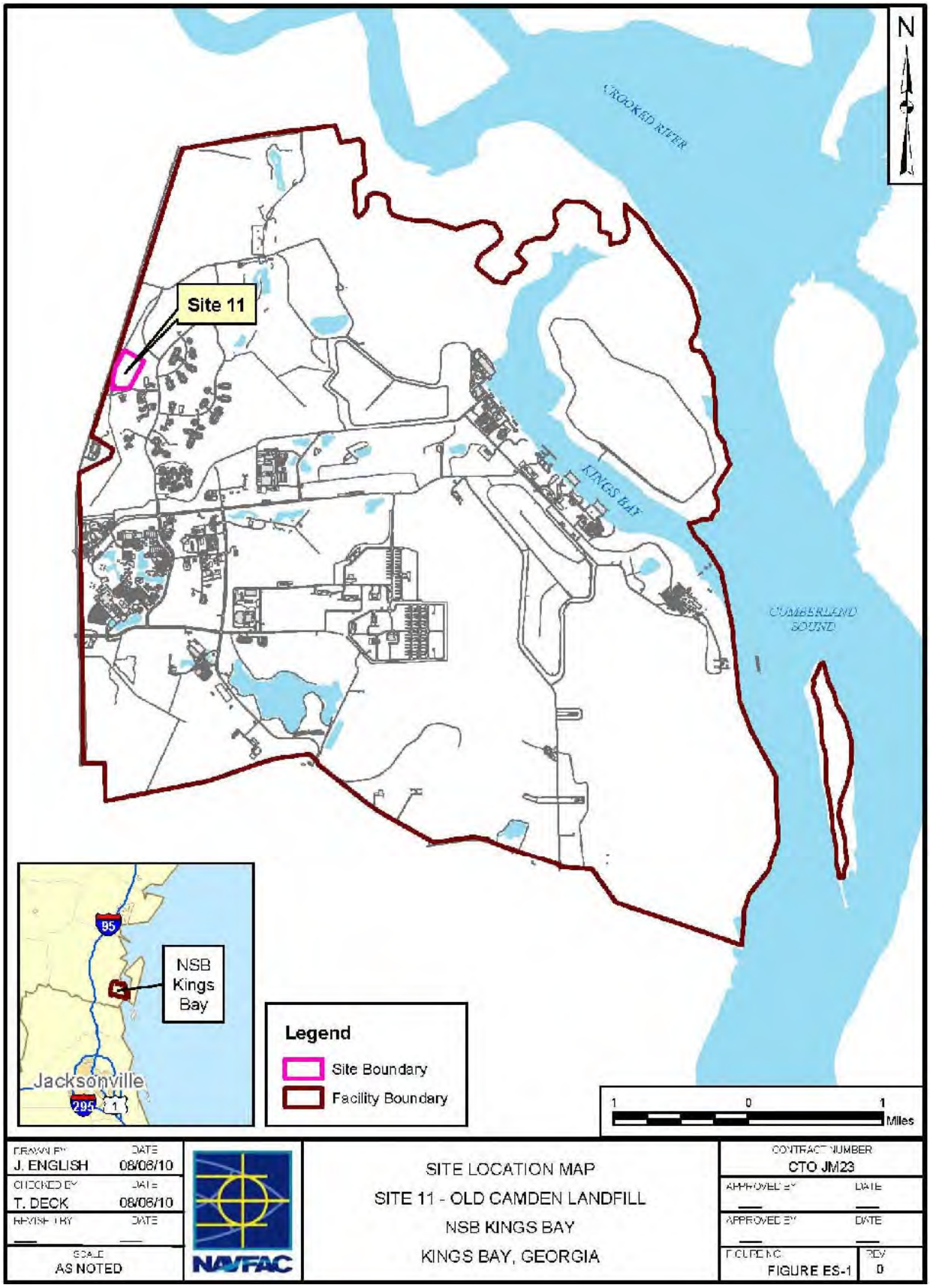
The recommendations are summarized as follows:

- Groundwater monitoring will be conducted at 16 wells only.
- The groundwater samples will be analyzed for PCE, TCE, cis-1,2-DCE, and vinyl chloride only. Field parameters (including dissolved oxygen, oxidation reduction potential, turbidity, specific conductance, temperature, and pH) will be collected at all 16 wells. Monitored natural attenuation (MNA) parameters will not be collected due to the demonstrated effectiveness of MNA at the site.
- Annual monitoring will be conducted for all wells except for the four sentinel wells and one source area well where semiannual monitoring will be conducted;
- The groundwater monitoring results will be reported annually in a comprehensive monitoring report. An interim semiannual submittal will be used to report semiannual results. The semiannual submittal will include a data presentation letter with one or two pages of text, tables, and figures summarizing monitoring results.

Site 11 currently is still in the phase of corrective action under MNA. The exit strategy for Site 11 is to demonstrate compliance of all remaining contaminants for three consecutive years with the GWPSs, which are equal to the USEPA Maximum Contaminant Levels. A well with an exceedance of a particular GWPS may be resampled within 30 days to determine if the initial result was valid. After demonstration of compliance with GWPS, a no further action status request will be submitted to the GEPD for approval.

The optimization study yielded significant reduction in the required monitoring effort at Site 11, yet ensures the data quality for the LTM at the site. Assuming ten years of additional monitoring are required to achieve site closure, a net value cost avoidance of approximately $790,000 was estimated and a reduction of approximately 80 percent in energy consumption and greenhouse gas emissions are expected.

The optimized sampling plan proposed in the optimization report was approved by GEPD and is the basis for the monitoring requirements listed in Section V of the current Hazardous Waste Facility Permit HW-014(S&T)-4. This SAP was prepared based on the recommendations in the approved optimization report and adopted in the permit. It was generated for, and complies with, applicable United States Department of Navy, USEPA, and Georgia Department of Natural Resources requirements, regulations, guidance, and technical standards. This includes the Department of Defense, Department of Energy, and USEPA Interagency Data Quality Task Force (IDQTF) environmental requirements regarding federal facilities. To comply with IDQTF requirements, this SAP is presented in the format of 37 standard worksheets specified in the Uniform Federal Policy for Quality Assurance Project Plans guidance documents (IDQTF, 2005).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CROOKED RIVER
Site 11
KINGS BAY
CUMBERLAND SOUND
95
NSB Kings Bay
Jacksonville
295
1
Legend
Site Boundary
Facility Boundary
1
0
1
Miles
DRAWN BY J. ENGLISH
DATE 08/06/10
CHECKED BY T. DECK
DATE 08/06/10
REVISED BY
DATE
SCALE AS NOTED
NAVFAC
SITE LOCATION MAP
SITE 11 - OLD CAMDEN LANDFILL
NSB KINGS BAY
KINGS BAY, GEORGIA
CONTRACT NUMBER CTO JM23
APPROVED BY
DATE
APPROVED BY
DATE
FIGURE NO. FIGURE ES-1
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ACRONYMS AND ABBREVIATIONS

%R	Percent Recovery
%RSD	Percent Relative Standard Deviation
ABB-ES	ABB Environmental Services, Inc.
BEC	Base Environmental Coordinator
BFB	bromofluorobenzene
Bechtel	Bechtel Environmental, Inc.
°C	degree Celsius
CA	Corrective Action
CAP	Corrective Action Plan
CAS	Chemical Abstracts Service
CCI	CH2M HILL Constructors, Inc.
CCV	Continuing Calibration Verification
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-term Environmental Action Navy
COC	contaminant of concern
CSM	Conceptual Site Model
CTO	Contract Task Order
cVOC	chlorinated volatile organic compound
DCE	dichloroethene
DL	detection limit
DO	dissolved oxygen
DoD	Department of Defense
DQI	Data Quality Indicator
DVM	Data Validation Manager
EDD	Electronic Data Deliverables
ELAP	Environmental Laboratory Accreditation Program
Ext.	extension
FOL	Field Operations Leader
FTMR	Field Task Modification Request
GADNR	Georgia Department of Natural Resources
GC/MS	Gas Chromatography/Mass Spectrometer
GEPD	Georgia Environmental Protection Department
GWMP	Groundwater Monitoring Plan
GWPS	Groundwater Protection Standards
HASP	Health and Safety Plan

ACRONYMS AND ABBREVIATIONS (CONTINUED)

HSM	Health and Safety Manager
ICAL	Initial Calibration
ICV	Initial Calibration Verification
IDQTF	Interagency Data Quality Task Force
IDW	investigation-derived waste
IRP	Installation Restoration Program
IS	Internal Standard
Katahdin	Katahdin Analytical Services, Inc.
LCS	Laboratory Control Sample
LCSD	Laboratory Control Sample Duplicate
LOD	Limit of Detection
LOQ	Limit of Quantitation
LTM	long-term monitoring
LUC	land use control
µg/L	microgram per liter
MCL	Maximum Contaminant Level
mL	milliliter
MNA	monitored natural attenuation
MPC	Measurement Performance Criterion
MS	Matrix Spike
MSD	Matrix Spike Duplicate
NA	Not Applicable
NAVFAC SE	Naval Facilities Engineering Command Southeast
NC	No Criteria
NFA	No Further Action
NSB	Naval Submarine Base
NTU	Nephelometric Turbidity Unit
ORP	Oxidation Reduction Potential
OSHA	Occupational Safety and Health Administration
PAL	Project Action Limit
Partnering Team	NSB Kings Bay Installation Restoration Partnering Team
PCE	Tetrachloroethene
PM	Project Manager
POC	Point of Contact

ACRONYMS AND ABBREVIATIONS (CONTINUED)

PPE	Personal Protective Equipment
PSL	Project Screening Level
PT	Proficiency Testing
QA	Quality Assurance
QAM	Quality Assurance Manager
QAO	Quality Assurance Officer
QC	Quality Control
QSM	Quality Systems Manual
RCRA	Resource Conservation and Recovery Act
RF	Response Factor
RFI	RCRA Facility Investigation
RG	Remediation Goal
RL	reporting limit
RPD	relative percent difference
RPM	Remedial Project Manager
RRT	Relative Retention Time
RT	Retention Time
SAP	Sampling and Analysis Plan
SDG	Sample Delivery Group
SOP	Standard Operating Procedure
SPCC	System Performance Check Compound
SQL	Structured Query Language
SSO	Site Safety Officer
SWMU	Solid Waste Management Unit
TBD	To Be Determined
TCE	trichloroethene
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plan
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	volatile organic compound

SAP Worksheet #2 -- SAP Identifying Information

(UFP-QAPP Manual Section 2.2.4)

Site Name/Number:	Site 11, Old Camden County Landfill, Naval Submarine Base (NSB) Kings Bay, Kings Bay, Georgia
Operable Unit:	Not applicable (NA)
Contractor Name:	Tetra Tech, Inc.
Contract Number:	N62470-08-D-1001
Contract Title:	Comprehensive Long-term Environmental Action Navy (CLEAN)
Work Assignment Number:	Contract Task Order (CTO) JM35

1. This Sampling and Analysis Plan (SAP) was prepared for Site 11, Old Camden County Landfill in accordance with the requirements of the United States Environmental Protection Agency (USEPA) *Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP)* (Interagency Data Quality Task Force [IDQTF], 2005) and *Guidance for Quality Assurance Project Plans, EPA QA/G-5* (USEPA, 2002).

2. Identify regulatory program: Resource Conservation and Recovery Act (RCRA).

3. This document is a project-specific SAP.

4. List dates of scoping sessions that were held:

Scoping Session	Date
Kick-off Meeting	May 20, 2010
NSB Kings Bay Installation Restoration Partnering Team (Partnering Team) Meeting	August 18-19, 2010
Partnering Team Meeting	November 29, 2011
Partnering Team Conference Calls	February 11 and 13, 2013; March 20, 2013

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

   Groundwater Sampling and Analysis Monitoring Plan, Site 11, Old Camden County Landfill Naval Submarine Base Kings Bay, Georgia, March 2011.

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

   Georgia Department of Natural Resources (GADNR) (regulatory stakeholder)

7. Lead organization: Naval Facilities Engineering Command Southeast (NAVFAC SE)

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

   NA, as there are no exclusions.

SAP Worksheet #3 -- Distribution List

(UFP-QAPP Manual Section 2.3.1)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-Mail Address
Dana Hayworth	Navy Remedial Project Manager (RPM)/ Manages Project Activities for the Navy	NAVFAC SE	(904) 542-6417	dana.hayworth@navy.mil
Brian Syme	Navy RPM/ Manages Project Activities for the Navy	NAVFAC SE	(904) 542-6151	brian.syme@navy.mil
Tom Stofflet	Base Environmental Coordinator (BEC)/ NSB Kings Bay Point of Contact (POC)	NSB Kings Bay	(912) 573-4646	thomas.stofflet@navy.mil
To Be Determined (TBD) (copy of final cover letter only)	Head of Reference Desk (NSB Kings Bay Administrative Record)	TBD	TBD	TBD
Amy Potter	GADNR RPM/ Provides Regulator Input	GADNR	(404) 657-8657	Amy.potter@dnr.state.ga.us
John Trepanowski (copy of cover letter only)	Tetra Tech Program Manager / Manages Navy Initiatives	Tetra Tech	(610) 382-1532	john.trepanowski@tetratech.com

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-Mail Address
Garth Glenn (copy of cover letter only)	Deputy Program Manager/ Manages Program Activities	Tetra Tech	(757) 461-3926	garth.glenn@tetratech.com
Alan Pate	Tetra Tech Project Manager (PM)/ Manages Project Activities	Tetra Tech	(904) 730-4669 extension (ext.) 214	alan.pate@tetratech.com
Dr. Tom Johnston	Tetra Tech Quality Assurance (QA) Manager (QAM)/ Manages Corporate QA Program and Implementation	Tetra Tech	(412) 921-8615	tom.johnston@tetratech.com
Matt Soltis (Health and Safety Plan [HASP] only)	Tetra Tech Health and Safety Manager (HSM)/ Manages Corporate Health and Safety Program	Tetra Tech	(412) 921-8912	matt.soltis@tetratech.com
Kelly Carper (electronic copy only)	Tetra Tech Project Chemist/ Provides Coordination with Laboratory	Tetra Tech	(412) 921-7273	kelly.carper@tetratech.com
Joseph Samchuck (electronic copy only)	Tetra Tech Data Validation Manager (DVM)/ Manages Data Validation	Tetra Tech	(412) 921-8510	joseph.samchuck@tetratech.com
Kelly Perkins (electronic copy only)	Laboratory PM/ Representative for Laboratory and Analytical Issues	Katahdin Analytical Services, Inc. (Katahdin)	(207) 847-2400	kperkins@katahdinlabs.com

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

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

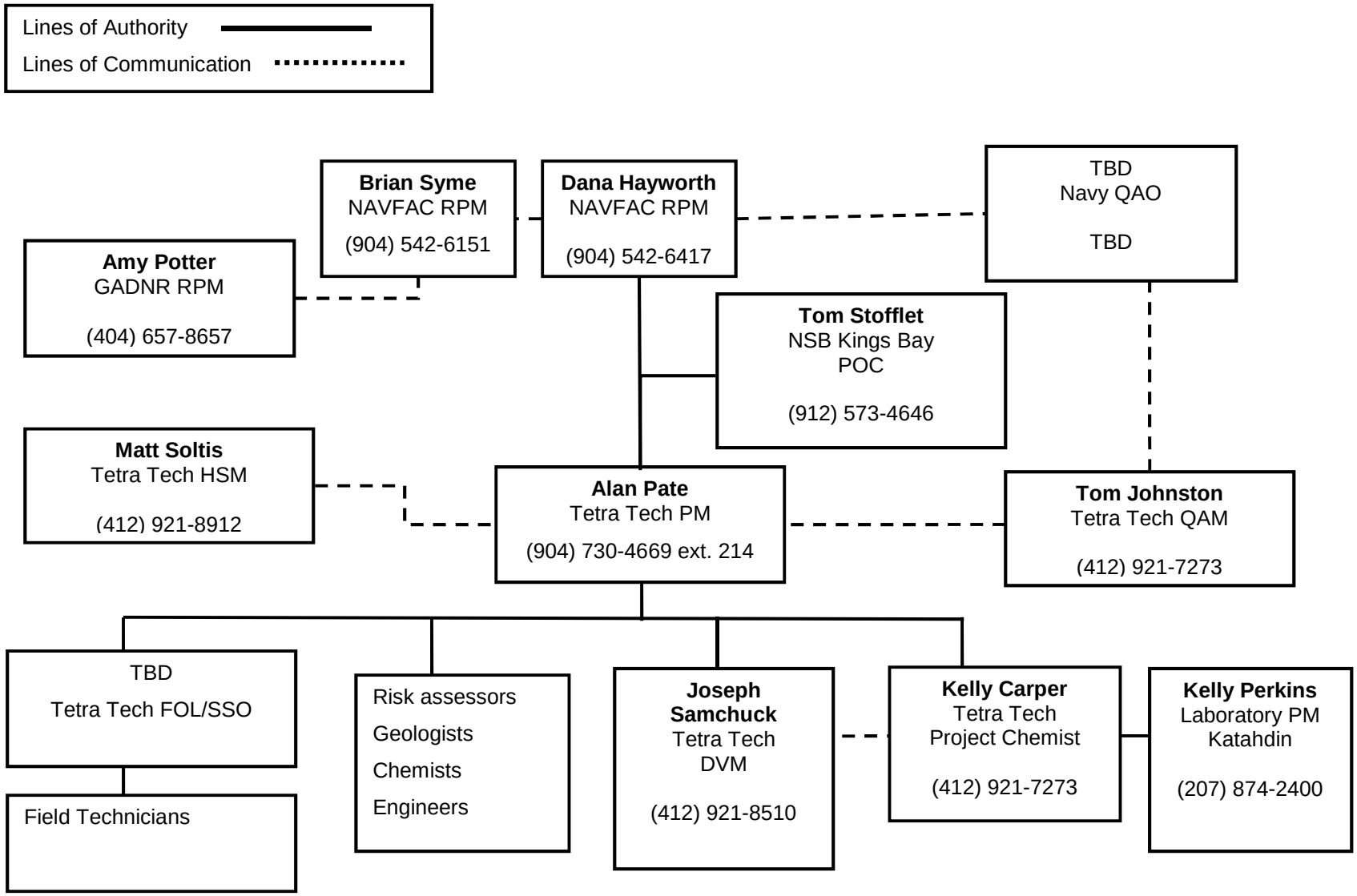
   A copy of the signed Worksheet #4 will be retained in the project files and is identified as a project document in Worksheet #29.

Name	Organization/Title/Role	Telephone Number	Signature/E-Mail Receipt	SAP Section Reviewed	Date SAP Read
Navy and Regulator Project Team Personnel					
Dana Hayworth	Navy /RPM/ Manages Project Activities for the Navy	(904) 542-6417	See Worksheet #1	All	
Brian Syme	Navy /RPM/ Manages Project Activities for the Navy	(904) 542-6151			
Tom Stofflet	Navy/BEC/ NSB Kings Bay POC	(912) 573-4646		All	
TBD	Navy/NAVFAC QA Officer (QAO)/ Government Chemist	TBD	See Worksheet #1	All	
Amy Potter	GADNR /RPM/ Provides Regulator Input	(404) 657-8657	See Worksheet #1	All	
Tetra Tech Project Team Personnel					
Alan Pate	Tetra Tech/ PM/ Manages Project Activities	(904) 730-4669 ext. 214	See Worksheet #1	All	

Name	Organization/Title/Role	Telephone Number	Signature/E-Mail Receipt	SAP Section Reviewed	Date SAP Read
TBD	Tetra Tech/ Field Operations Leader (FOL)/ Oversees Overall Field Team Effort			All and HASP	
TBD	Tetra Tech/ Site Safety Officer (SSO)/ Oversees Safety of Field Team			All and HASP	
Dr. Tom Johnston	Tetra Tech/ QAM/ Manages Corporate QA Program and Implementation	(412) 921-8615	See Worksheet #1	All	
Matt Soltis	Tetra Tech/ HSM/ Manages Corporate Health and Safety Program	(412) 921-8912	See HASP for signature	HASP	
Kelly Carper	Tetra Tech/ Project Chemist/ Provides Coordination with Laboratory	(412) 921-7273		All	
Joseph Samchuck	Tetra Tech/ DVM/ Manages Data Validation	(412) 921-8510		Worksheets #12, #14, #15, #19, #20, #23-28, #30, #34-37	
Subcontractor Personnel					
Kelly Perkins	Katahdin/ Laboratory PM/ Representative for Laboratory and Analytical Issues	(207) 874-2400		Worksheets #6, #12, #14, #15A-E, #19, #20, #23-28, #30, #34-36	

SAP Worksheet #5 -- Project Organizational Chart

(UFP-QAPP Manual Section 2.4.1)



SAP Worksheet #6 -- Communication Pathways

(UFP-QAPP Manual Section 2.4.2)

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
Changes in schedule	Tetra Tech PM Navy RPM	Alan Pate Dana Hayworth	904-730-4669 ext. 214 904-542-6417	Tetra Tech PM informs Navy RPM via e-mail or verbal communication within two days of realizing impact. Navy RPM informs Project Team via email within one day.
SAP Amendments	Tetra Tech PM Navy RPM	Alan Pate Dana Hayworth	904-730-4669 ext. 214 904-542-6417	The Tetra Tech PM will document the proposed changes via a Field Task Modification Request (FTMR) form within five days and send the Navy RPM a concurrence letter within seven days of identifying the need for change. SAP Amendments will be submitted by the Tetra Tech PM to the Navy RPM for review and approval. The Tetra Tech PM will send scope changes to the Project Team via e-mail within one business day.
Field issues that require changes in the scope or implementation of field work	Tetra Tech FOL Tetra Tech PM Navy RPM	TBD Alan Pate Dana Hayworth	TBD 904-730-4669 ext. 214 904-542-6417	Tetra Tech FOL informs Tetra Tech PM via verbal communication on the day that the issue is discovered. Tetra Tech PM informs Navy RPM via verbal communication within one day of discovery. The Navy RPM will issue a scope change (verbally or via e-mail), if warranted. The scope change is to be implemented before further work is executed. The Tetra Tech PM will document the change via an FTMR form within two days of identifying the need for change and will obtain required approvals within five days of initiating the form.
Stop work recommendations, for example, to protect workers from unsafe conditions or situations or to prevent a degradation in quality of work	Tetra Tech FOL Tetra Tech PM Tetra Tech QAM Tetra Tech HSM Navy RPM	TBD Alan Pate Tom Johnston Matt Soltis Dana Hayworth	TBD 904-730-4669 ext. 214 412- 921-8615 412- 921-8912 904-542-6417	Responsible party informs subcontractors, Navy, and Project Team within one week via e-mail or verbal communication. If stop work order is issued, document via letter or memorandum to file. Navy to inform NSB Kings Bay Project Team via email within one day.

Communication Drivers	Responsible Affiliation	Name	Phone Number	Procedure
Field data quality issues	Tetra Tech FOL Tetra Tech PM	TBD Alan Pate	TBD 904-730-4669 ext. 214	The Tetra Tech FOL will inform the Tetra Tech PM verbally or by e-mail on the same day that a field data quality issue is discovered.
Analytical data quality issues	Laboratory PM Tetra Tech Project Chemist Tetra Tech DVM Tetra Tech PM Navy RPM	Jennifer Obrin Kelly Carper Joseph Samchuck Alan Pate Dana Hayworth	207-874-2400 412-921-7273 412-921-8510 904-730-4669 ext. 214 904-542-6417	The Laboratory PM will notify (verbally or via e-mail) the Tetra Tech Project Chemist within 1 business day of when an issue related to laboratory data is discovered. The Tetra Tech Project Chemist will notify (verbally or via e-mail) the Tetra Tech PM and DVM within one business day. Tetra Tech DVM or Project Chemist notifies Tetra Tech PM verbally or via e-mail within 48 hours of validation completion that a non-routine and significant laboratory quality deficiency has been detected that could affect this project and/or other projects. The Tetra Tech PM verbally advises the Navy RPM within 24 hours of notification from the Tetra Tech Project Chemist or DVM. The Navy RPM takes corrective action appropriate for the identified deficiency. Examples of significant laboratory deficiencies include data reported that has a corresponding failed tune or initial calibration verification. Corrective actions may include a consult with the Navy Chemist.

SAP Worksheet #7 – Personnel Responsibilities Table

(UFP-QAPP Manual Section 2.4.3)

Name	Title/Role	Organizational Affiliation	Responsibilities
Dana Hayworth	Navy / RPM/ Manages Project Activities for the Navy	NAVFAC SE	Oversees project implementation including scoping, data review, and evaluation.
Brian Syme	Navy / RPM/ Manages Project Activities for the Navy	NAVFAC SE	Oversees project implementation including scoping, data review, and evaluation.
Tom Stofflet	Navy/ BEC/ NSB Kings Bay POC	NSB Kings Bay	Oversees site activities and participates in scoping, data review, evaluation, and reviews the SAP.
Amy Potter	GADNR /RPM/ Provides Regulator Input	GADNR	Participates in scoping, data review, evaluation, and approves the SAP.
Alan Pate	Tetra Tech/ PM/ Manages Project Activities	Tetra Tech	Oversees project, manages financial, schedule, and technical day-to-day activities of the project. Ensures timely resolution of project-related technical, quality, and safety questions associated with Tetra Tech operations.
TBD	Tetra Tech/ FOL/ Oversees Overall Field Team Effort	Tetra Tech	Supervises, coordinates, and performs field sampling activities.
TBD	Tetra Tech/ SSO/ Oversees Safety of Field Team	Tetra Tech	Responsible for on-site project-specific health and safety training and monitoring site conditions. Details of these responsibilities are presented in the HASP.
Tom Johnston	QAM/ Manages Corporate QA Program and Implementation	Tetra Tech	Reviews the SAP and ensures quality aspects of the CLEAN program are implemented, documented, and maintained.
Matt Soltis	HSM/ Manages Corporate Health and Safety Program	Tetra Tech	Oversees CLEAN Program Health and Safety Program.

Name	Title/Role	Organizational Affiliation	Responsibilities
Kelly Carper	Project Chemist/ Provides Coordination with Laboratory	Tetra Tech	Participates in project scoping, prepares laboratory scopes of work, and coordinates laboratory-related functions with laboratory. Oversees data quality reviews and QA of data validation deliverables.
Joseph Samchuck	DVM/ Oversees Data Validation Activities	Tetra Tech	Manages data validation activities within Tetra Tech, including ensuring QA of data validation deliverables, providing technical advice on data usability, and coordinating and maintaining the data validation review schedule.
Jennifer Obrin	Laboratory PM/ Representative for Laboratory and Analytical Issues	Katahdin	Coordinates analyses with laboratory chemists, ensures that scope of work is followed, provides QA of data packages, and communicates with Tetra Tech project staff.

SAP Worksheet #8 -- Special Personnel Training Requirements Table

(UFP-QAPP Manual Section 2.4.4)

Each site worker will be required to have completed a 40-hour course (and 8-hour refresher, if applicable) in Hazardous Waste Operations and Emergency Response health and safety training as described under Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulations (CFR) 1910.120(b)(4) (OSHA, 2002).

SAP Worksheet #9 -- Project Scoping Session Participants Sheet
(UFP-QAPP Manual Section 2.5.1)

Project Name: Site 11, Old Camden County Landfill PM: Alan Pate	Site Name: Groundwater Sampling and Analysis Monitoring Plan Site 11, Old Camden County Landfill Naval Submarine Base Site Location: Kings Bay, Georgia
Date of Session: May 20, 2010 **Scoping Session Purpose:** Kick-off Meeting for Site 11	

Name	Title	Affiliation	Phone #	E-Mail Address	Project Role
Alan Pate	PM	Tetra Tech	(904) 730-4669 ext. 214	alan.pate@tetratech.com	Tetra Tech POC
Dana Hayworth	Navy RPM	NAVFAC SE	(904) 542-6417	dana.hayworth@navy.mil	Installation Restoration Program (IRP) Lead
Brian Syme	Navy RPM	NAVFAC SE	(904) 542-6151	brian.syme@navy.mil	IRP Lead
Mike Singletary	Navy RPM	NAVFAC SE	(904) 542-4204	michael.a.singletary@navy.mil	Tier II Link
Tom Stofflet	BEC	NSB Kings Bay	(912) 573-4646	thomas.stofflet@navy.mil	Facility POC
Mike Maughon	Tetra Tech Technical Support	Tetra Tech	(843) 886-4547	mike.maughon@navy.mil	Technical Lead
Mark Peterson	Florida Operations Manager	Tetra Tech	(904) 730-4669 ext. 213	mark.peterson@tetratech.com	Technical Support
Libby Claggett	Administrative Project Assistant	Tetra Tech	(904) 730-4669 ext. 212	libby.claggett@tetratech.com	Scribe

Site 11

The SAP should be a streamlined version, and the SAP needs to be flexible enough to incorporate the elimination of wells.

Data evaluation will be performed first on current data. The Final Optimization Report should contain the final recommendation. A draft report should be presented to the state to verify wells to be sampled and frequency. Mike Singletary suggested going to the state with an initial set of recommendations and fine-tuning the recommendations with input from the state.

At this time, it is unclear if an exit strategy would be required. In the end, the RCRA permit would need to be modified. Requirements of the permit (quarterly sampling) may need to be maintained until the permit is modified.

It was noted that it is important to ensure Amy Potter (GADNR) is engaged in the process of closing the Consent Order for Site 11. Modifications to the Hazardous and Solid Waste Amendments (HSWA) permit cost implications will be the next step in the RCRA process.

Project Name: Site 11, Old Camden County Landfill PM: Alan Pate	Site Name: Groundwater Sampling and Analysis Monitoring Plan, Site 11, Old Camden County Landfill, NSB Kings Bay Site Location: Kings Bay, Georgia
Date of Session: August 18-19, 2010 **Scoping Session Purpose:** Partnering Team Meeting for Site 11	

Name	Title	Affiliation	Phone #	E-Mail Address	Project Role
Alan Pate	PM	Tetra Tech	(904) 730-4669 ext. 214	alan.pate@tetratech.com	Tetra Tech POC
Dana Hayworth	Navy RPM	NAVFAC SE	(904) 542-6417	dana.hayworth@navy.mil	IRP Lead
Brian Syme	Navy RPM	NAVFAC SE	(904) 542-6151	brian.syme@navy.mil	IRP Lead
Amy Potter	GADNR RPM	GADNR	(404) 656-2833	amy_potter@dnr.state.ga.us	GADNR Lead
Tom Stofflet	BEC	NSB, Kings Bay	(912) 573-4646	thomas.stofflet@navy.mil	Facility POC
Mike Maughon	Technical Lead	Tetra Tech	(843) 886-4547	mike.maughon@navy.mil	Technical Lead
William Powell	Environ. Engineer	GADNR	(404) 463-7508	william.powell@dnr.state.ga.us	Technical Support
Mo Ghazi	Geologist	GADNR	(404) 463-0008	mo.ghazi@dnr.state.ga.us	Technical Support
Thomas Deck	Environ. Scientist	Tetra Tech	(904) 730-4669 ext. 228	tom.deck@tetratech.com	Technical Support
Libby Claggett	Project Support	Tetra Tech	(904) 730-4669 ext. 212	libby.claggett@tetratech.com	Scribe
Gus Campana	Facilitator	The Management Edge	NA	afcampana@earthlink.net	Facilitator

Site 11 Discussions

Optimization Study Discussion – Over the past 10 years, two monitoring programs (quarterly monitoring [RCRA] and natural attenuation monitoring by United States Geological Survey [USGS]) occurred at Site 11. Data from the two sampling programs have been combined into one database. The monitoring plans will be streamlined into one plan (the SAP). The monitored natural attenuation (MNA) parameter list might, at times, be pared down to about five parameters. Historically, tetrachloroethene (PCE), trichloroethene (TCE), cis-dichloroethene (DCE), and vinyl chloride were the only constituents with exceedances.

The first sampling event will be conducted in the same manner as previous long-term monitoring (LTM). After the Optimization Study is complete, sampling methods will be modified per the recommendation of the study. A path forward and exit strategy will also be developed for Site 11. Per GADNR comments, wells KBA-11-03B and 108 Cottage Court will be added to the sampling plan.

A preliminary optimization summary was presented to the project team. Team members viewed and discussed the Decision Criteria for Optimizing Monitoring Locations and Decision Criteria for Optimizing Monitoring Frequency tables in the presentation. Any well without a significant upward trend would be reduced to annual sampling. GADNR suggested having the same monitoring frequency for all wells. When viewed in correlation with the plume map, Tetra Tech believes GADNR will further understand the proposed monitoring frequency. Sentinel wells were proposed to be sampled semiannually. Tetra Tech stated that a permit modification would have to be made in order to change the monitoring frequency. GADNR stated the permit is up for renewal and the monitoring program could be changed. Tetra Tech would like to see the optimization results incorporated into the permit.

Vapor intrusion should not be a concern at Site 11. The Corrective Action Plan (CAP) contains a section stating vapor intrusion has been evaluated. In addition, USEPA is revising their guidance, and soil gas sampling next to a house will be replaced with subslab sampling to determine indoor air intrusion risks. For residential scenarios, USEPA guidance is followed. For industrial scenarios, OSHA guidance is followed.

Steps Forward:

1) Complete the Monitoring Plan in order to begin semiannual sampling in February 2013 and annual sampling in October 2013.
2) Perform sampling and analyze data. The laboratory has a 28-day turnaround.
3) Provide Final Monitoring Reports with the sampling data and trend analyses (to GADNR for review).

Anticipated Schedule and Prioritization of Documents:

1) Draft Monitoring Report – First Semiannual Event – February 20, 2013
2) Draft Final Monitoring Report – First Semiannual Event – March 20, 2013
3) Final Monitoring Report – First Semiannual Event – April 19, 2013
4) Draft Monitoring Report – First Annual Event – October 30, 2013
5) Draft Final Monitoring Report – First Annual Event – November 28, 2013
6) Final Monitoring Report – First Annual Event – December 20, 2013
7) Draft Monitoring Report – Second Semiannual Event – March 20, 2014
8) Draft Final Monitoring Report – Second Semiannual Event – April 25, 2014
9) Final Monitoring Report – Second Semiannual Event – May 23, 2014

Project Name: Site 11, Old Camden County Landfill PM: Alan Pate	Site Name: Groundwater Sampling and Analysis Monitoring Plan, Site 11, Old Camden County Landfill, NSB Kings Bay Site Location: Kings Bay, Georgia

Date of Session: November 29, 2011
Scoping Session Purpose: Partnering Team Meeting for Site 11 – Review Optimization Report and Optimization Recommendations

Name	Title	Affiliation	Phone #	E-Mail Address	Project Role
Alan Pate	PM	Tetra Tech	(904) 730-4669 ext. 214	alan.pate@tetratech.com	Tetra Tech POC
Dana Hayworth	Navy RPM	NAVFAC SE	(904) 542-6417	dana.hayworth@navy.mil	IRP Lead
Brian Syme	Navy RPM	NAVFAC SE	(904) 542-6151	brian.syme@navy.mil	IRP Lead
Amy Potter	GADNR RPM	GADNR	(404) 656-2833	amy_potter@dnr.state.ga.us	GADNR Lead
Tom Stofflet	BEC	NSB, Kings Bay	(912) 573-4646	thomas.stofflet@navy.mil	Facility POC
Mike Maughon	Technical Lead	Tetra Tech	(843) 886-4547	mike.maughon@navy.mil	Technical Lead
William Powell	Environmental Engineer	GADNR	(404) 463-7508	william.powell@dnr.state.ga.us	Technical Support
Mo Ghazi	Geologist	GADNR	(404) 463-0008	mo.ghazi@dnr.state.ga.us	Technical Support
Libby Claggett	Project Support	Tetra Tech	(904) 730-4669 ext. 212	libby.claggett@tetratech.com	Scribe
Gus Campana	Facilitator	The Management Edge	NA	afcampana@earthlink.net	Facilitator
Sarah Reed	Navy IRP Manager	NAVFAC SE	(904) 542-6290	sarah.reed@navy.mil	Navy Tier II

Site 11 Discussions

In April 2011, Tetra Tech collected baseline groundwater quality data from 19 existing monitoring wells as part of the Optimization Study approved during the August 2010 Partnering Team meeting. Additional samples were collected from another existing well in January 2012 and one newly installed monitoring well in March 2012. The additional samples were collected at the request of Georgia Environmental Protection Division (GEPD).

The response to GADNR comments on previous monitoring reports was presented during the November 21, 2011, Partnering Team meeting. An overview of the previously submitted Optimization Study Report was provided. The Optimization Report describes the rationale for semiannual and annual monitoring.

Based on the optimization study results submitted to the Navy in August 2012, Tetra Tech recommended adjustments to the monitoring well network, monitoring frequency, analyte list, reporting frequency, and the exit strategy. The recommendations are summarized as follows:

- Reduce the number of designated monitoring wells sampled historically from 27 wells to 16 wells;
- Reduce the sampling frequency from quarterly and semiannually in most wells to annual monitoring of all wells except four sentinel wells and one source area well to be monitored semiannually;
- Reduce by more than 75 percent the number of samples analyzed compared to the previous sampling regimes based on the reduced number of wells sampled and sampling frequency;
- Reduce the number of contaminants of concern (COCs) and related analytes reported from 20 to 4 (PCE, TCE, cis-1,2-DCE, and vinyl chloride);
- Eliminate the expensive analyses for the Appendix IX parameters previously required at only two wells, and;
- Reduce the reporting frequency from quarterly to annually with an interim submittal of semiannual results in a more simplified report format.

The exit strategy for Site 11 is to demonstrate compliance for three consecutive years with the Groundwater Protection Standards (GWPS), which are equal to the USEPA Maximum Contaminant Levels for all remaining contaminants. Following submittal of the anticipated favorable sampling data from the three years of monitoring, a o further action (NFA) status request will be submitted to the GEPD for approval.

GADNR provided relatively minor comments on the optimization report and related LTM optimization recommendations. The comments were addressed and final revisions were made to the Optimization Report on September 26, 2012. Final approval of the Optimization Report and related recommendations was received from Amy Potter, GADNR, on October 26, 2012.

The optimized LTM plan recommended in the final Optimization Report became the basis for the Site 11 LTM requirements included in Section V of the current Hazardous Waste Facility Permit HW-014(S&T)-4 (as amended August 7, 2012).

The current SAP is consistent with the recommendations of the Optimization Report and the current Hazardous Waste Facility Permit HW-014(S&T)-4.

Project Name: Site 11, Old Camden County Landfill PM: Alan Pate	Site Name: Groundwater Sampling and Analysis Monitoring Plan, Site 11, Old Camden County Landfill, NSB Kings Bay Site Location: Kings Bay, Georgia
Dates of Session: February 11 and 13, 2013; March 20, 2013 **Scoping Session Purpose:** Partnering Team Conference Calls – Discussion of RCRA Permit Provisions	

Name	Title	Affiliation	Phone #	E-Mail Address	Project Role
Dana Hayworth	Navy RPM	NAVFAC SE	(904) 542-6417	dana.hayworth@navy.mil	IRP Lead
Amy Potter	GADNR RPM	GADNR	(404) 656-2833	amy_potter@dnr.state.ga.us	GADNR Lead
Mike Maughon	Technical Lead	Tetra Tech	(843) 886-4547	mike.maughon@navy.mil	Technical Lead
William Powell	Environmental Engineer	GADNR	(404) 463-7508	william.powell@dnr.state.ga.us	Technical Support

Site 11 Discussions

Team conference calls were conducted to clarify common understanding of requirements in the current Hazardous Waste Facility Permit HW-014(S&T)-4 related to the CAP, procedures for recommending future LTM optimization, e.g., eliminating wells that have met GWPSs for three consecutive years, and the compliance period and monitoring necessary to achieve NFA.

GADNR clarified the CAP does not need to be amended. MNA, as well as source reduction, is already specified as a remedy in the CAP and the optimization report demonstrated the effectiveness of MNA.

GADNR indicated recommendations and supporting information provided in the periodic monitoring reports are sufficient to request GADNR's approval to cease sampling wells that have met GWPSs for three consecutive years.

GADNR clarified when COCs in all wells in the monitoring program have not exceeded GWPS, GEPD will work with the Navy to review historical data and identify up to five specific wells that will require semiannual monitoring to demonstrate compliance with GWPSs for three consecutive years, and the Permit may be modified at that time.

The team agreed on the following general criteria for selecting the specific wells for semiannual compliance monitoring:

1) Remaining Wells: Monitoring may have already ceased in some wells, other than sentinel wells, based on Permit Condition V.C.5 (i.e., wells where COC sampling results have not exceeded GWPS for three

consecutive years). When sampling results in all of the wells remaining in the monitoring program do not exceed GWPS, the specific wells that will require semiannual compliance monitoring will be selected from these remaining wells.

2) Historical Data: The specific wells that will require semiannual compliance monitoring will be selected based on historical data, including relative variability of sampling results and persistence of COCs.

3) Location of Wells: The specific wells that will require semiannual compliance monitoring will be selected considering typical criteria for compliance wells, i.e., downgradient, beyond the Solid Waste Management Unit (SWMU) boundary.

To better focus the proposed well selection criteria, the Navy proposed limiting the number of specific wells that will require the semiannual compliance monitoring to up to five wells. The Partnering Team agreed that the selected wells for semiannual compliance monitoring would likely be five or less. Amy Potter indicated that the specific wells to be selected at this point usually come down to the remaining few "hold out" wells that have not already met GWPS for three years.

The Partnering Team acknowledged the need to retain sentinel wells in the monitoring program, but agreed that the improving COC data at that point may warrant designating sentinel wells closer to the SWMU boundary as was recently done as a result of the optimization study. Sentinel wells potentially could also serve as wells selected for the semiannual compliance monitoring.

With regard to Criteria 3 above, the Partnering Team discussed and acknowledged that the wells selected for semiannual compliance monitoring will be located downgradient, beyond the SWMU boundary. However, if COCs in the one well that is being monitored within the SWMU source area (i.e., well KBA-11-34) has not achieved the GWPS, then appropriate land use controls (LUCs) would need to be in place to restrict groundwater use, potentially resulting in an NFA with LUCs.

Partnering Team meeting minutes are presented in Appendix A.

SAP Worksheet #10 -- Conceptual Site Model
(UFP-QAPP Manual Section 2.5.2)

Site 11, Old Camden County Landfill is located within the NSB Kings Bay facility. NSB Kings Bay is located in the southeastern corner of Georgia, approximately 8 miles north of the Georgia-Florida state line. NSB Kings Bay is approximately 16,168 acres and is located in Camden County, Georgia. NSB Kings Bay supports submarines, crew training, weapons handling and storage, submarine maintenance and associated personnel (Bechtel Environmental, Inc. [Bechtel], 1999a). Additional details concerning the Conceptual Site Model (CSM) including historical site activities, past investigations, current site conditions, and potential unacceptable ecological and human exposures are provided below.

10.1 SITE DESCRIPTION

Site 11, Old Camden County Landfill, is located on the northwestern boundary of NSB Kings Bay east of the residential subdivision Crooked River Plantation. The landfill is approximately 26.28 acres in size (see Figure 10-1). The landfill was operated by Camden County beginning in 1974 and ceased operation in October 1981 at which time it was covered by 2 feet of fill. During this time, the landfill reportedly received 100 cubic yards of firefighting pit sludge from a proposed dredge disposal area at NSB Kings Bay (Bechtel, 1999a).

10.2 PREVIOUS INVESTIGATIONS AND ACTIONS

Environmental investigations began at Site 11 in 1992 after volatile organic compound (VOC) groundwater contamination (including vinyl chloride, DCE, cis-1,2-DCE, TCE, PCE, benzene, toluene, ethylbenzene, m&p-xylene, and o-xylene) was identified during a RCRA Facility Investigation (RFI) conducted by ABB Environmental Services, Inc. (ABB-ES, 1993). A groundwater extraction and treatment system was designed and installed as an interim measure. The system was operated in three phases from March 1994 and March 1999 at which time the system was shut down. In-situ chemical oxidation treatment was conducted in four phases from August 1998 to January 2002 with hydrogen peroxide and ferrous iron catalyst. Following the third phase of in-situ chemical oxidation, CH2M HILL Constructors, Inc. (CCI) performed additional source delineation using a membrane interface probe during November 2000 and January 2001. Upon completion of the fourth phase of in-situ chemical oxidation, the pH of the groundwater was adjusted using potassium hydroxide and soybean oil injections to enhance natural attenuation. These injections were conducted from December 2001 to January 2002 (CCI, 2004).

During this time, the site was monitored in accordance with the Hazardous Waste Facility Operations Permit (HW-014) dated December 23, 1998, and the CAP dated July 1998 that includes quarterly MNA,

quarterly groundwater monitoring, and annual monitoring followed according to these documents. LTM has been conducted at this site from September 1999 through the present. A semiannual monitoring event was conducted January 2009 based on GADNR recommendation to further monitor the roadway of the Crooked River Subdivision. During the monitoring time frame, downgradient monitoring wells have demonstrated a greater than one order of magnitude reduction in VOC concentrations. Previous quarterly monitoring data was reported in the October-December 2009 Quarterly Groundwater Monitoring Report (VT Group, 2010). Based on groundwater quality data collected by Tetra Tech during the optimization study in April 2011 and early 2012, concentrations of chlorinated VOCs (cVOCs) show a decreasing trend, while the direction of groundwater flow remains consistent with historical data indicating a northwesterly flow direction. The most current groundwater quality data was reported in Tetra Tech's *Optimization of Groundwater Monitoring Program* report dated August 2012. Following approval of the monitoring report in October 2012, the GEPD revised the Hazardous Waste Facility Permit HW-014(S&T)-4 based on the optimized monitoring program proposed in the optimization report.

10.3 CONCEPTUAL SITE MODEL

A summary of the CSM based on current site conditions are shown on Figure 10-2. The text below describes the CSM. Considering the most recent groundwater quality data, the CSM remains relatively unchanged other than a reduction in the areal impact to groundwater and fewer contaminants of concern.

10.3.1 Potential or Known Sources of Contamination

Based on the 1992 RFI, groundwater contamination by VOCs was identified. Although a complete source has not been identified, the firefighting pit sludge reportedly disposed of at Site 11 and a discarded 55-gallon drum with high levels of PCE removed from the site most likely contributed to the VOC-impacted groundwater currently present. The groundwater contamination at Site 11 that has been identified is in the dissolved phase. Identified contaminants that exceed regulatory screening criteria (GADNR GWPS) have historically included PCE, TCE, cis-DCE, and vinyl chloride. The current groundwater quality data indicate concentrations of only TCE and vinyl chloride, the degradation products of PCE, exceed the GWPS levels. The historical distribution of PCE, TCE, cis-DCE, and vinyl chloride, including the April 2011 data, are presented in Figures 10-3, 10-4, 10-5, and 10-6, respectively.

10.3.2 Contaminant Migration Pathways

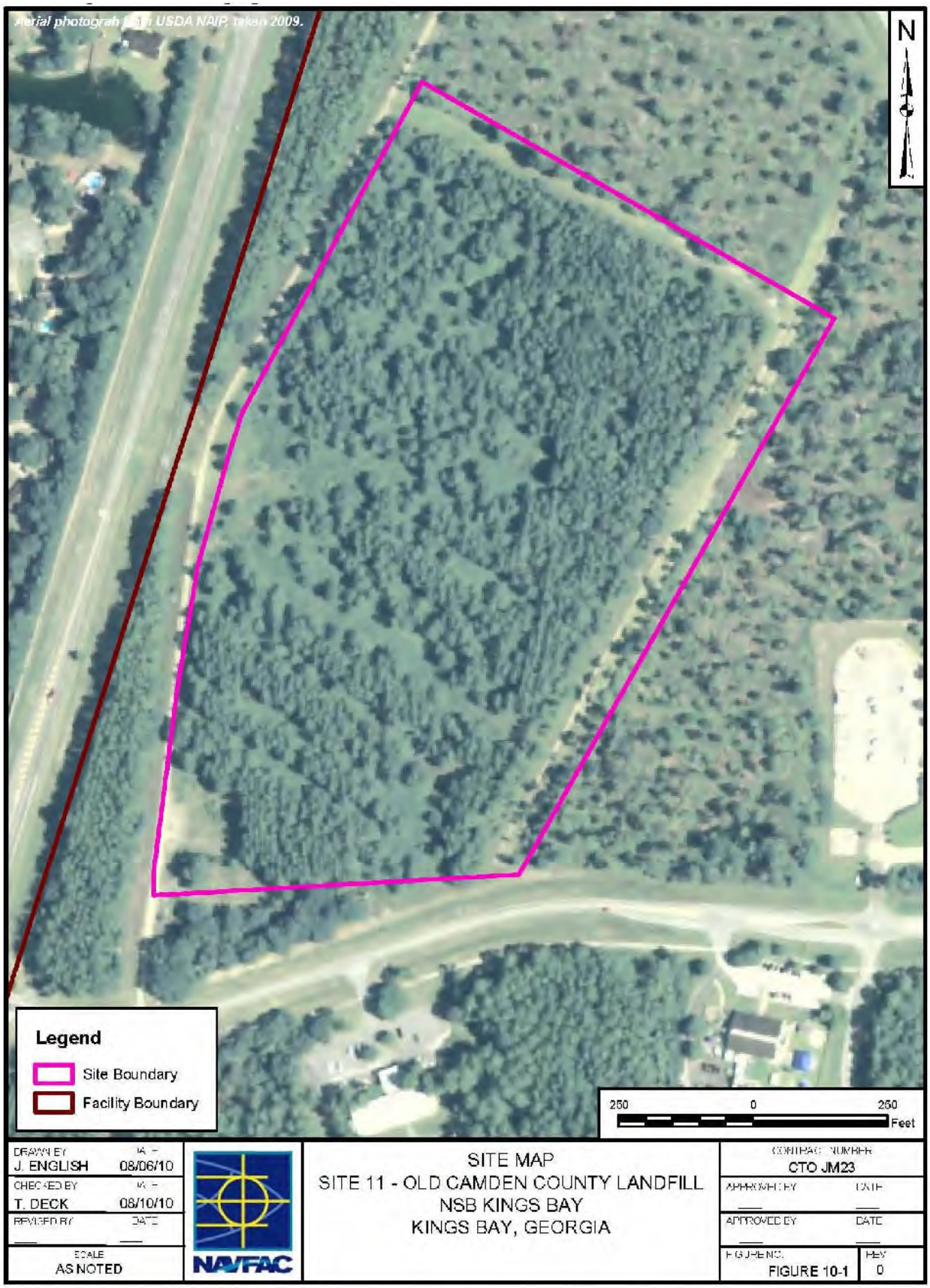
VOC contamination is present in a 10-foot-thick strata of permeable sand located 30 to 40 feet below ground surface and is bound by a layer of finer grained sands and clay of lower hydraulic conductivity. The narrow groundwater plume has migrated in the northwestern direction from the source area.

Recharge water at the site filters through an organic-rich layer which removes dissolved oxygen (DO), creating an anoxic zone (USGS, 1998). In the methanogenic and sulfate-reducing environment present in the source area, reductive dechlorination of PCE and TCE to cis-DCE and vinyl chloride is currently occurring (USGS, 1998). Downgradient, the more oxidizing Iron (III) reducing conditions further degrade cis-DCE and vinyl chloride to carbon dioxide and inorganic chloride (Bechtel, 1998). Current LTM data has shown that the VOC-contaminated groundwater plume has reduced in size following in-situ chemical oxidation and soy bean oil injections (USGS, 2009) with only TCE and vinyl chloride remaining at concentrations that exceed the GWPS. This decreasing trend in cVOC concentrations was verified by the April 2011 groundwater quality data.

10.3.3 Human Health Receptors and Exposure Pathways

Because of the potential for exposure from irrigation wells located in the residential development to the west of Site 11, human health risks to residents, maintenance workers, and trespassers will be evaluated. Residents, maintenance workers, and trespassers may be exposed to contaminants in the groundwater via dermal contact and inhalation of vapors. Residents may also be exposed to chemicals that have volatilized from groundwater and migrated through building foundations into indoor air.

Ecological receptors (small mammals and birds) may be exposed to contaminants in the irrigated groundwater via dermal contact. However, exposure of small mammals and birds to the contaminants in the irrigated groundwater is severely limited by the lack of viable habitat in the residential community and therefore will not be evaluated as part of this investigation.


Aerial photograph from USDA NAIP, taken 2009.
N
Legend
Site Boundary
Facility Boundary
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0
250
Feet
DRAWN BY
J. ENGLISH
08/06/10
CHECKED BY
T. DECK
08/10/10
REVISED BY
DATE
SCALE
AS NOTED
NAVFAC
SITE MAP
SITE 11 - OLD CAMDEN COUNTY LANDFILL
NSB KINGS BAY
KINGS BAY, GEORGIA
CONTRACT NUMBER
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APPROVED BY
DATE
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DATE
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FIGURE 10-1
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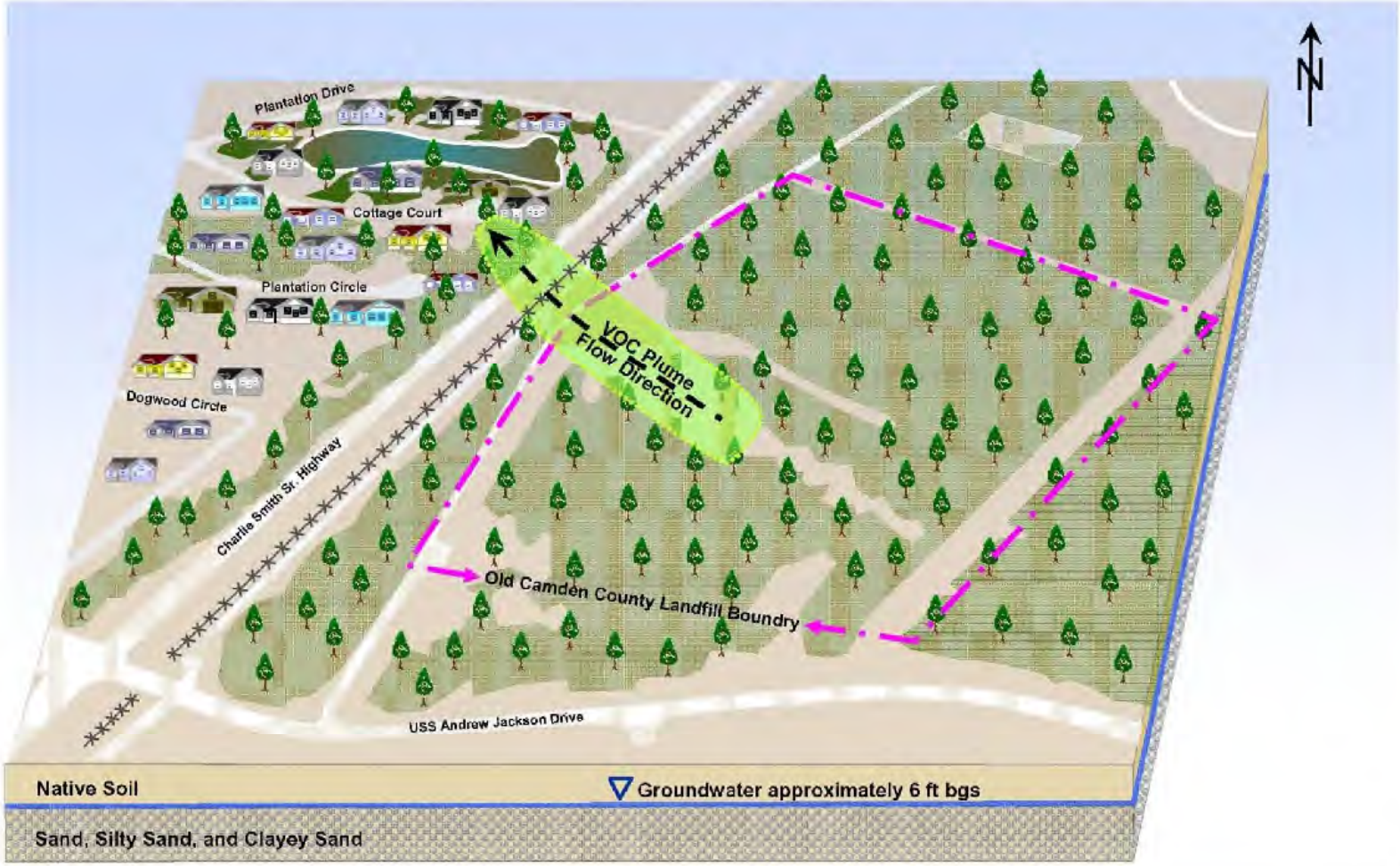

DRAWN BY C. PENNINGTON DATE 8-3-10	NAVFAC	CONCEPTUAL SITE MODEL SITE 11 - OLD CAMDEN COUNTY LANDFILL NSB KINGS BAY KINGS BAY, GEORGIA	CONTRACT NO. CTO
CHECKED BY DATE			OWNER NO.
REVISED BY DATE			APPROVED BY DATE
SCALE NOT TO SCALE			DRAWING NO. FIGURE 10-2 REV.

LEGEND

- Water Table
- Native Trees
- Fence
- VOC Plume
- Site 11 Boundary
- Native Soil
- Sand, Silty Sand, and Clayey Sand

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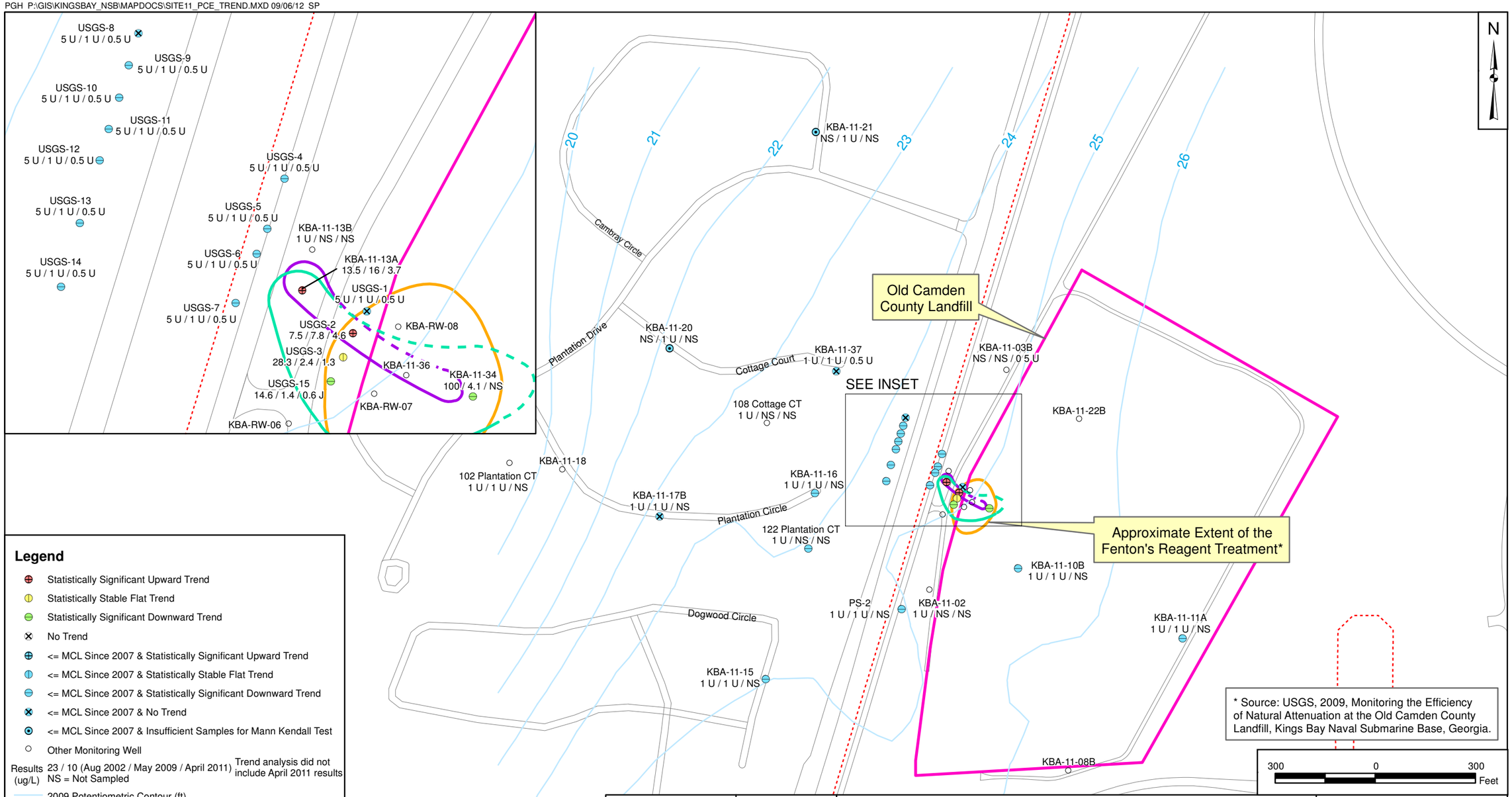

Legend

- Statistically Significant Upward Trend
- Statistically Stable Flat Trend
- Statistically Significant Downward Trend
- No Trend
- <= MCL Since 2007 & Statistically Significant Upward Trend
- <= MCL Since 2007 & Statistically Stable Flat Trend
- <= MCL Since 2007 & Statistically Significant Downward Trend
- <= MCL Since 2007 & No Trend
- <= MCL Since 2007 & Insufficient Samples for Mann Kendall Test
- Other Monitoring Well

Results (ug/L): 23 / 10 (Aug 2002 / May 2009 / April 2011) — Trend analysis did not include April 2011 results
NS = Not Sampled

- 2009 Potentiometric Contour (ft)
- Fence Line
- Road

PCE Isoconcentration Contour (5 ug/L)

- Based on August 2002 Results (Dashed Where Inferred)
- Based on May 2009 Results (Dashed Where Inferred)

NOTE: No exceedances were found in April 2011

DRAWN BY	DATE
K. MOORE	06/13/11
CHECKED BY	DATE
R. MCCANN	09/06/12
COST/SCHEDULE AREA	
SCALE	
AS NOTED	

NAVFAC

TETRACHLOROETHENE DISTRIBUTIONS
AUGUST 2002, MAY 2009, AND APRIL 2011
SITE 11, OLD CAMDEN COUNTY LANDFILL
NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

CONTRACT NUMBER	
CTO	
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO. FIGURE 10 - 3	REV 0

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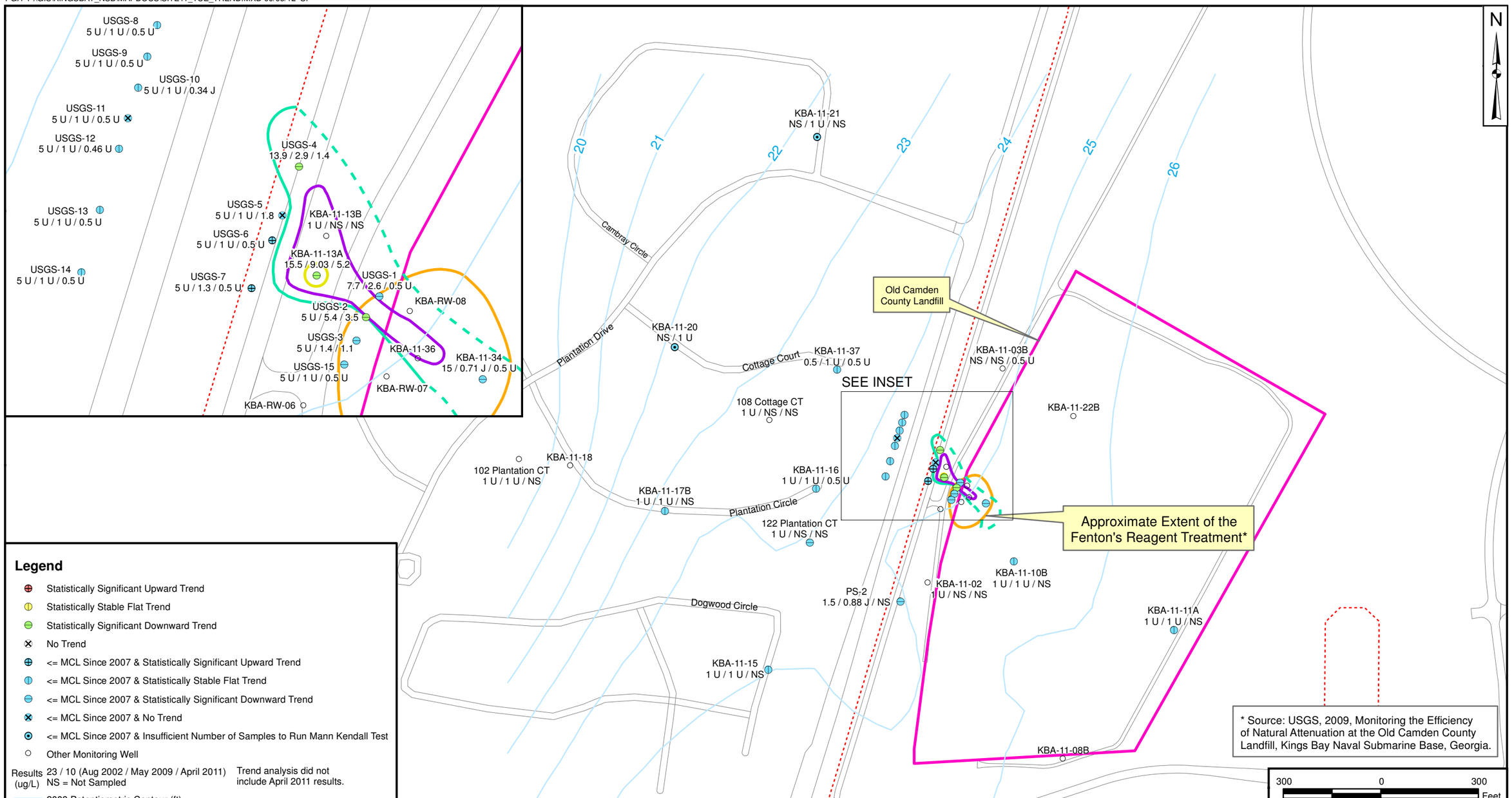

Legend

- Statistically Significant Upward Trend
- Statistically Stable Flat Trend
- Statistically Significant Downward Trend
- No Trend
- <= MCL Since 2007 & Statistically Significant Upward Trend
- <= MCL Since 2007 & Statistically Stable Flat Trend
- <= MCL Since 2007 & Statistically Significant Downward Trend
- <= MCL Since 2007 & No Trend
- <= MCL Since 2007 & Insufficient Number of Samples to Run Mann Kendall Test
- Other Monitoring Well

Results (ug/L) 23 / 10 (Aug 2002 / May 2009 / April 2011)
NS = Not Sampled

Trend analysis did not include April 2011 results.

- 2009 Potentiometric Contour (ft)
- Fence Line
- Road

TCE Isoconcentration Contour (5 ug/L)

- Based on August 2002 Results (Dashed Where Inferred)
- Based on May 2009 Results (Dashed Where Inferred)
- Based on April 2011 Results (Dashed Where Inferred)

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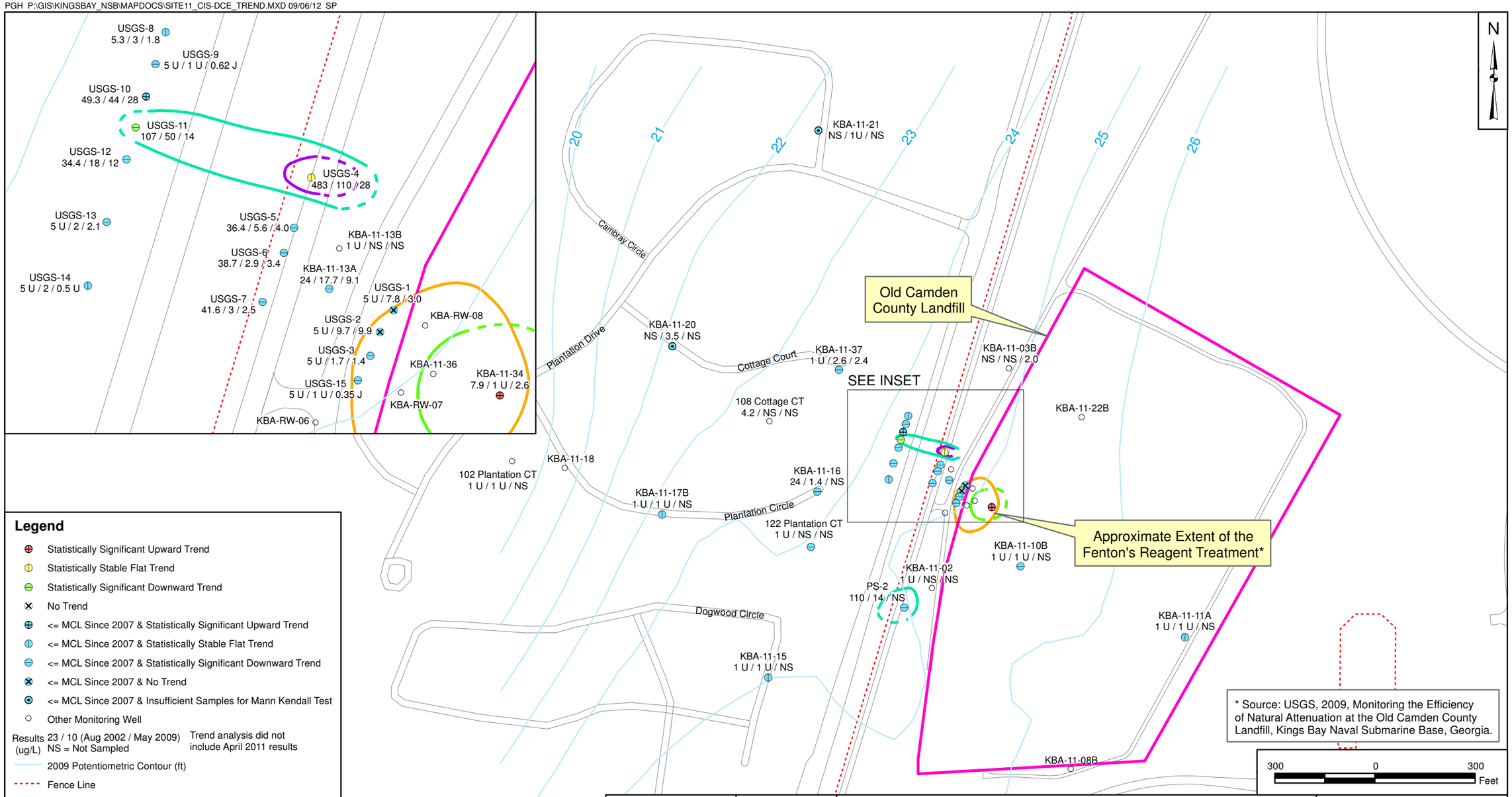
K. MOORE	06/13/11
CHECKED BY	DATE
B. LI	09/06/12
REVISED BY	DATE
S. PAXTON	09/06/12
SCALE	
AS NOTED	

NAVFAC

TRICHLOROETHENE DISTRIBUTIONS
AUGUST 2002, MAY 2009, AND APRIL 2011
SITE 11, OLD CAMDEN COUNTY LANDFILL
NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

CONTRACT NUMBER	CTO NUMBER
2831	—
APPROVED BY	DATE
—	—
APPROVED BY	DATE
FIGURE NO. FIGURE 10 - 4	REV 0

PGH P:\GIS\KINGSBAY_NSB\MAPDOCS\SITE11_CIS-DCE_TREND.MXD 09/06/12 SP



* Source: USGS, 2009, Monitoring the Efficiency of Natural Attenuation at the Old Camden County Landfill, Kings Bay Naval Submarine Base, Georgia.

Legend

- Statistically Significant Upward Trend
- Statistically Stable Flat Trend
- Statistically Significant Downward Trend
- No Trend
- <= MCL Since 2007 & Statistically Significant Upward Trend
- <= MCL Since 2007 & Statistically Stable Flat Trend
- <= MCL Since 2007 & Statistically Significant Downward Trend
- <= MCL Since 2007 & No Trend
- <= MCL Since 2007 & Insufficient Samples for Mann Kendall Test
- Other Monitoring Well

Results (ug/L) 23 / 10 (Aug 2002 / May 2009) NS = Not Sampled — Trend analysis did not include April 2011 results

- 2009 Potentiometric Contour (ft)
- Fence Line
- Road

cis-1,2-DCE Isoconcentration Contour (70 ug/L)

- Based on August 2002 Results (Dashed Where Inferred)
- Based on May 2009 Results (Dashed Where Inferred)
- Based on August 2009 Results (Dashed Where Inferred)

NOTE: No exceednaces were found in April 2011

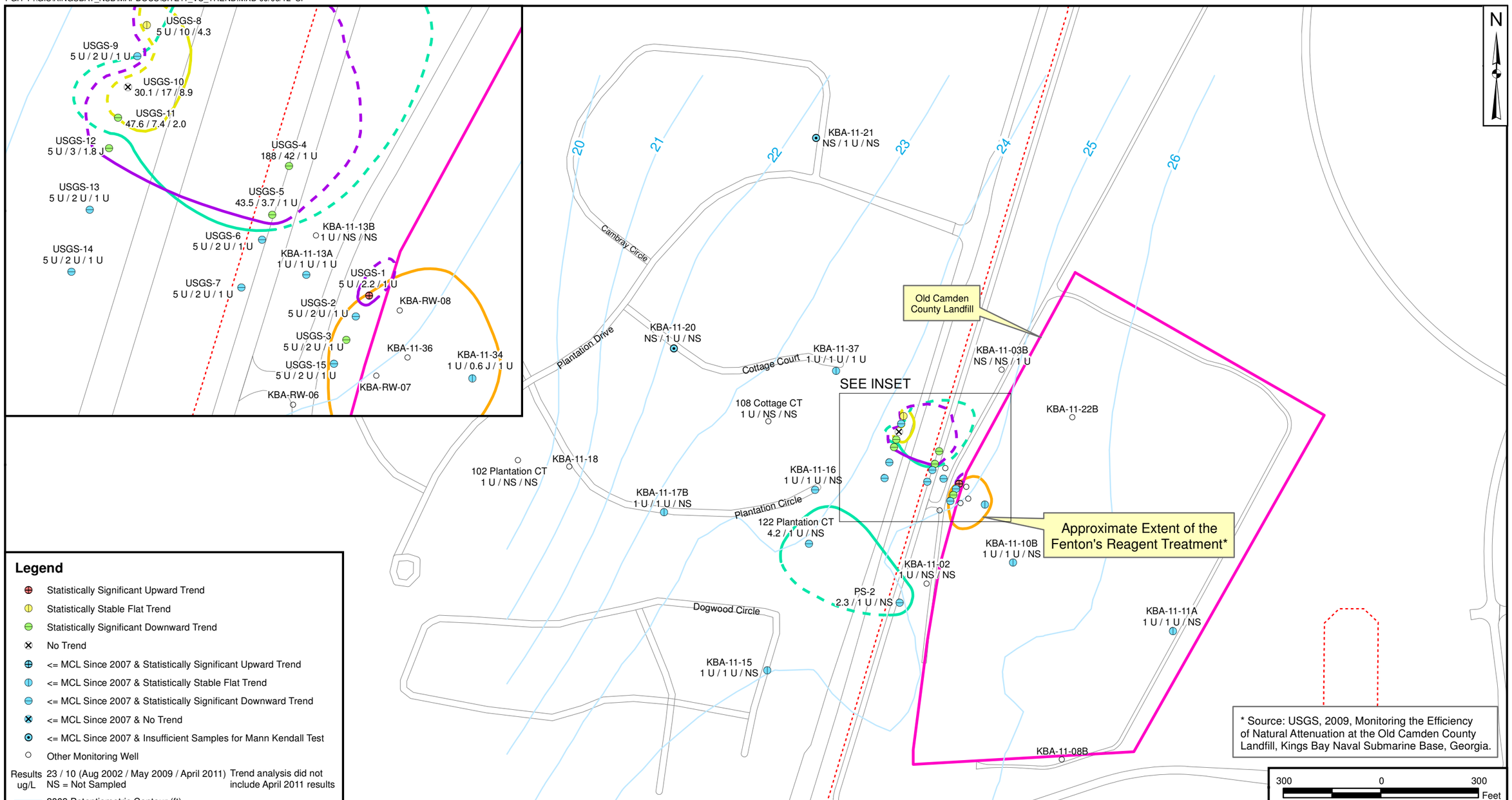
DRAWN BY	DATE
K. MOORE	06/13/11
CHECKED BY	DATE
B. LI	09/06/12
COST/SCHEDULE AREA	
SCALE AS NOTED	

NAVFAC

CIS-1,2-DICHLOROETHENE DISTRIBUTIONS
AUGUST 2002, MAY 2009, AND APRIL 2011
SITE 11, OLD CAMDEN COUNTY LANDFILL
NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

CONTRACT NUMBER CTO	
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO. FIGURE 10 - 5	REV 0

PGH F:\GIS\KINGSBAY_NSB\MAP-DOCS\SITE11_VC_TREND.MXD 09/06/12 SP



Legend

- Statistically Significant Upward Trend
- Statistically Stable Flat Trend
- Statistically Significant Downward Trend
- No Trend
- <= MCL Since 2007 & Statistically Significant Upward Trend
- <= MCL Since 2007 & Statistically Stable Flat Trend
- <= MCL Since 2007 & Statistically Significant Downward Trend
- <= MCL Since 2007 & No Trend
- <= MCL Since 2007 & Insufficient Samples for Mann Kendall Test
- Other Monitoring Well

Results ug/L: 23 / 10 (Aug 2002 / May 2009 / April 2011) Trend analysis did not include April 2011 results
NS = Not Sampled

- 2009 Potentiometric Contour (ft)
- Fence Line
- Road

Vinyl Chloride Isoconcentration Contour (2 ug/L)

- Based on August 2002 Results (Dashed Where Inferred)
- Based on May 2009 Results (Dashed Where Inferred)
- Based on April 2011 Results (Dashed Where Inferred)

DRAWN BY	DATE
K. MOORE	06/13/11
CHECKED BY	DATE
B. LI	09/06/12
REVISED BY	DATE
S. PAXTON	09/06/12
SCALE	
AS NOTED	

NAVFAC

VINYL CHLORIDE DISTRIBUTIONS
AUGUST 2002, MAY 2009, AND APRIL 2011
SITE 11, OLD CAMDEN COUNTY LANDFILL
NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

CONTRACT NUMBER	CTO NUMBER
APPROVED BY	DATE
APPROVED BY	DATE
FIGURE NO. FIGURE 10 - 6	REV 0

SAP Worksheet #11 -- Project Quality Objectives/Systematic Planning Process Statements
(UFP-QAPP Manual Section 2.6.1)

The following text describes the development of the Project Quality Objectives using USEPA's Data Quality Objective Process.

11.1 PROBLEM DEFINITION

As a result of historical landfill disposal of wastes at SWMU 3, also known as Site 11, Old Camden County Landfill (Site 11), groundwater was contaminated by chlorinated organic solvent-related and fuel-related VOCs. A series of investigations showed a plume of dissolved VOC constituents from a localized area within the landfill extending west beyond the landfill boundary. A groundwater monitoring well network was developed based on the extent of the contaminant plume and was adjusted for use in compliance monitoring at Site 11. A Corrective Action (CA) that utilized chemical oxidation injection, enhanced bioremediation, and MNA was implemented beginning 1998 to protect human health and the environment by eliminating, reducing, or controlling the hazards posed by the groundwater contamination. The objectives of the previous monitoring plan, which had been maintained since 1999 through 2009, was the following:

- Monitor the CA until the contaminants no longer exceed the applicable GADNR GWPS for three consecutive years, as defined in the RCRA Permit Amendment to Permit Number HW-014(S)(2) dated October 30, 1998; and
- Document the reduction of total chlorinated ethenes (summation of PCE, TCE, cis-1,2-DCE, trans-1,2-DCE, and vinyl chloride) to less than 100 micrograms per liter (µg/L) at each monitoring well associated with the site, as defined in the CAP dated July 1998.

Based on recommendations included in Tetra Tech's Optimization report dated August 2012, various wells have been eliminated while other wells have been incorporated into the designated monitoring well network. In addition, the sampling regimes, sampling frequencies, and reporting frequencies have been adjusted to represent the current groundwater quality conditions and provide more meaningful data to monitor potential impacts to human health and the environment. The Optimization Study fully demonstrated the effectiveness of natural attenuation as the final remedy and that the requirement for comparing total chlorinated ethenes to the 100 µg/L criteria was determined to be no longer applicable and is not required in the new RCRA permit. The optimized LTM plan recommended in the final Optimization Report became the basis for the Site 11 LTM requirements included in Section V of the current Hazardous Waste Facility Permit HW-014(S&T)-4 (as amended August 7, 2012).

The monitoring requirements in this current SAP are consistent with the recommendations of the Optimization Report and the current Hazardous Waste Facility Permit HW-014(S&T)-4.

To meet the Remediation Goals (RGs) of the CA through the monitoring plan, groundwater at Site 11 that has been adversely impacted by contaminants must be monitored until the concentrations decrease by natural attenuation processes to GWPS, which are currently the Maximum Contaminant Levels (MCLs) for PCE, TCE, cis-1,2-DCE, and vinyl chloride.

11.2 INFORMATION INPUTS

The following physical and chemical data will be collected during the monitoring plan:

1. Chemical Data: Groundwater will be analyzed from different locations at established frequencies for the select lists of target analytes that are presented in Worksheet #15 in accordance with the requirements in the Hazardous Waste Facility Permit HW-014(S&T)-4. The sampling locations, frequencies, and methods that will be utilized are presented in Worksheet #18, and the analytical methods are presented in Worksheet #19.

2. Field Parameters: Field investigation parameters for groundwater will include DO, oxidation-reduction potential (ORP), pH, conductivity, temperature, and turbidity. These data will be collected in the field. The groundwater measurements will be used to determine when groundwater samples are representative of the groundwater from the aquifer being investigated. The relevant Standard Operating Procedures (SOPs) are presented in Worksheet #21.

3. Groundwater Level Measurements: Synoptic groundwater levels (depth to water and total well depth) will be measured in each well to monitor the groundwater flow direction and gradient. The sampling methods are presented in Worksheets #14 and #18.

4. Project Action Limits (PALs): Concentrations of target analytes in groundwater will be compared to the GADNR GWPS, which are equal to the USEPA MCLs.

To conduct comparisons of site data to the PALs for groundwater, the selected laboratory should be able to achieve Limits of Quantitation (LOQs) that are low enough to measure the analytical constituents at concentrations less than the applicable PALs, which are identified in Worksheet #15. In some cases, this may not be achievable. The Project Team will accept the laboratory analytical results between the Detection Limit (DL) and the LOQ if the results are “J” qualified. J-flagged data will be accepted to

achieve project goals when the PAL is between the LOQ and the DL. Any data limitations and the impact on data usability will be documented in each Semiannual Groundwater Monitoring Report.

A RG is the targeted objective that the target analytes must meet for a particular medium of concern to achieve one or more of the established Remedial Action Objectives. RGs are developed to ensure that contaminant concentration levels left on site are protective of human and ecological receptors. The groundwater RGs are the GWPS, as specified in Hazardous Waste Facility Permit HW-014(S&T)-4. Analytical data collected from groundwater samples are compared with the GWPS to ensure protection of human health and the environment.

Quality Control (QC) samples for estimating precision, bias, and contamination potential will be collected at frequencies established in Worksheet #12.

11.3 STUDY BOUNDARIES

The site is bounded by the eastern boundary of the landfill to the east, Plantation Village Road to the south, and Plantation Drive to the west and to the north. Groundwater of interest is the intermediate hydrogeologic unit of the surficial aquifer hydraulically downgradient from the source areas that could be adversely affected by contaminants that may leach from the source areas, as this zone has been identified as the preferential pathway for groundwater flow and contaminant transport for the system.

Within this hydrogeologic unit, the groundwater populations of interest are groundwater within the source area, groundwater in the plume interior area, groundwater that is hydraulically downgradient of the plume, and groundwater that is hydraulically upgradient of the source area.

Regarding temporal boundaries, groundwater conditions are not expected to change significantly over a 6-month to 1-year time frame. The first semiannual groundwater monitoring event will be conducted in June 2013.

11.4 ANALYTICAL APPROACH

This SAP was developed to ensure that the remedial action performed at Site 11, as identified Hazardous Waste Facility Permit HW-014(S&T)-4, continues to be protective of human and ecological receptors. In general, changes in contaminant concentration must be monitored to determine whether some action is necessary, or continued monitoring is appropriate. The objective of groundwater monitoring at Site 11 is to evaluate the performance, progress, and effectiveness of natural attenuation of the contaminants at source areas and to determine that the contaminants are not migrating further downgradient from the sentinel monitoring wells. To achieve this objective, this SAP is designed to verify that contaminant

reduction is occurring and that exceedances of the PALs are not occurring at the sentinel monitoring wells.

Based on the recommendations from the optimization study and the current Hazardous Waste Facility Permit HW-014(S&T)-4, groundwater samples will be collected from sixteen designated monitoring wells and analyzed for PCE, TCE, cis-1,2-DCE, and vinyl chloride by USEPA Method 8260B. Groundwater monitoring frequency will be based on the requirements established in Hazardous Waste Facility Permit HW-014(S&T)-4 (i.e., annual monitoring with the exception of semiannual monitoring to be performed at four semiannual wells and one source area well). However, the number of monitoring wells to be sampled, the parameters to be analyzed, and the sampling frequency may change over time depending on sample results and with the approval of the Navy and GADNR.

Based on the information provided in Hazardous Waste Facility Permit HW-014(S&T)-4, the exit strategy identified in the optimization study (Tetra Tech, 2012) and Partnering Team conference calls held on February 11 and 12 and March 20, 2013, decision rules were developed to govern data use. The decision rules include the direct comparison of the laboratory analytical results to the applicable PAL to determine if the RG has been met. The primary RG for the corrective action of natural attenuation for groundwater at Site 11 is for target analytes to be detected at concentrations less than or equal to the applicable PALs at all designated monitoring wells. Once the PALs are met, three consecutive years of semiannual monitoring at select wells to be determined by GEPD and the Navy will be conducted to demonstrate consistent seasonal compliance with GWPS during the 3-year compliance period.

Ongoing Corrective Action – Evaluation of Exceedances and Future Optimization

Decision Rule #1:

With the exception of sentinel wells, if the analytical results of three consecutive years of monitoring are less than or equal to the GWPSs for all target analytes at a particular monitoring well, sampling at this well will be ceased per the approval from GEPD. Request to cease sampling at a particular well will be included in the annual report or the semiannual monitoring results submittal.

Decision Rule #2:

If the Navy believes that a sample result from a well is anomalous, the Navy may resample the well(s). The Navy must submit to the GEPD written notification of the plan to resample the well(s) within 30 days of the discovery of an anomalous result. The written notification shall include an explanation for the belief that the sampling results were anomalous and the date upon which the resampling will take place.

Termination of Corrective Action – Demonstration of Compliance – Monitoring to Achieve NFA

Decision Rule #3:

When COCs in all wells in the monitoring program have not exceeded GWPS, GEPD will work with the Navy to review historical data and identify up to five specific wells that will require semiannual monitoring to demonstrate compliance with GWPS for three consecutive years, and the Permit may be modified at that time.

General criteria to be used for selecting the specific wells for semiannual compliance monitoring are listed in Worksheet #9 and the related Partnering Team Conference Call Meeting Minutes on February 11 and 13, 2013, and March 20, 2013.

After demonstration of compliance with GWPS during the three year compliance period, a NFA status request will be submitted to the GEPD for approval.

11.5 PERFORMANCE CRITERIA

Monitoring well locations were selected in the optimization report (Tetra Tech, 2012) based on the comprehensive review of the historical data from 1999 through 2011. The monitoring well selection is also consistent with the current Hazardous Waste Facility Permit HW-014(S&T)-4 requirements.

Individual measured target analyte concentrations detected in groundwater samples collected from each monitoring well in the monitoring plan will be compared without adjustment to their applicable PAL and RG. Statistical criteria will be involved in the comparison of the analytical results to their applicable PAL and RG; however, data quality will be evaluated as part of the verification/validation and the data usability processes described in Worksheets #34 through #37. Failure to meet validation targets or limitations on data use identified during data usability assessment shall be described in each Groundwater Monitoring Report.

11.6 PLAN FOR OBTAINING DATA

The groundwater sampling design, rationale, and locations are summarized in Worksheets #17 and #18 and consistent with the current Hazardous Waste Facility Permit HW-014(S&T)-4 requirements. These Worksheets identify which monitoring wells are to be sampled, the sampling frequency for each well, analyses that will be conducted for each sample, and the reasons for including the monitoring well in the monitoring plan.

SAP Worksheet #12 -- Measurement Performance Criteria Table – Field Quality Control Samples
(UFP-QAPP Manual Section 2.6.2)

QC Sample	Analytical Group	Frequency	Data Quality Indicators (DQIs)	Measurement Performance Criteria	QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&A)
Trip Blank	VOCs	1 per cooler containing VOC samples	Accuracy / Bias Contamination	No analytes ≥ ½ LOQ, except common lab contaminants, which must be < LOQ.	S & A
Rinsate Blank[1]	All fractions	1 per 20 samples per sampling equipment	Accuracy / Bias Contamination	No analytes ≥ ½ LOQ, except common lab contaminants, which must be < LOQ.	S & A
Field Duplicate	All fractions	1 per 10 environmental samples	Precision	Relative percent difference (RPD) must be ≤ 30% for aqueous samples. If sample results are < 2x LOQ, professional judgment shall be used in determining an acceptable RPD.	S & A
Cooler Temperature Indicator	All fractions	1 per cooler	Representativeness	Temperature must be less than or equal to 6 degrees Celsius (°C).	S

1 – Equipment rinsate blanks will be collected if non-dedicated sampling equipment is used. For disposable equipment, one sample per batch of disposable equipment will be collected.

SAP Worksheet #13 -- Secondary Data Criteria and Limitations Table

(UFP-QAPP Manual Section 2.7)

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**
Site 11 LTM Data	Quarterly Ground Water Monitoring Report April to June 2009	VT Group Groundwater data and historical LTM data	LTM of groundwater– compares current data to that observed during previous LTM events	None
Site 11 LTM Data	Quarterly Ground Water Monitoring Report October to December 2009	VT Group Groundwater data and historical LTM data	LTM of groundwater– compares current data to that observed during previous LTM events	None
Site 11 LTM Data	Semiannual Corrective Action Report April to September 2009	VT Group Groundwater data and historical LTM data	LTM of groundwater– compares current data to that observed during previous LTM events	None
Site 11 LTM Data	April 2011 Sampling Event Letter Report – June 2011	Tetra Tech Groundwater data	LTM of groundwater– compares current data to that observed during previous LTM events	None
Site 11 USGS LTM Data	USGS – Data tables	USGS	LTM of groundwater– compares current data to that observed during previous LTM events	None
Site 11 USGS LTM Data	Report – Monitoring the Efficiency of Natural Attenuation at the Old Camden County Landfill, Kings Bay Naval Submarine Base, Georgia, 2009	USGS MNA data	LTM of groundwater– compares current data to that observed during previous LTM events	None

SAP Worksheet #14 -- Summary of Project Tasks
(UFP-QAPP Manual Section 2.8.1)

The field tasks associated with the Site 11 sampling are summarized below along with short descriptions of these tasks. All data recording and management procedures are described in Worksheet #29.

- Mobilization/Demobilization
- Site-Specific Health and Safety Training
- Monitoring Equipment Calibration
- Water Level Measurements
- Groundwater Sampling
- Investigation-Derived Waste (IDW) Management
- Field Decontamination Procedures

Additional project activities include the following tasks:

- Field Documentation Procedures
- Analytical Tasks
- Data Management Tasks
- Assessment and Oversight
- Data Review
- LTM Reports

Mobilization/Demobilization

Mobilization shall consist of the delivery of all equipment, materials, and supplies to the site; the complete assembly in satisfactory working order of all such equipment at the site; and the satisfactory storage of all such materials and supplies at the site. The Tetra Tech FOL or designee will coordinate with the Base to identify locations for the storage of equipment and supplies. Site-specific health and safety training will be provided to all Tetra Tech subcontractors as part of the site mobilization.

Demobilization shall consist of the prompt and timely removal of all equipment, materials, and supplies from the site following completion of the work. Demobilization includes the cleanup and removal of IDW generated during the groundwater sampling events.

Site-Specific Health and Safety Training

Site-specific health and safety training to all Tetra Tech field staff and subcontractors will be provided as part of the site mobilization and is also addressed in Worksheet #8.

Monitoring Equipment Calibration

These procedures are described in Worksheet #22.

Water Level Measurements

Water level measurements as specified in Worksheets #17 and #18 will be conducted at the site as part of each groundwater sampling event to provide information regarding groundwater flow patterns and gradients. Water level measurements will be completed within the shortest time possible on the same day, and no sooner than 24 hours after a significant precipitation event to minimize the precipitation effects on the data sets. Water level measurements will be recorded to the nearest 0.01 foot and referenced to a top of casing notch, or if a notch is absent, to the north side of the top of the well casing. The measurement instrument will be decontaminated prior to conducting the measurement event and between each monitoring well.

Groundwater Sampling

Groundwater samples will be collected using low-flow purging techniques (discharge rate of less than 1 liter per minute) with a peristaltic pump using Teflon® tubing dedicated to each well. When a well is developed for sampling, a water quality meter will be used to monitor pH, ORP, DO, turbidity, and conductivity. All groundwater samples will be collected using the procedures specified in Tetra Tech SOP SA-1.1, Groundwater Sample Acquisition and Onsite Testing (see Appendix B). Worksheets #17 and #18 specify the groundwater sample locations and analytes for groundwater sampling events, and Worksheet #23 specifies the analytical methods to be used.

Prior to groundwater sample collection, the monitoring wells will be purged. Both purging and sampling operations will be conducted at a flow rate that results in a groundwater turbidity measurement of 10 Nephelometric Turbidity Units (NTUs) or less (inherent turbidity will be minimized to the greatest extent possible using low flow techniques; individual well conditions and local geology may preclude meeting the 10 NTU criteria). If 10 NTUs cannot be achieved a minimum of five well volumes will be purged.

The sample aliquot for VOC analysis will be the last one collected. The Teflon™ tubing will be slowly pulled out of the well to minimize agitation of the water in the monitoring well and then the contents of the tubing will be transferred to a VOC vial. After collection, the samples will be placed in a cooler, chilled with ice, and shipped under chain of custody protocol to the off-site laboratory for analysis.

Each monitoring well will be inspected and maintained during monitoring events. Well logs, well caps, well labels, plant growth, and weather conditions will be documented in field notes and maintenance will be conducted if necessary.

Investigation-Derived Waste Management

IDW generated during the activities will be managed in accordance with the NSB Kings Bay IDW Plan and will be conducted in an environmentally responsible manner consistent with NSB Kings Bay requirements (e.g., designation of staging areas). The objectives of the IDW management are:

- Management of IDW in a manner that prevents contamination of uncontaminated areas (by IDW) and that is protective of human health and the environment.
- Minimization of IDW, thereby reducing costs and the potential for human or ecological exposure to contaminated materials.
- Compliance with federal and state requirements that are Applicable or Relevant and Appropriate Requirements.
- Bagging and disposal of used personal protective equipment (PPE), such as gloves, as regular trash in an appropriate facility waste container.

Field Decontamination Procedures

Decontamination of major equipment and sampling equipment will be in accordance with Tetra Tech SOP SA-7.1, Decontamination of Field Equipment and Waste Handling (Appendix B).

Field Documentation Procedures

Field documentation will be performed in accordance with Tetra Tech SOP SA-6.3, Field Documentation (see Appendix B).

A summary of all field activities will be properly recorded in a bound logbook with consecutively numbered pages that cannot be removed. Logbooks will be assigned to field personnel and will be stored in a secured area when not in use. At a minimum, the following information will be recorded in the site logbook:

- Name of the person to whom the logbook is assigned.
- Project name.
- Project start date.
- Names and responsibilities of on-site project personnel including subcontractor personnel.

- Arrival/departure of site visitors.
- Arrival/departure of equipment.
- Sampling activities and sample log sheet references.
- Description of subcontractor activities.
- Sample pick-up information, including chain-of-custody numbers, air bill numbers, carrier, time, and date.
- Description of borehole or monitoring well installation activities and operations.
- Health and safety issues.
- Description of photographs including date, time, photographer, picture number, location, and compass direction of photograph.

All entries will be written in 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; the person making the correction will initial and date the change.

Analytical Tasks

Chemical will be performed by Katahdin. Katahdin is a Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) accredited laboratory. A copy of the laboratory accreditation is located in Appendix C. Analyses will be performed in accordance with the analytical methods identified in Worksheet #19. Katahdin will meet the PALs as shown in Worksheet #15. Katahdin will perform chemical analysis following laboratory-specific SOPs (Worksheets #19 and #23) developed based on the analytical methods listed in Worksheet #19 and #30. Copies of the Laboratory SOPs are included in Appendix C.

This information will also be captured in the project database which will eventually be uploaded to Naval Installation Restoration Information Solution.

The analytical data packages provided by Katahdin 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 (results, recoveries, relative percent differences, relative standard deviations, and/or percent differences etc.).

Data Management Tasks

- Project documentation and records

- Field sample collection and field measurement records are described in Worksheets #27 and #29.
- Laboratory data package deliverables are described in the analytical specifications.
- Data assessment documents and records are listed in Worksheet #29.

- Data recording formats are described in Worksheet #27.

Data Handling and Management – After the field investigation is completed, the field sampling log sheets will be organized by date and media and filed in the project files. The field logbooks for this project will be used only for these sites, 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 the laboratories will meet the requirements of the technical specification. The electronic data results will be automatically downloaded into the Tetra Tech database in accordance with proprietary Tetra Tech processes.

Data Tracking and Control – The Tetra Tech PM (or designee) is responsible for the overall tracking and control of data generated for the project.

- Data Tracking: Data is tracked from its generation to its archiving in the Tetra Tech project-specific files. The Tetra Tech Project Chemist (or designee) is responsible for tracking the samples collected and shipped to the subcontracted laboratory. Upon receipt of the data packages from the analytical laboratory, the Tetra Tech Project Chemist will oversee the data validation effort, which includes verifying that the data packages are complete and results for all samples have been delivered by the analytical laboratory.

- Data Storage, Archiving, and Retrieval: The data packages received from the subcontracted laboratory are tracked in the data validation logbook. After the data are validated, the data packages are entered into the Tetra Tech CLEAN file system and archived in secure files. The field records including field logbooks, sample logs, chain-of-custody records, and field calibration logs will be submitted by the Tetra Tech FOL to be entered into the CLEAN file system prior to archiving in secure project files. The project files are audited for accuracy and completeness. At the completion of the Navy contract the records will be stored by Tetra Tech and eventually handed over to NAVFAC.

- Data Security: The Tetra Tech project files are restricted to designated personnel only. Records can only be borrowed temporarily from the project file using a sign-out system. The Tetra Tech Data

Manager maintains the electronic data files. Access to the data files is restricted to qualified personnel only. File and data backup procedures are routinely performed.

Assessment and Oversight

Refer to Worksheet #32 for assessment findings and corrective actions and Worksheet #33 for QA management reports.

Data Review

Data verification is described in Worksheet #34. Data validation is described in Worksheets #35 and #36. Usability assessment is described in Worksheet #37.

Semiannual Data Submittal and Annual Groundwater Monitoring Reports

A comprehensive groundwater monitoring report will be issued annually. An interim semiannual submittal will be in a simplified format and would include a data presentation letter with one or two pages of text and tables and figures summarizing monitoring results from the wells sampled semiannually and related trend analysis results. The interim semiannual submittal would also highlight any substantial variations from previous monitoring results, such as an order of magnitude increase in concentrations at a particular monitoring location or indication of further off-site plume migration.

The comprehensive annual report will use the format recommended by the GEPD. The reports will include appropriate data contained in the following sections:

- **Current Period Progress**
  - Introduction – Provide a brief introduction, the time-frame (month/year to month/year) that covers the current period's Progress Report, and brief summary of actions taken during this period.
  - Previous Progress Reports – Provide a summary of the previous progress reports, including trends, migration, and overall effectiveness/reduction in contaminant concentrations to date.
  - Remedial Actions (as applicable) – Provide in detail any active remedial actions taken or in progress during this period.

- Monitoring Program
  - -- Overview – Brief summary of the program. Include a table of the required sampling events taken this period. Identify in this table which wells are used to monitor progress (i.e., compliance well), which wells are used to monitor for possible migration (i.e., sentry well), and which wells have been added or suspended from the program. Include a table of the COCs, the maximum detected concentration of each COC for this sampling event, and their respective reporting limits (RLs).
  - -- Sampling Results – Include a table of the sample identification (e.g., well number), medium sampled, COC concentrations, and the analysis/method used. Include lab detection and quantification limits, as well as the RLs for each COC. This table may be included in a Tables Appendix.
  - -- Summary Results of Sampling Events – Summarize results, including figures, current potentiometric map, and summary tables that include, but are not limited to, contaminant detections and groundwater well elevation history. At least one figure should show the results of the sampling event for each sample point (and include iso-concentrations and groundwater flow direction as applicable). Figures and maps may be put in a Figures Appendix.
  - -- Trend Analysis – Discuss results of the current period's trend analyses with data and graphs to support logical conclusions. Trend graphs may be put in an appendix. Include overall reduction in contaminants from start of Corrective Action.
  - -- MNA Parameters (as applicable) – Discuss MNA parameter monitoring results, and provide logical conclusions.
  - -- Remediation Derived Waste (as applicable) – Provide details on quantity of wastes generated, and how it was handled and disposed of in accordance with the State of Georgia Rules for Hazardous Waste Management and the approved CAP. Provide the results of any Toxicity Characteristic Leaching Procedure analyses.
- Deviations – Discuss any deviations from the approved CAP or monitoring program during this period.
- Status at End of Period – Discuss the progress made during this period toward meeting the Remediation Levels and completion criteria with respect to the approved CAP.

- **Status of LUCs** – Provide the results of the most recent inspection of any LUCs that were specified in the approved CAP, including fences, signage, etc. Also include any changes in site conditions such as construction activity, vegetative growth, erosion, training activity, and so forth. Evaluate the effectiveness of the LUCs and whether they should be altered.

- **Recommendations and Conclusions** – Summarize the overall progress toward meeting the Remediation Goals and any recommendations for further optimization of the monitoring program, and

whether modifications should be made to the CAP to improve the effectiveness of the corrective action.

- **References** – Each monitoring report will be issued in draft to the NAVFAC RPM for initial review. NAVFAC RPM comments will be addressed, and the draft-final report will be issued to GADNR for regulatory review.

SAP Worksheet #15 -- Reference Limits for Groundwater
(UFP-QAPP Manual Section 2.8.1)

Matrix: Groundwater
Analytical: VOCs

Analyte	CAS Number	PAL (µg/L)	PAL Reference	Project Quantitation Limit Goal (µg/L)	LOQ (µg/L)	LOD (µg/L)	DL (µg/L)
CIS-1,2-DICHLOROETHENE	156-59-2	70	GWPS	23	1	0.5	0.21
TETRACHLOROETHENE	127-18-4	5	GWPS	1.7	1	0.5	0.4
TRICHLOROETHENE	79-01-6	5	GWPS	1.7	1	0.5	0.28
VINYL CHLORIDE	75-01-4	2	GWPS	0.67	2	1	0.25

CAS – Chemical Abstracts Service
GWPS – Georgia Groundwater Protection Standard is equal to the MCLs for the remaining COCs.
LOD – Limit of Detection
NC – No Criteria

SAP Worksheet #16 -- Project Schedule/Timeline Table

(UFP-QAPP Manual Section 2.8.2)

Activities	Organization	Dates (MM/DD/YYYY)		Deliverable	Deliverable Due Date
		Anticipated Date(s) of Initiation	Anticipated Date of Completion		
Optimization Plan/Revised SAP					
Final Optimization Plan	Tetra Tech	--	--	Final Plan	8/15/2012
Draft SAP Revision	Tetra Tech	8/15/2012	8/31/2012	Draft SAP Revision	9/7/2012
Final SAP Revision	Tetra Tech	9/15/2012	7/31/13	Final SAP Revision	7/31/13
Monitoring Reports					
Draft Monitoring Report – 1st Semiannual	Tetra Tech	8/9/13	9/13/13	Draft Monitoring Report – 1st S-A	10/25/13
Draft Final Monitoring Report – 1st Semiannual	Tetra Tech	10/25/13	11/22/13	Draft Final Report – 1st S-A	12/20/13
Final Monitoring Report – 1st Semiannual	Tetra Tech	12/20/13	1/17/14	Final Report – 1st S-A	2/17/14
Draft Monitoring Report – 1st Annual	Tetra Tech	2/28/14	3/28/14	Draft Monitoring Report – 1st Annual	3/28/14
Draft Final Monitoring Report – 1st Annual	Tetra Tech	4/18/14	5/2/14	Draft Final Report – 1st Annual	5/2/14
Final Monitoring Report – 1st Annual	Tetra Tech	5/2/14	6/13/14	Final Report – 1st Annual	6/13/14
Draft Monitoring Report – 2nd Semiannual	Tetra Tech	7/7/14	8/22/14	Draft Monitoring Report – 1st S-A	8/22/14
Draft Final Monitoring Report – 2nd Semiannual	Tetra Tech	8/22/14	9/26/14	Draft Final Report – 1st S-A	9/26/14
Final Monitoring Report – 2nd Semiannual	Tetra Tech	9/26/14	10/31/14	Final Report – 1st S-A	10/31/14

This schedule identifies the project schedule for the SAP revisions and associated semiannual and annual groundwater sampling events for Site 11 as identified in this SAP. LTM will continue at Site 11 under a revision of this SAP until the Project Team agrees that NFA is appropriate at the site.

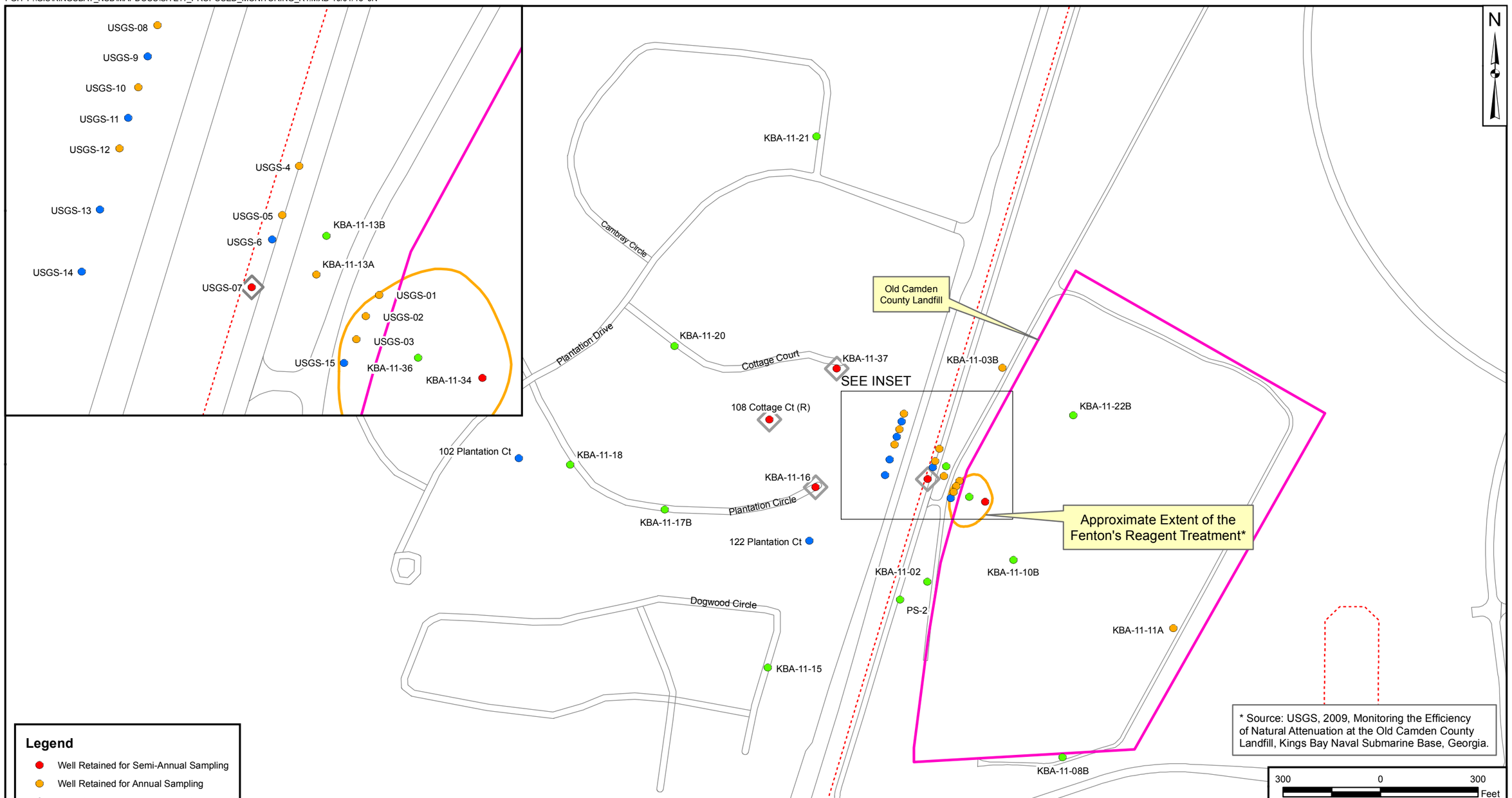
SAP Worksheet #17 -- Sampling Design and Rationale
(UFP-QAPP Manual Section 3.1.1)

The sampling design and rationale for Site 11, Old Camden County Landfill, is presented in the optimization study (Tetra Tech, 2012). The sampling design is also consistent with the requirements in the current Hazardous Waste Facility Permit HW-014(S&T)-4. The proposed sample locations are presented on Figure 17-1. The analytical program recommended for each proposed sample is presented in Worksheet #18. The field QC samples required are specified in Worksheet #20.

The following monitoring wells will be sampled semiannually: KBA-11-16, KBA-11-34, KBA-11-37, USGS-7, and 108 Cottage Ct (R). Groundwater samples from these wells will be analyzed for PCE, TCE, cis-1,2-DCE, and vinyl chloride only. Field parameters will also be collected from these wells, including DO, ORP, turbidity, specific conductance, temperature, and pH.

The following monitoring wells will be sampled annually: KBA-11-03B, KBA-11-11A, KBA-11-13A, USGS-1, USGS-2, USGS-3, USGS-4, USGS-5, USGS-8, USGS-10, and USGS-12. Groundwater samples from these wells will be analyzed for PCE, TCE, cis-1,2-DCE, and vinyl chloride only. Field parameters will also be collected from these wells, including DO, ORP, turbidity, specific conductance, temperature, and pH.

The following wells will be for semiannual water level measurements only: KBA-11-10B, KBA-11-15, KBA-11-17B, PS-2, KBA-11-20, KBA-11-21, KBA-11-08B, KBA-11-18, KBA-11-22B, KBA-11-36, KBA-11-02, and KBA-11-13B.



DRAWN BY	DATE
K. MOORE	06/13/11
CHECKED BY	DATE
M. MAUGHON	10/01/13
REVISED BY	DATE
J. NOVAK	10/01/13
SCALE	
AS NOTED	

NAVFAC

PROPOSED MONITORING PROGRAM
SITE 11, OLD CAMDEN COUNTY LANDFILL
NAVAL SUBMARINE BASE
KINGS BAY, GEORGIA

CONTRACT NUMBER	CTO NUMBER
2831	___
APPROVED BY	DATE
___	___
APPROVED BY	DATE
___	___
FIGURE NO. FIGURE 17 - 1	REV 0

SAP Worksheet #18 -- Sampling Locations and Methods/SOP Requirements Table
(UFP-QAPP Manual Section 3.1.1)

Sampling Location/ Identification Number(1)	Matrix	Sampling Frequency	Analytical Parameters	Number of Samples (identify field duplicates)[2]	Sampling SOP Reference(3)
Groundwater Monitoring					
USGS-1-YYYYMMDD	GW	Annually	PCE, TCE, cis-DCE, and vinyl chloride	1	SA-1.1 – Groundwater Sample Testing
USGS-2-YYYYMMDD	GW	Annually	PCE, TCE, cis-DCE, and vinyl chloride	1	Tetra Tech SOPs SA-1.1
USGS-3-YYYYMMDD	GW	Annually	PCE, TCE, cis-DCE, and vinyl chloride	1	Tetra Tech SOPs SA-1.1,
USGS-4-YYYYMMDD	GW	Annually	PCE, TCE, cis-DCE, and vinyl chloride	1	Tetra Tech SOPs SA-1.1
USGS-5-YYYYMMDD	GW	Annually	PCE, TCE, cis-DCE, and vinyl chloride	1	Tetra Tech SOPs SA-1.1
USGS-7-YYYYMMDD	GW	Semiannually	PCE, TCE, cis-DCE, and vinyl chloride	1	Tetra Tech SOPs SA-1.1
USGS-8-YYYYMMDD	GW	Annually	(PCE, TCE, cis-DCE, trans-DCE, and vinyl chloride)	1	Tetra Tech SOPS SA-1.1
USGS-10-YYYYMMDD	GW	Annually	PCE, TCE, cis-DCE, and vinyl chloride	1	Tetra Tech SOPs SA-1.1
USGS-12-YYYYMMDD	GW	Annually	PCE, TCE, cis-DCE, and vinyl chloride	1	Tetra Tech SOPs SA-1.1
KBA-11-03B-YYYYMMDD	GW	Annually	PCE, TCE, cis-DCE, and vinyl chloride	1	Tetra Tech SOPs SA-1.1
108 Cottage Ct (R)-YYYYMMDD	GW	Semiannually	PCE, TCE, cis-DCE, and vinyl chloride	1	Tetra Tech SOPs SA-1.1
KBA-11-10B-YYYYMMDD	GW	Semiannually	None – Water Levels Only	--	Tetra Tech SOPs SA-1.1
KBA-11-11A-YYYYMMDD	GW	Annually	PCE, TCE, cis-DCE, and vinyl chloride	1	Tetra Tech SOPS SA-1.1
KBA-11-13A-YYYYMMDD	GW	Annually	PCE, TCE, cis-DCE, and vinyl chloride	1	Tetra Tech SOPS SA-1.1
KBA-11-15-YYYYMMDD	GW	Semiannually	None – Water Levels Only	--	Tetra Tech SOPs SA-1.1
KBA-11-16-YYYYMMDD	GW	Semiannually	PCE, TCE, cis-DCE, and vinyl chloride	1	Tetra Tech SOPs SA-1.1
KBA-11-17B-YYYYMMDD	GW	Semiannually	None – Water Levels Only	--	Tetra Tech SOP SA-1.1

Sampling Location/ Identification Number(1)	Matrix	Sampling Frequency	Analytical Parameters	Number of Samples (identify field duplicates)2	Sampling SOP Reference(3)
KBA-11-34-YYYYMMDD	GW	Semiannually	PCE, TCE, cis-DCE, and vinyl chloride	1	Tetra Tech SOP SA-1.1
KBA-11-37-YYYYMMDD	GW	Semiannually	PCE, TCE, cis-DCE, and vinyl chloride	1	Tetra Tech SOP SA-1.1
KBA-11-08B-YYYYMMDD	GW	Semiannually	None – Water Levels Only	--	Tetra Tech SOP SA-1.1
KBA-11-18-YYYYMMDD	GW	Semiannually	None – Water Levels Only	--	Tetra Tech SOP SA-1.1
KBA-11-22B-YYYYMMDD	GW	Semiannually	None – Water Levels Only	--	Tetra Tech SOP SA-1.1
KBA-11-36-YYYYMMDD	GW	Semiannually	None – Water Levels Only	--	Tetra Tech SOP SA-1.1
KBA-11-2-YYYYMMDD	GW	Semiannually	None – Water Levels Only	--	Tetra Tech SOP SA-1.1
KBA-11-13B-YYYYMMDD	GW	Semiannually	None – Water Levels Only	--	Tetra Tech SOP SA-1.1
PS-2-YYYYMMDD	GW	Semiannually	None – Water Levels Only	--	Tetra Tech SOP SA-1.1
KBA-11-20-YYYYMMDD	GW	Semiannually	None – Water Levels Only	--	Tetra Tech SOP SA-1.1
KBA-11-21-YYYYMMDD	GW	Semiannually	None – Water Levels Only	--	Tetra Tech SOP SA-1.1

1 YYYYMMDD – date of sample –year, month, day
2 Field duplicates may be consolidated across sites at Tetra Tech FOL's discretion so as to yield one field duplicate per 10 environmental samples.
3 Refer to the Project Sampling SOP References Table (Worksheet #21).
4 GW = Groundwater

SAP Worksheet #19 -- Analytical SOP Requirements Table

(UFP-QAPP Manual Section 3.1.1)

Matrix	**Analytical Group**	**Analytical and Preparation Method / SOP Reference**[1]	**Sample Size**	**Containers** (number, size, and type)	**Preservation Requirements**	**Maximum Holding Time** (preparation / analysis)
Groundwater and Aqueous QC Samples	VOCs (PCE, TCE, cis-DCE, and vinyl chloride)	SW846 8260B / CA-202	40 milliliter (mL) (each)	Three 40-mL vials	Hydrochloric acid to pH <2; no headspace; Cool to <6 °C	14 days to analysis

[1] Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23). Laboratory SOPs are subject to revision and updates during duration of the project, the laboratory will use the most current revision of the SOP at the time of analysis.

Groundwater Field Analyses[1] Biological Activity Indicators Field Analytical SOP Requirements Table

Parameter	Method/ Reference	Sample Volume, Container, and Preservation
Temperature	Direct-reading meter	100 to 250 mL in glass or plastic container. Analyze at well head.
DO	Direct-reading meter	100 to 250 mL in glass or plastic container. Analyze at well head.
pH	Direct-reading meter	100 to 250 mL in glass or plastic container. Analyze at well head.
Specific Conductivity	Direct-reading meter	100 to 250 mL in glass or plastic container. Analyze at well head.
ORP	Direct-reading meter	10 to 250 mL in glass container filling from the bottom. Do not aerate or agitate. Analyze at well head with flow-through cell.
Turbidity	Direct-reading meter	10 to 250 mL in glass container filling from the bottom. Do not aerate or agitate. Analyze at well head with flow-through cell.

[1] Table adapted from overview of the Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water (USEPA, 1998).

SAP Worksheet #20 -- Field Quality Control Sample Summary Table

(UFP-QAPP Manual Section 3.1.1)

Matrix	Analytical Group	Number of Sampling Locations	Number of Field Duplicates	Number of MS/MSDs[1]	Number of Field Blanks	Number of Equipment Blanks	Number of VOC Trip Blanks	Number of Proficiency Testing (PT) Samples	Total Number of Samples to Lab
Annual Monitoring									
Groundwater	VOCs[2]	16	2	1/1	NA	1	1	NA	20
Semi-Annual Monitoring									
Groundwater	VOCs[2]	5	1	1/1	NA	1	1	NA	8

MS = matrix spike
MSD = matric spike duplicate
PT = proficiency testing

1 Although the MS/MSDs are not typically considered field QCs and are not included in the *Total Number of Samples to Lab*, they are included here because location determination is often established in the field.

2 VOCs are PCE, TCE, cis-1,2-DCE, and vinyl chloride.

SAP Worksheet #21 -- Project Sampling SOP References Table

(UFP-QAPP Manual Section 3.1.2)

Reference Number	Title, Revision Date, and/or Number	Organization of Sampling SOP	Equipment Type	Modified for Project Work?	Comments
CT-04	Sample Nomenclature (March 2009, Revision 2)	Tetra Tech	None	N	Refer to Appendix B for Field SOPs
CT-05	Database Records and Quality Assurance (January 2001, Revision 2)	Tetra Tech	None	N	
GH-1.2	Evaluation of Existing Monitoring Wells and Water Level Measurement (September 2003, Revision 2)	Tetra Tech	Field logbook, electric water-level indicator or hydrocarbon interface probe, field forms, decontamination equipment and supplies, Photoionization Detector	N	
GH-2.8	Groundwater Monitoring Well Installation (Revision 3, September 2003)	Tetra Tech	Health and safety equipment, well drilling and installation equipment, hydrogeologic equipment, drive point installation tools	N	
GW-0001	Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells (Revision 2, 1996)	USEPA Region 1	Submersible pump, multiparameter meter, turbidimeter	N	
SA-1.1	Groundwater Sample Acquisition and Onsite Water Quality Testing (April 2008, Revision 7)	Tetra Tech	Sample bottle ware, packaging material, shipping material, field tools and instrumentation, peristaltic pump, tubing, buckets, decontamination equipment and supplies, field logbook, paper towels, combination meter for monitoring field parameters	N	
SA-6.1	Non-Radiological Sample Handling (February 2004, Revision 3)	Tetra Tech	Sample bottle ware, packaging material, shipping materials	N	
SA-6.3	Field Documentation (March 2009, Revision 3)	Tetra Tech	Field logbook, field sample forms, boring logs	N	
SA-7.1	Decontamination of Field Equipment (January 2009, Revision 6)	Tetra Tech	Decontamination equipment, scrub brushes, phosphate-free detergent, deionized water	N	

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 (CA)	Responsible Person	SOP Reference	Comments
Electric Water Level Indicator	Visual Inspection Field checks as per manufacturer	Daily Once upon receiving from vendor	0.01 foot accuracy	Operator correction or replacement	Tetra Tech FOL or designee	GH-1.2, Manufacturer's Guidance Manual	None
Multi-Parameter Water Quality Meter (YSI 600 Series or equivalent)	Visual Inspection Calibration/ Verification	Daily Beginning and end of day	Manufacturer's guidance	Operator correction or replacement	Tetra Tech FOL or designee	GH-2.8, GW-0001, SA-1.1, Manufacturer's Guidance Manual	None
Turbidity Meter (LaMotte 2020 or equivalent)	Visual Inspection Calibration/ Verification	Daily Beginning and end of day	Manufacturer's guidance Calibrations must bracket expected values. Initial Calibration Verification (ICV) must be <5 NTU.	Operator correction or replacement	Tetra Tech FOL or designee	GH-2.8, GW-0001, SA-1.1, Manufacturer's Guidance Manual	To be used to determine the need to collect dissolved metals samples (if >5 NTU).
Portable Colorimeter (Hach DR 890 or equivalent)	Visual Inspection Calibration/ Verification	Daily Beginning and end of day	Manufacturer's guidance	Operator correction or replacement	Tetra Tech FOL or designee	GH-2.8, GW-0001, SA-1.1, Manufacturer's Guidance Manual	None

SAP Worksheet #23 -- Analytical SOP References Table

(UFP-QAPP Manual Section 3.2.1)

Lab SOP Number	Title, Revision Date, and / or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Variance to QSM? (Y/N)	Modified for Project Work?[1] (Y/N)
CA-202	Analysis of Volatile Organic Compounds by Purge and Trap GC/MS: SW-846 Method 8260, 03/12, Revision 13.	Definitive	Groundwater and aqueous QC samples/ VOCs	GC/MS	Katahdin	N	N

GC/MS = Gas Chromatography/Mass Spectroscopy
QSM = Quality Systems Manual

SAP Worksheet #24 -- Analytical Instrument Calibration Table

(UFP-QAPP Manual Section 3.2.2)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference[1]
GC/MS VOCs	Initial Calibration (ICAL) - A minimum five-point calibration is required.	Calibrate the instrument when it is received and after a major change or if the daily calibration fails.	VOCs: The average Response Factors (RFs) for System Performance Check Compounds (SPCCs) must be ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane and ≥ 0.10 for chloromethane, 1,1-dichloroethane and bromoform. The Percent Relative Standard Deviation (%RSD) for RFs for Calibration Check Compounds must be ≤ 30%, and one option below must be met: Option 1) %RSD < 15% for all other compounds. If not met: Option 2) Linear least squares regression: correlation coefficient (r) ≥ 0.995. Option 3) Non-linear regression: coefficient of determination (r^2) ≥ 0.99 (six points for second order).	Repeat calibration if criterion is not met	Analyst / Supervisor	CA-202
	ICV (Second Source)	Once after each ICAL.	The Percent Recovery (%R) must be 80-120% for all target compounds.	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat ICAL.	Analyst / Supervisor	
	Retention Time (RT) Window Position Establishment	Once per ICAL for each analyte and surrogate.	Position shall be set using the midpoint standard of the ICAL curve when ICAL is performed. On days when ICAL is not performed, the initial continuing calibration verification is used.	NA	Analyst / Supervisor	

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference[1]
	Evaluation of Relative Retention Times (RRTs)	With each sample.	RRT of each target analyte must be within ± 0.06 RRT units.	Correct problem, then rerun ICAL.	Analyst / Supervisor	
	Continuing Calibration Verification (CCV)	Analyze a standard at the beginning of each 12-hour shift after a bromofluorobenzene (BFB) tune.	VOCs: The RFs for SPCCs must be ≥ 0.30 for chlorobenzene and 1,1,2,2-tetrachloroethane and ≥ 0.10 for chloromethane, 1,1-dichloroethane and bromoform. The Percent Difference for all target compounds and surrogates must be ≤ 20%	DoD project-level approval must be obtained for each of the failed analytes or CA must be taken. Correct problem, then rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since last acceptable CCV.	Analyst / Supervisor	
	BFB Tune	Every 12 hours.	Criteria listed in Section 7.3, current revision of SOPs CA-202 and CA-220.	Retune and/or clean source.	Analyst / Supervisor	

[1] Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23). Laboratory SOPs are subject to revision and updates during duration of the project, the laboratory will use the most current revision of the SOP at the time of analysis.

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	CA	Responsible Person	SOP Reference[1]
GC/MS	Check pressure, gas supply and vacuum daily. Bake out trap and column, manual tune if BFB not in criteria, change septa as needed, cut column as needed, change trap as needed, clean MS source as needed. Other maintenance specified in laboratory Equipment Maintenance SOP.	VOCs	Ion source, injector liner, column, column flow, purge lines, purge flow, trap.	Prior to ICAL and/or as necessary.	Acceptable ICAL or CCV.	Correct the problem and repeat ICAL or CCV.	Analyst/ Supervisor	CA-202

1 Specify the appropriate reference letter or number from the Analytical SOP References table (Worksheet #23).

SAP Worksheet #26 -- Sample Handling System

(UFP-QAPP Manual Appendix A)

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): FOL or designee/ Tetra Tech
Sample Packaging (Personnel/Organization): FOL or designee / Tetra Tech
Coordination of Shipment (Personnel/Organization): FOL or designee / Tetra Tech
Type of Shipment/Carrier: FedEx
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Sample Custodians/Katahdin
Sample Custody and Storage (Personnel/Organization): Sample Custodians/ Katahdin
Sample Preparation (Personnel/Organization): Extraction Lab, Metals Preparation Lab/ Katahdin
Sample Determinative Analysis (Personnel/Organization): GC Lab, GC/MS Lab, Metals Lab/ Katahdin
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 60 days from receipt
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 3 months from sample digestion/extraction
Biological Sample Storage (No. of days from sample collection): NA
SAMPLE DISPOSAL
Personnel/Organization: Sample Custodians/ Katahdin

SAP Worksheet #27 – Sample Custody Requirements Table

(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.

Sample Nomenclature

Refer to Worksheet #18 for how the samples will be labeled. Also, refer to Worksheet #20 for how the field QA/QC samples will be labeled. Sample nomenclature will be conducted in general accordance with the procedures outlined in Tetra Tech SOP CT-04, Sample Nomenclature (see Appendix B). Sample nomenclature put forth for this field event has been selected based on historical usage. The sample nomenclature for each tracking number includes the site being investigated, sample media identifier, and sample location number. The standard sample matrix and type codes used for this field event are as follows: Duplicate samples will be submitted to the laboratory as blind duplicates. The QA/QC type codes used for this field event are as follows: TB for Trip Blanks and RB for rinsate blanks. Field QC blanks will be labeled sequentially followed by the date (i.e., TB-20101213, FB-20101214, etc.). Samples to be used for matrix spikes and matrix spike duplicates will be labeled MS/MSD on the container label and noted on the chain-of-custody, as required in the laboratory QA Plan; however, “MS/MSD” will not be part of the unique sample identifier in order to maintain consistency with the project database. Additional information regarding protocol for sample labeling is contained in Tetra Tech SOP SA-6.3, Field Documentation (see Appendix B).

Sample Collection Documentation

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

Field sample log sheets will be used to document sample collection details, and other observations and activities will be recorded in the field logbook. Instrument calibration logs will be used to record the daily instrument calibration. Example field forms are included in Appendix B.

For sampling and field activities, the following types of information will be recorded in the field log 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 PPE

Sample Handling and Tracking System

Following sample collection into the appropriate bottle ware, 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 the bottle ware during shipment. The cooler will be secured using strapping tape along with a signed custody seal. Sample coolers will be delivered to a local courier location for priority overnight delivery to the selected laboratory for analysis. Samples will be preserved as appropriate based on the analytical method. The laboratories will provide pre-preserved sample containers for sample collection. Samples will be maintained at 0 to 6 °C until delivery to the laboratory. Proper custody procedures will be followed throughout all phases of sample collection and handling.

After collection, each sample will be maintained in the sampler's custody until formally transferred to another party (e.g., FedEx). For all samples collected, chain-of-custody forms will document the date and time of sample collection, the sampler's name, and the names of all others who subsequently held custody of the sample. Specifications for chemical analyses will also be documented on the chain-of-custody form. Tetra Tech SOP SA-6.3 (Field Documentation) provides further details on the chain-of-custody procedure, which is provided in Appendix B.

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

Sample handling requirements are described in Worksheet #26. Tetra Tech personnel will collect the samples. The samplers will take care not to contaminate samples through improper handling. Samples will be sealed in appropriate containers, packaged by Tetra Tech personnel and placed into sealed

coolers under chain-of-custody in accordance with the applicable SOP (see Worksheet #21). Samples to be analyzed for VOCs will be accompanied by a VOC trip blank. All coolers will contain a temperature blank. Samples will be transferred under chain-of-custody to a courier as described below. Once received by the laboratory, receipt will be documented on the chain-of-custody form and the samples will be checked in. The samples will remain under chain-of-custody throughout the analysis period to ensure their integrity is preserved. Details are provided below.

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

27.2 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 Tetra Tech SOP SA-6.1, Non-Radiological Sample Handling (Appendix B).

A sample is under custody if:

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

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

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

The Tetra Tech FOL is responsible for the care and custody of the samples collected until they are delivered to the laboratory or are entrusted to a carrier. When transferring samples, the individuals relinquishing and receiving them will sign, date, and note the time on the chain-of-custody form. This record documents the sample custody transfer from the sampler to the laboratory, often through another

person or agency (common carrier). Upon arrival at the laboratory, internal sample custody procedures will be followed as defined by Laboratory SOPs.

Laboratory Chain of Custody – Katahdin

Laboratory sample custody procedures (receipt of samples, archiving, and disposal) will be used according to Katahdin Laboratory SOPs. Coolers are received and checked for proper temperature and preservation. A sample cooler receipt form will be filled out to note conditions and any discrepancies. The chain of custody will be checked against the sample containers for correctness. Samples will be logged into the Laboratory Information Management System and given a unique log number that can be tracked through processing. The Katahdin Laboratory PM will notify the Tetra Tech FOL of any problems on the same day that the issue is identified.

SAP Worksheet #28 -- Laboratory QC Samples Table

(UFP-QAPP Manual Section 3.4)

Matrix	**Groundwater, and aqueous QC samples**
Analytical Group	**VOCs**
Analytical Method/ SOP Reference	**SW-846 8260B/ CA-202**

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CAs	DQI	Measurement Performance Criterion (MPC)
Method Blank	One per batch of 20 or less.	All target analytes must be ≤ ½ LOQ, except common lab contaminants, which must be < LOQ.	Investigate source of contamination. Rerun method blank prior to analysis of samples if possible. Evaluate the samples and associated QC: if blank results are greater than LOQ, report sample results that are < LOQ or > 10X the blank concentration. Reanalyze blank and samples > LOQ and < 10X the blank.	Analyst, Supervisor	Accuracy/Bias/ Contamination	Same as Method/SOP QC Acceptance Limits.

Matrix	**Groundwater, and aqueous QC samples**
Analytical Group	**VOCs**
Analytical Method/ SOP Reference	**SW-846 8260B/ CA-202**

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CAs	DQI	Measurement Performance Criterion (MPC)
Surrogate	Four per sample: Dibromofluoro-methane, 1,2-dichloroethane-d4, Toluene-d8, Bromofluorobenzene	%Rs must meet the DoD QSM, Version 4.2, limits per Appendix G.	If sample volume available, and within hold time, reanalyze.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Laboratory Control Sample (LCS)	One per batch of 20 or less.	%Rs must meet the DoD QSM for Environmental Laboratories, Version 4.2, limits per Appendix G. RPD must be ≤ 30% (for LCS/Laboratory Control Sample Duplicate [LCSD], if LCSD is performed). In-house statistical laboratory limits are used when DoD QSM, Version 4.2, does not specify.	Correct problem, then reprepare and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available. Contact Tetra Tech if samples cannot be reanalyzed within hold time.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

Matrix	**Groundwater, and aqueous QC samples**
Analytical Group	**VOCs**
Analytical Method/ SOP Reference	**SW-846 8260B/ CA-202**

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CAs	DQI	Measurement Performance Criterion (MPC)
Internal Standard (IS)	Four per sample- Pentafluorobenzene 1,4-Difluorobenzene, Chlorobenzene-d5 1,4-dichlorobezene-d4	RTs for ISs must be ± 30 seconds and the responses within -50% to +100% of last calibration verification (12 hours) for each IS.	Inspect MS or GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning.	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS/MSD	One per Sample Delivery Group (SDG) or every 20 samples.	%Rs should meet the DoD QSM, Version 4.2, limits per Appendix G. RPD must be ≤ 30%	CA will not be taken for samples when recoveries are outside limits and surrogate and LCS criteria are met. If both the LCS and MS/MSD are unacceptable, reprepare the samples and QC.	Analyst, Supervisor	Precision/ Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Results between DL and LOQ	NA	Apply “J” qualifier to results between DL and LOQ.	NA	Analyst, Supervisor	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.

SAP Worksheet #29 -- Project Documents and Records Table

(UFP-QAPP Manual Section 3.5.1)

Document	Where Maintained
Field Documents Field Logbook Field Sample Forms Chain of Custody Records Air Bills Sampling Instrument Calibration Logs Sampling Notes Photographs FTMR Forms This SAP HASP	Field documents will be maintained in the project file located in the Tetra Tech Jacksonville, Florida office.
Laboratory Documents Sample receipt, custody, and tracking record Equipment calibration logs Sample preparation logs Analysis Run logs CA forms Reported field sample results Reported results for standards, QC checks, and QC samples Extraction/clean-up records Raw data	Laboratory documents will be included in the hardcopy and portable documents format deliverables from the laboratory. Laboratory data deliverables will be maintained in the Tetra Tech Jacksonville, Florida project file and in long-term data package storage at a third-party professional document storage firm. Electronic data results will be maintained in a database on a password protected structured query language (SQL) server.
Assessment Findings Field Sampling Audit Checklist (if conducted) Analytical Audit Checklist (if conducted) Data Validation Memoranda (includes tabulated data summary forms)	All assessment documents will be maintained in the Tetra Tech Pittsburgh office.
Reports Monitoring Report	All reports will be stored in hardcopy in the Tetra Tech Jacksonville, Florida project file and electronically in the server library.

SAP Worksheet #30 -- Analytical Services Table

(UFP-QAPP Manual Section 3.5.2.3)

Matrix	Analytical Group	Sample Locations/ID Numbers	Analytical Method	Data Package Turnaround Time	Laboratory / Organization (name and address, contact person and telephone number)	Backup Laboratory/ Organization (name and address, contact person and telephone number)
Groundwater and Aqueous QC Samples	VOCs	See Worksheet #18	SW-846 8260B	21 calendar days	Katahdin Analytical Services, Inc. 600 Technology Way Scarborough, Maine 04074 Ms. Jennifer Obrin (207) 874-2400 jobrin@katahdinlab.com	NA

SAP Worksheet #31 -- Planned Project Assessments Table

(UFP-QAPP Manual Section 4.1.1)

Assessment Type	**Frequency**	**Internal or External**	**Organization Performing Assessment**	**Person(s) Responsible for Performing Assessment** (title and organizational affiliation)	**Person(s) Responsible for Responding to Assessment Findings** (title and organizational affiliation)	**Person(s) Responsible for Identifying and Implementing Corrective Actions** (title and organizational affiliation)	**Person(s) Responsible for Monitoring Effectiveness of Corrective Action** (title and organizational affiliation)
Laboratory Systems Audit[1]	Every two years	External	DoD ELAP Accrediting Body	DoD ELAP Accrediting Body Auditor	Laboratory QAM or Laboratory Manager, Katahdin	Laboratory QAM or Laboratory Manager, Katahdin	Laboratory QAM or Laboratory Manager, Katahdin

[1] Katahdin is DoD ELAP and Florida accredited for all analytical groups and target analytes that are required for this project. The DoD ELAP accreditation documentation is included in Appendix C.

SAP Worksheet #32 -- Assessment Findings and Corrective Action Responses

(UFP-QAPP Manual Section 4.1.2)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings (name, title, organization)	Timeframe of Notification	Nature of CA Response Documentation	Individual(s) Receiving CA Response (name, title, organization)	Timeframe for Response
Laboratory System Audit	Written audit report	Leslie Dimond, Laboratory QAM, Katahdin	Specified by DOD ELAP Accrediting Body	Letter	DOD ELAP Accrediting Body	Specified by DOD ELAP Accrediting Body

SAP Worksheet #33 -- QA 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 SDG	Within 3 weeks of receipt of laboratory data package	DVM or designee, Tetra Tech	PM and project file, Tetra Tech
Major Analysis Problem Identification (Internal Tetra Tech Memorandum)	When persistent analysis problems are detected by Tetra Tech that may impact data usability	Immediately upon detection of problem (on the same day)	CLEAN QAM, Tetra Tech	PM, CLEAN QAM, Program Manager, and project file, Tetra Tech
Project Monthly Progress Report	Monthly for duration of project	Monthly	PM, Tetra Tech	Navy RPM, Navy; CLEAN QAM, Program Manager, and project file, Tetra Tech
Laboratory QA Report	When significant plan deviations result from unanticipated circumstances	Immediately upon detection of problem (on the same day)	Laboratory PM, Katahdin	PM and project file, Tetra Tech

SAP Worksheet #34 -- Verification (Step I) Process Table

(UFP-QAPP Manual Section 5.2.1)

Verification Input	Description	Internal / External	Responsible for Verification (name, organization)
Chain-of-custody forms	The Tetra Tech FOL or designee will review and sign the chain-of-custody form to verify that all samples listed are included in the shipment to the laboratory and the sample information is accurate. The forms will be signed by the sampler and a copy will be retained for the project file, the Tetra Tech PM, and the Tetra Tech Data Validators. See Tetra Tech SOP SA-6.3.	Internal	Sampler and FOL, Tetra Tech
	The Laboratory Sample Custodian will review the sample shipment for completeness, integrity, and sign accepting the shipment. The Tetra Tech Data Validators will check that the chain-of-custody form was signed/dated by the Tetra Tech FOL or designee relinquishing the samples and also by the Laboratory Sample Custodian receiving the samples for analyses.	Internal/ External	1 - Laboratory Sample Custodian, Katahdin 2 - Data Validators, Tetra Tech
SAP Sample Tables/ Chain-of-Custody Forms	Verify that all proposed samples listed in the SAP tables have been collected.	Internal	FOL or designee, Tetra Tech
Sample Log Sheets	Verify that information recorded in the log sheets is accurate and complete.	Internal	FOL or designee, Tetra Tech
SAP/ Field Logs/ Analytical Data Packages	Ensure that all sampling SOPs were followed. Verify that deviations have been documented and MPCs have been achieved. Particular attention should be given to verify that samples were correctly identified, that sampling location coordinates are accurate, and that documentation establishes an unbroken trail of documented chain-of-custody from sample collection to report generation. Verify that the correct sampling and analytical methods/SOPs were applied. Verify that the sampling plan was implemented and carried out as written and that any deviations are documented.	Internal	PM or designee, Tetra Tech
SAP/ Laboratory SOPs/ Raw Data/ Applicable Control Limits Tables	Ensure that all laboratory SOPs were followed. Verify that the correct analytical methods/SOPs were applied. Establish that all method QC samples were analyzed and in control as listed in the analytical SOPs. If method QA is not in control, the Laboratory QAM will contact the Tetra Tech PM via telephone or e-mail for guidance prior to report preparation.	Internal	Laboratory QAM, Katahdin
SAP/ Chain-of-Custody Forms	Check that field QC samples listed in Worksheet #20 were collected as required.	Internal	FOL or designee, Tetra Tech
Electronic Data Deliverables (EDDs)/ Analytical Data Packages	Each EDD will be verified against the chain-of-custody and hard copy data package for accuracy and completeness. Laboratory analytical results will be verified and compared to the electronic analytical results for accuracy. Sample results will be evaluated for laboratory contamination and will be qualified for false positives using the laboratory method/preparation blank summaries. Positive results reported between the DL and the LOQ will be qualified as estimated. Extraneous laboratory qualifiers will be removed from the validation qualifier.	External	Data Validators, Tetra Tech

Verification Input	Description	Internal / External	Responsible for Verification (name, organization)
Analytical Data Packages	All analytical data packages will be verified internally for completeness by the laboratory performing the work. The Laboratory QAM will sign the case narrative for each data package.	Internal	Laboratory QAM, Katahdin
	Each data package will be verified for completeness by the Tetra Tech Data Validator. Missing information will be requested by the Tetra Tech Data Validator from the Laboratory PM.	External	Data Validators, Tetra Tech
SAP/ Laboratory SOPs/ Raw Data/ Applicable Control Limits Tables	Ensure that all laboratory SOPs were followed. Verify that the correct analytical methods/SOPs were applied. Establish that all method QC samples were analyzed and in control as listed in the analytical SOPs. If method QA is not in control, the Laboratory QAM will contact the Tetra Tech PM via telephone or e-mail for guidance prior to report preparation.	Internal	Laboratory QAM, Katahdin

SAP Worksheet #35 -- Validation (Steps IIa and IIb) Process Table

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

Step IIa / IIb	Validation Input	Description	Responsible for Validation (name, organization)
IIa	SAP/ Sample Log Sheets	Sample Coordinates - Ensure that sample locations are correct and in accordance with the SAP proposed locations. Document any discrepancies in the final report.	PM, FOL, or designee, Tetra Tech
IIa	Chain-of-Custody Forms	Custody - Ensure that the custody and integrity of the samples was maintained from collection to analysis and the custody records are complete and any deviations are recorded. 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 listed in Worksheet #19.	Project Chemist or Data Validators, Tetra Tech
IIa/IIb	SAP/ Laboratory Data Packages/ EDDs	Accuracy - Ensure that the laboratory QC samples listed in Worksheet #28 were analyzed and that the MPCs listed in Worksheet #12 were met for all field samples and QC analyses. Check that specified field QC samples were collected and analyzed and that the analytical QC criteria set up for this project were met.	Project Chemist or Data Validators, Tetra Tech
		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/LCSD, if available. Ensure compliance with the methods and project MPCs accuracy goals listed in Worksheet #12.	
		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.	
		Completeness - Review the chain-of-custody forms generated in the field to ensure that the required analytical samples have been collected, appropriate sample identifications have been used, and correct analytical methods have been applied. The Tetra Tech Data Validator will verify that elements of the data package required for validation are present, and if not, the laboratory will be contacted and the missing information will be requested. Validation will be performed as per Worksheet #36. Check that all data have been transferred correctly and completely to the final SQL database.	

Step IIa / IIb	Validation Input	Description	Responsible for Validation (name, organization)
IIb	SAP/ Laboratory Data Packages/ EDDs	Sensitivity - Ensure that the project LOQs listed in Worksheet #15 were achieved.	Project Chemist or Data Validators, Tetra Tech
		Project Screening Levels (PSLs) - Discuss the impact on reported DLs due to matrix interferences or sample dilutions performed because of the high concentration of one or more other contaminants, on the other target compounds reported as non-detected. Document this usability issue and inform the Tetra Tech PM. Review and add PSLs to the laboratory EDDs. Flag samples and notify the Tetra Tech PM of samples that exceed PSLs listed in Worksheet #15.	
		QA/QC - Ensure that all QC samples specified in the SAP were collected and analyzed and that the associated results were within prescribed SAP acceptance limits. Ensure that QC samples and standards prescribed in analytical SOPs were analyzed and within the prescribed control limits. If any significant QC deviations occur, the Laboratory QAM shall have contacted the Tetra Tech PM.	
		Deviations - Summarize deviations from methods, procedures, or contracts in the Data Validation Report. Determine the impact of any deviation from sampling or analytical methods and SOPs requirements and matrix interferences effect on the analytical results. Qualify data results based on method or QC deviation and explain all the data qualifications. Print a copy of the project database qualified data depicting data qualifiers and data qualifiers codes that summarize the reason for data qualifications. Determine if the data met the MPCs and determine the impact of any deviations on the technical usability of the data.	

SAP Worksheet #36 -- Analytical Data Validation (Steps IIa and IIb) Summary Table

(UFP-QAPP Manual Section 5.2.2.1)

Step IIa / IIb	Matrix	Analytical Group	Validation Criteria	Data Validator (title and organizational affiliation)
IIa and IIb	Groundwater	VOCs	Limited data validation* will be performed using criteria for SW-846 8260B listed in Worksheets #12, #15, #24, and #28, and the current DoD QSM. If not included in the aforementioned, then the logic outlined in USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review EPA-540/R-99-008 (USEPA, 1999) will be used to apply qualifiers to data.	Data Validation Specialist, Tetra Tech

* Limited data validation focuses the review to specific review parameters (Data Completeness/Data Verification, Holding times, Calibrations, Blank Contamination, and Detection Limits) to determine gross deficiencies only. The limited data validation is best expressed as a review to preclude the possibility of false negatives and to eliminate false positives. Raw data are not evaluated and sample result verification is not conducted. A formal report, similar to a full data validation report, is prepared but the scope is more limited than a full validation report. The data packages provided by Katahdin will be expansive enough to allow future complete formal data validation, if necessary.

SAP Worksheet #37 -- Usability Assessment

(UFP-QAPP Manual Section 5.2.3)

Data Usability Assessment
The usability of the data directly affects whether project objectives can be achieved. The following characteristics will be evaluated at a minimum. The results of these evaluations will be included in the project report. The characteristics will be evaluated for multiple concentration levels if the evaluator determines that this is necessary. To the extent required by the type of data being reviewed, the assessors will consult with other technically competent individuals to render sound technical assessments of these DQI characteristics: **Completeness** For each matrix that was scheduled to be sampled, the Tetra Tech FOL, acting on behalf of the Project Team, will prepare a table listing planned samples/analyses to collected samples/analyses. If deviations from the scheduled sample collection or analyses are identified the Tetra Tech PM and Project Risk Assessor will determine whether the deviations compromise the ability to meet project objectives. If they do, the Tetra Tech PM will consult with the Navy RPM and other Project Team members, as necessary (determined by the Navy RPM), to develop appropriate CAs. **Precision** The Tetra Tech PM, 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 field duplicate results will be no less precise than laboratory duplicate results. If the goals are not met, or data have been flagged as estimated (J qualifier), limitations on the use of the data will be described in the project report. **Accuracy** The Tetra Tech PM, acting on behalf of the Project Team, will determine whether the accuracy/bias goals were met for project data. This will be accomplished by comparing percent recoveries of LCS, LCSD, MS, MSD, and surrogate compounds to accuracy goals identified in Worksheet #28. This assessment will include an evaluation of field and laboratory contamination; instrument calibration variability; and analyte recoveries for surrogates, matrix spike, and laboratory control samples. If the goals are not met, limitations on the use of the data will be described in the project 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 Tetra Tech PM, acting on behalf of the Project Team, will determine whether the data are adequately representative of intended populations, both spatially and temporally. This will be accomplished by verifying that samples were collected and processed for analysis in accordance with the SAP, by reviewing spatial and temporal data variations, and by comparing these characteristics to expectations. The usability report will describe the representativeness of the data 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 Tetra Tech PM, acting on behalf of the Project Team, will determine whether the data generated under this project are sufficiently comparable to historical site data generated by different methods and for samples collected using different procedures and under different site conditions. This will be accomplished by comparing overall precision and bias among data sets for each matrix and analytical fraction. This will not require quantitative comparisons unless professional judgment of the Tetra Tech PM indicates that such quantitative analysis is required.

Sensitivity

The Tetra Tech PM, 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 (LOQs and DLs) 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. The Tetra Tech PM will enlist the help of the Project Risk Assessor to evaluate deviations from planned sensitivity goals.

Project Assumptions and Data Outliers

The Tetra Tech PM and designated team members will evaluate whether project assumptions are valid. This will typically be a qualitative evaluation but may be supported by quantitative evaluations. The type of evaluation depends on the assumption being tested. Potential outliers will be removed if a review of the associated indicates that the results have an assignable cause that renders them inconsistent with the rest of the data. During this evaluation, the team will consider whether outliers could be indications of unanticipated site conditions. Consideration will be given to whether outliers represent an unanticipated site condition.

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

Upon receipt of the data from the laboratory, 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. 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. Trend lines will be generated to show concentrations over time, including data collected prior to this investigation. The Project Team members identified by the Tetra Tech PM will assess whether the data collectively support the attainment of project objectives. This will be accomplished in part by comparing concentrations to PALs, but also by inspecting temporal trend lines to determine whether there are any anomalies present that indicate a deviation from expected trends. 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.

For statistical comparisons and mathematical manipulations, non-detected values will be represented by a concentration equal to the sample-specific detection limit. Duplicate results (original and duplicate) will not be averaged for the purpose of representing the range of concentrations. However, the average of the original and duplicate samples will be used to represent the concentration at a particular sampled location.

Identify the personnel responsible for performing the usability assessment:

The Tetra Tech PM and FOL will be responsible for conducting the listed data usability assessments. The data usability assessment will be reviewed with the Navy RPM, and the GADNR RPM. 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). Written documentation will support the non-compliance estimated or rejected data results. The project report will identify and describe the data usability limitations and suggest re-sampling or other corrective actions, if necessary.

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APPENDIX A

PARTNERING TEAM MEETING MINUTES

NAVAL SUBMARINE BASE KINGS BAY, GA
Kick-off Meeting for Site 11
May 20, 2010
Tetra Tech, Jacksonville, Florida

Leader: Dana Hayworth
Scribe: Libby Claggett

Attending:	Libby Claggett Libby.Claggett@TetraTech.com	Tetra Tech, Jacksonville, FL, Scribe (904) 730-4669, extension 212
	Dana Hayworth Dana.Hayworth@navy.mil	NAVFAC SE (904) 542-6417
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	Mark Peterson Mark.Peterson@TetraTech.com	Tetra Tech, Jacksonville, FL (904) 730-4669, extension 213
	Mike Singletary Michael.A.Singletary@navy.mil	NAVFAC SE (904) 542-6303
	Tom Stofflet Thomas.Stofflet@navy.mil	Naval Submarine Base Kings Bay (912) 573-4646

Meeting Start Time: 10:00 a.m.

1. Introduction

The roles and responsibilities for the Site 11 Project at Naval Submarine Base Kings Bay, GA are as follows:

Dana Hayworth	NAVFAC SE	IRP Lead
Alan Pate	Tetra Tech	Point of Contact (POC)
Mike Maughon	Tetra Tech	Technical Lead
Mark Peterson	Tetra Tech	Project Manager
Tom Stofflet	Kings Bay	POC
Mike Singletary	NAVFAC SE	Tier II Link
Libby Claggett	Tetra Tech	Meeting Scribe

2. Task Order

One area of concern is if items in the Consent Order have been completed and captured correction. Reducing sampling parameters and establishing a Partnering Team/Process are other areas Dana would like to address.

Mike S. stated would probably only need two meetings a year for Site 11. Teaming with the compliance side would be necessary (GA Department of Natural Resources). Site 11 is a RCRA site; there is no EPA involvement. There is a HSWA permit on the site, and the site is ER,N funded. The permit is currently being updated. The new permit states the Site 11 is under a Consent Order.

The Consent Order may need to be rewritten to address (and remove) the demands that have been met. The Navy would need to decide the approach while Tetra Tech would provide the technical approach.

Quarterly sampling is being performed at Site 11 using outside funding sources. Outside funding was leveraged with ER,N funding for the extra sampling. The Navy fells the extra data would help reduce uncertainty. Two wells overlap with BOA sampling. Dana stated a need to know the BOA sampling configuration. The Navy is currently weighing options regarding sampling contractor, funding, and sampling. Optimization will be captured as part of NORM.

Action Item: Alan will confirm the dates of the USGS sampling at Site 11 and send the information to meeting attendees.

Action Item: Alan will contact Frank to get database information.

Dana would like to have the Administrative Record updated. The AR has not been updated since 2003. Tetra Tech will update the AR as part of the project.

The last sampling event for VT Griffin will be September 2010. Tetra Tech will complete a HASP and begin sampling after approval of the UFP/SAP. The UFP/SAP is scheduled for delivery in October. Mike S. stated it would be good to have the state involved in the process ahead of time. Decision rules will be developed for eliminating wells, eliminating analytes, and reducing frequency. Mike S. stated the UFP/SAP should be a streamlined version, and the UFP/SAP needs to be flexible enough to incorporate the elimination of wells.

Data evaluation will be performed first on current data. The Final Optimization Report should contain the final recommendation. A draft report should be presented to the state to verify wells to be sampled and frequency. Mike S. suggested going to the state with an initial set of recommendations and fine-tuning the recommendations with input from the state.

The Consent Order came about due to a NOV. Dana would like to close out the Consent Order and decide the next steps for Site 11. At this time, it is unclear if an Exit Strategy would be required. In the end, the RCRA permit would need to be modified. Requirements of the permit (quarterly sampling) may need to be maintained until the permit is modified.

Ensure Amy Potter (GADNR) is engaged in the process of closing the Consent Order for Site 11. Modifications to the HSWA permit cost implications will be the next step in the RCRA process.

3. Base Access

The housing portion of the base has been recently opened to public access; however, the base does need to be notified of any activity performed. Alan would still need base access to get to other sites and offices on the base.

Action Item: Tom will check on getting base access for Alan Pate to include emailing needed paperwork to Alan and Dana.

To get base access must be/have the following:
US Citizen
Insurance papers (for vehicle)
Registration (for vehicle)
Completed paperwork

Action Item: Alan will email Dana and copy Tom when planning to be on base and what activities will be performed.

4. Partnering

Approval has been obtained for Partnering. Dana would like to schedule times/dates for meetings. The facilitator for meetings has not been decided at this time, although Pat Franklin has been mentioned as a possible facilitator.

Mike S. suggested having a meeting relatively soon with Amy to get the GADNR on board and discuss the initial scoping of the DQOs. It is preferred to have meetings at the Tetra Tech Jacksonville office, but any travel restrictions for GADNR will be taken into consideration. Discussion ensured regarding if a site visit would be necessary. Dana suggested the initial meeting be held at the Tetra Tech Jacksonville office to discuss the path forward for Site 11 and provide an optimization presentation (the process, some decision rules, data starting point). For the initial meeting, Frank Chapelle should be invited to attend.

Action Item: Mike S. will contact Amy and Frank Chapelle to inform them of the upcoming meeting and to verify the primary point of contact at GADNR for Site 11.

Action Item: Tetra Tech is to email the Team when the optimization presentation is ready, and then Dana will propose possible dates/times for the initial Partnering meeting.

5. Restoration Advisory Board

There have not been any RAB meetings since Tom took over. The overall community feeling at this point is unknown. Tom does not believe there is much community interest; however, a new contractor on site may spike interest. A RAB must meet at least once every two years (due to the Consent Order) and there should be a Community Relations Plan in place.

Action Item: Tetra Tech will research if a Community Relations Plan is in place and, if so, determine if it needs to be updated. Tetra Tech is to get with Dana regarding the status of the Community Relations Plan so Dana can determine if a contract modification is needed.

6. Georgia Department of Natural Resources (GADNR)

This was covered while discussing Partnering meetings.

7. Other Business

<u>Sampling</u>
Frank uses a low-flow sampling method. At one point, samples were taken a few days apart on the same wells using the same sampling method, but different labs, and yielded different results. Split samples were taken at the next sampling event and yielded similar results. Tom suggested using the same sampling methods used in the past.

<u>Standard Operating Procedures</u>
Action Item: Alan is to review the GADNR SOPs for sampling.

<u>IDW</u>
Purge water is handled by the BOSC (VT Griffin). Tetra Tech will supply drums, collect the purge water, fill the drums, label the drums, and contact the BOSC to pick up the drums. The base is funded for the BOSC, but not the DRMO costs. The contractor would pay the DRMO costs. Currently, DRMO bills the contractors directly. No hazardous waste is anticipated at Site 11.

Action Item: Alan will get with the BOSC (which will be changing October 2011) to determine payment method for IDW disposal.

Data for GIS, Base Mapping, Photos, Etc.
Action Item: Alan will contact Suzanne Paxton to gather information regarding GIS, Base Mapping, NIRIS, etc. for Kings Bay.

Green Sustainable Remediation
Need to include Green Remediation (in remedy selection) for Site 11.

The meeting concluded at 11:45 a.m.

Action Items
May 20, 2010

Action Items Developed May 2010

05-2010-2.1 Alan will confirm the dates of the USGS sampling at Site 11 and send the information to meeting attendees.

05-2010-2.2 Alan will contact Frank to get database information.

05-2010-3.1 Tom will check on getting base access for Alan Pate to include emailing needed paperwork to Alan and Dana.

05-2010-3.2 Alan will email Dana and copy Tom when planning to be on base and what activities will be performed.

05-2010-4.1 Mike S. will contact Amy and Frank Chapelle to inform them of the upcoming meeting and to verify the primary point of contact at GADNR for Site 11.

05-2010-4.2 Tetra Tech is to email the Team when the optimization presentation is ready, and then Dana will propose possible dates/times for the initial Partnering meeting.

05-2010-5.0 Tetra Tech will research if a Community Relations Plan is in place and, if so, determine if it needs to be updated. Tetra Tech is to get with Dana regarding the status of the Community Relations Plan so Dana can determine if a contract modification is needed.

05-2010-7.1 Alan is to review the GADNR SOPs for sampling.

05-2010-7.2 Alan will get with the BOSC (which will be changing October 2011) to determine payment method for IDW disposal.

05-2010-7.3 Alan will contact Suzanne Paxton to gather information regarding GIS, Base Mapping, NIRIS, etc. for Kings Bay.

NSB KINGS BAY TIER I PARTNERING MEETING
August 18-19, 2010
Tetra Tech, Jacksonville, Florida

Leader: Dana Hayworth
Time Keeper: Alan Pate
Scribe: Libby Claggett

Members Present:	Mo Ghazi	GA DNR
	Dana Hayworth	NAVFAC SE
	Alan Pate	Tetra Tech, Jacksonville
	Will Powell	GA DNR
	Tom Stofflet	NSB Kings Bay
Guests / Adjunct Members Present:	Gus Campana	The Management Edge
	Libby Claggett	Tetra Tech, Jacksonville, Scribe
	Tom Deck	Tetra Tech
	Mike Maughon	Tetra Tech
	Amy Potter	GA DNR, Tier II

Meeting Start Time: 1:00 p.m.

1.1 Check In/Opening Remarks

Team members shared their backgrounds and experience with each other. Tom Stofflet stated that he had not been to Basics of Partnering (BOP) training; other Team members have had BOP training.

Gus reviewed the Partnering process and emphasized that communication is the key to Partnering. The Partnering process relies on people following the ground rules and not having any hidden agenda.

Site 11 is the first site; another site (Building 1039) will be added in the near future. Depending on the RFI (for Building 1039), the Partnering process could grow.

Gus provided Team members with an example of ground rules for review and input. Gus further explained the standard meeting process.

Team member Roles and Responsibilities were reviewed. Voting (consensus items) Team members include Dana, Alan, Tom, Will, and Mo. The roles of Team Leader and Time Keeper will rotate alphabetically among the voting Team members. Tom and Mike will be technical advisors. Amy will represent Tier II. Gus provided a sample of the written Roles and Responsibilities for Team members to review and providing input.

Gus stated the Team should have a Charter, but it does not have to be a formal charter. The Charter should include vision and mission statements, goals and objectives, ground rules, and Roles and Responsibilities.

A conference call is usually held 1 month prior to a meeting to discuss the agenda. Virtual meetings (in lieu of a face-to-face meeting) are usually facilitated.

The scribe will keep the action item list, consensus item list, and parking lot. These lists will be included at the end of the distributed meeting minutes.

1.2 Agenda Modifications/Additions

Team members reviewed the agenda. No modifications were made.

1.3 Site 11 Discussions

1.3.1 Response to Comments – GA DNR received the Response to Comments and would like to review them on Day 2.

1.3.2 Optimization Study Discussion – Mike Maughon provided an overview of Site 11. Over the past 10 years, two monitoring programs (quarterly monitoring [RCRA] and natural attenuation monitoring [USGS]) occurred at Site 11. Data from the two sampling programs have been combined into one database. The monitoring plans will be streamlined into one plan (UFP-SAP).

The NA parameter list will be pared down to about five. Historically, PCE, TCE, cis-DCE, and VC were the only constituents with exceedances.

Tetra Tech is in the process of preparing a UFP-SAP for Site 11. The first sampling event will be conducted in the same manner as in the past. After the Optimization Study is complete, sampling methods will be modified per the recommendation of the study. A path forward and exit strategy will also be developed for Site 11.

GA DNR suggested adding another column for Engineer Comments in the Mann Kendall Results Summary (Table 3-6). The Mann Kendall test will be run on new data. It is understood that new data could be significantly different (due to sampling methods). Four wells (KBA-11-13A [PCE], KBA-11-34 [cis-DCE], USGS-1 [VC], and USGS-2 [PCE]) have a significant upward trend.

Per EPA comments, wells KBA-11-03B and 108 Cottage Court will be added to the sampling plan.

GA DNR suggested overlaying the plumes on the maps.

Mike shared the preliminary optimization summary with the Team. Team members viewed and discussed the Decision Criteria for Optimizing Monitoring Locations (Table 3-1). Mike will add another row to monitor the effectiveness of MNA.

Table 3-2, Decision Criteria for Optimizing Monitoring Frequency, proposes sentinel wells to be sampled semiannually. Any well without a significant upward trend would be reduced to annual sampling. GA DNR suggested having the same monitoring frequency for all wells. When viewed in correlation with the plume map, Tetra Tech believes GA DNR will further understand the proposed monitoring frequency.

Table 3-3, Decision Criteria for Optimizing Analytes, proposes eliminating an analyte from the monitoring program if no exceedances detected from any of the monitoring wells site-wide in the most recent five consecutive years. GA DNR stated an analyte could not be eliminated if it is a degradation product.

Action Item: Mike is to add another column for Engineer Comments in the Mann Kendall Results Summary (Table 3-6).

Action Item: Mike is to save Appendix B spreadsheets in Microsoft Excel 2003 format for GA DNR.

Action Item: Mike is to add another row to Table 3-1, Decision Criteria for Optimizing Monitoring Locations, for monitoring the effectiveness of MNA.

Action Item: Mike is to change Table 3-3, Decision Criteria for Optimizing Analytes, to clarify statement regarding degradation products.

Action Item: Mike is to create a pie chart in the Optimization Report depicting the Mann Kendall results/progress.

1.3.3 RCRA Permit Modification Requirements –Tetra Tech stated that a permit modification would have to be made in order to change the monitoring frequency. GA DNR stated the permit is up for renewal and the monitoring program could be changed. Tetra Tech would like to see the optimization results incorporated into the permit.

GA DNR is concerned about having the monitoring scheme in the permit and the possibility that the permit would need to be modified if a well is changed. A Groundwater Monitoring Plan would need to be recreated and reviewed on a yearly basis. Dana suggested preparing an Exit Strategy document for Site 11.

1.4 Break

1.5 Site 11 Discussions Continued

1.5.1 Consent Order Exit Strategy – The permit should have superseded the Consent Order. GA DNR stated the Consent Order should be closed out.

Action Item: Amy is to investigate how to terminate the Consent Order.

1.5.2 Next Step in RCRA Process – After the Consent Order is terminated, the CAP needs to be reviewed to determine what needs to be amended (i.e., groundwater monitoring replaced with groundwater monitoring plan). The Phase I Interim Measures Corrective Action Plan has been completed. Item 4 in the Consent Order has been completed. Corrective action at Site 11 has been implemented.

Dana asked if a RAB would be needed. Mo commented there was a RAB at one time. Amy stated that when the permit is issued, a public meeting could be held to find out if there is any interest in a RAB. Since Site 11 is RCRA, a RAB is not required.

Vapor intrusion should not be an issue at Site 11. The CAP should contain a section stating vapor intrusion has been evaluated. In addition, EPA is revising their guidance, and soil gas sampling next to a house will be replaced with subslab sampling to determine indoor air intrusion. For residential, EPA guidance is followed. For industrial, OSHA guidance is followed.

Action Item: Dana is to check to see if there is a Statement of Basis for SWMU 3.

Action Item: Tetra Tech is to prepare an amended CAP for Site 11.

<u>DAY 2</u>

2.1 Check-In / Review Agenda

Team members shared events of the past night.

2.2 Response to Comments

Team members provided comments to the Response to Comments for EPD Consolidated Review of Semiannual and Quarterly Corrective Action Reports at Site 11.

Discussions regarding scheduling ensued. February 12, 2012, is the completion date for Navy/Tetra Tech for the Site 11 contract.

<u>Steps Forward</u>
1) Complete UFP-SAP in order to begin sampling in September 2010.
2) Perform sampling and analyze data. The laboratory has a 28-day turn around.

3) Provide a Letter Report with the sampling data (to GA DNR review). If there is not a significant difference in data, the Optimization Report (RPO) will not be updated.
4) If there is a significant data difference, the Optimization Report will be updated with new data and recommendations.
5) Possibly amend permit.

Action Item: Tetra Tech is to send Amy a letter stating the MNA parameters to be sampled for the baseline study at Site 11.

Action Item: Amy is the send Alan Pate a letter concurring with the MNA parameters to be sampled for the baseline study at Site 11.

Action Item: Alan is to arrange a conference call with Team members after receiving Site 11 analytical data to discuss the Optimization Report.

Schedule and Prioritization of Documents
1) UFP-SAP, September 2010
2) Letter Report with September sampling data, November 1, 2010
3) Conference call and Optimization Report decision, November 2010
4) Optimization Report, if needed – contingent upon conference call
5) Update SAP per Optimization Report – contingent upon EPD review of Optimization Report
6) Amend CAP – contingent upon EPD review of SAP and Optimization Report
7) Decide if an extension will be needed.

The CAP states semiannual monitoring. The Optimization Report will discuss which MNA wells (possibly 5 to 6 wells for each contaminant) to sample.

Action Item: Amy is to send Alan the link to the EPA MNA monitoring document.

Response to Comments
The quoted portion of the permit (Exit Strategy, Page 2, RCRA Permit Section IV.E.) in the RTC does not match what is actually in the permit. Per GA DNR, the permit supersedes any inconsistencies in the report. Two different versions of the permit were in use. The correct version of the permit is dated December 23, 1998, and not October 30, 1998. Need to clarify that four consecutive quarters and two annual sampling events equals three consecutive years of sampling. GA DNR would like to see the statement simplified. If the baseline sampling is consistent with the past data, semiannual sampling can be justified in lieu of quarterly sampling. GA DNR would like the quote changed to reflect what is in the current permit (3 consecutive years and not 4 quarters plus 2 years).

Action Item: Tetra Tech is to modify the Response to Comments and Optimization Report to include the four bulleted items from Section 3.0 Exit Strategy from the Site 11 Groundwater Monitoring Plan.

2.3 Environmental Indicator Reporting

GA DNR believes all military bases have met CA 725 and 750. NSB Kings Bay falls under the new set of GPRA goals (2008 baseline). NSB Kings Bay has not met CA 400 because of the 1039 site; CA 550 has not been met either. Once CA 400 and 550 are met, environmental indicators can be changed.

2.4 Team Charter / Ground Rules / Visioning Training

Gus led Team members through a discussion regarding a Team Charter. A sample charter was provided to Team members who, in turn, provided feedback to Gus.

Action Item: Gus is to update the Ground Rules and Team Charter per Team comments and email to the Team.

Gus showed the Team a video on "Focus Your Vision" with photographer Dewitt Jones with a presentation.

Action Item: Gus is to send Team members a .pdf file of the presentation.

2.5 Meeting Wrap-Up

Action Item: Libby is to create a NSB Kings Bay Partnering Team listing and sent to Team members.

Action and Consensus Item Review

Action and consensus items were reviewed and provided on the next page(s).

Next Meeting

The next meeting is tentatively scheduled for the first week of March 2011 (March 1, 2, or 3) (½ day, ½ day) at Tetra Tech NUS, Inc. in Jacksonville, Florida. Alan Pate will be the Team Leader, and Will Powell will be the Timekeeper.

Tentative Meeting Dates/Location

March 2011	Jacksonville, FL
August or September 2011	Jacksonville, FL

Plus/Delta

+	Δ
Good 1st meeting	Tom Stofflet not at Day 2
Mike Maughon's presentation on Site 11	
Good discussions throughout meeting	
Openness of group / no hidden agendas	
Socialization process at dinner	
Learning more about Team members	

Action Items
NSB Kings Bay Partnering Meeting
August 18-19, 2010

Action Items Developed August 2010

08.10.1.3.2.1 Mike is to add another column for Engineer Comments in the Mann Kendall Results Summary (Table 3-6) by September 15.

08.10.1.3.2.2 Mike is to save Appendix B spreadsheets (Albany Report) in Microsoft Excel 2003 format for GA DNR by September 15.

08.10.1.3.2.3 Mike is to add another row to Table 3-1, Decision Criteria for Optimizing Monitoring Locations, for monitoring the effectiveness of MNA by September 15.

08.10.1.3.2.4 Mike is to change Table 3-3, Decision Criteria for Optimizing Analytes, to clarify statement regarding degradation products by September 15.

08.10.1.3.2.5 Mike is to create a pie chart in the Optimization Report depicting the Mann Kendall results/progress by September 15.

08.10.1.5.1 Amy is to investigate how to terminate the Consent Order by August 31.

08.10.1.5.2.1 Dana is to check to see if there is a Statement of Basis for SWMU 3 by the next meeting.

08.10.1.5.2.2 Tetra Tech is to prepare an amended CAP for Site 11.

08.01.2.2.1 Tetra Tech (Alan) is to send Amy a letter stating the MNA parameters to be sampled for the baseline study at Site 11. **Done**

08.01.2.2.2 Amy is the send Alan Pate a letter concurring with the MNA parameters to be sampled for the baseline study at Site 11. **Done**

08.01.2.2.3 Alan is to arrange a conference call with Team members after receiving Site 11 analytical data to discuss the Optimization Report.

08.01.2.2.4 Amy is to send Alan the link to the EPA MNA monitoring document by August 20.

08.01.2.2.5 Tetra Tech (Mike) is to modify the Response to Comments and Optimization Report to include the four bulleted items from Section 3.0 Exit Strategy from the Site 11 Groundwater Monitoring Plan by August 31.

08.01.2.4.1 Gus is to update the Ground Rules and Team Charter per Team comments and email to the Team by August 31.

08.01.2.4.2 Gus is to send Team members a .pdf file of the presentation by August 31.

08.01.2.5 Libby is to create a NSB Kings Bay Partnering Team listing and sent to Team members by next meeting.

Consensus Items
NSB Kings Bay Partnering Meeting
August 18-19, 2010

There were no consensus items made during the meeting.

Parking Lot Items
NSB Kings Bay Partnering Meeting
August 18-19, 2010

CA 400 and CA 550 environmental indicators

Discussion at next meeting on status on moving forward

RAB

Building 1039 status

Document status update

NSB KINGS BAY TIER I PARTNERING MEETING
November 29, 2011
Tetra Tech, Jacksonville, Florida

Leader: Dana Hayworth
Scribe: Libby Claggett
Time Keeper: Alan Pate

Members Present:	Mo Ghazi	GA DNR
	Dana Hayworth	NAVFAC SE
	Alan Pate	Tetra Tech, Jacksonville
	Will Powell	GA DNR
	Tom Stofflet	NSB Kings Bay
	Brian Syme	NAVFAC SE
Guests / Adjunct Members Present:	Gus Campana	The Management Edge
	Libby Claggett	Tetra Tech, Jacksonville, Scribe
	Mike Maughon	Tetra Tech
	Amy Potter	GA DNR, Tier II
	Sarah Reed	NAVFAC SE
	Zach Scribner	Tetra Tech

Meeting Start Time: 8:30 a.m.

1.1 Pre-Meeting (Introductions, Action Item List, Consensus Item List, Parking Lot)

Team members shared events since the last meeting held in August 2010.

Team members reviewed the ground rules, action item list, consensus item list, the parking lot, and the draft August 2010 meeting minutes.

Action Item: Dana, Alan, and Brian are to discuss contract status.

Team members reached consensus to approve the August 2010 minutes as final.

Gus provided a training video on “More Than One Right Answer » a short film by Dewitt Jones” followed by a presentation.

1.2 Site 11 Discussions (Response to Comments, Optimization Study Discussion

1.2.1 Response to Comments – Team members were provided with a copy of the Response to Comments to the earlier monitoring reports. Tetra Tech addressed all comments, and the responses are included in the Optimization Study.

1.2.2 Optimization Study Discussion – Section 3.2, Decision Criteria, was revised to address comments received. Mike proceeded to explain the Mann-Kendall test results and to walk the team through the other tables and figures to provide an overview of the optimization process and recommendations.

It was questioned why monitoring well KBA-11-34 was being kept in the monitoring program. The study proposed keeping monitoring well KBA-11-34 since it is on the upgradient side of the ISCO and vegetable oil injection area and to see if there is any rebound. It will be monitored semiannually.

Will P. would like to have well KBA-11-36 sampled at least once to see if any constituents exceed MCLs. The vinyl chloride plume, the largest plume, has shrunk significantly.

Action Item: Alan is to check well KBA-11-36 and determine what type of well it is.

Will P. stated the need to verify that the quantification limits are below the MCLs.

Action Item: Amy is to review the MNA parameters that were sampled for in April 2011 and the MNA parameters proposed in the optimization recommendations.

The next sampling event is scheduled for the second week of January 2012.

Action Item: Alan is to obtain USGS well installation information (documentation from Frank Chappelle).

Table 3-9 in the Optimization Study Report provides the current monitoring program and proposed monitoring program. A total of 16 wells will be monitored in the proposed program. Dana would like to see a table summarizing the results of optimizing the sampling plan, i.e., number and percent wells eliminated, analytes reduction, frequency changes, and related cost avoidance and sustainability improvement.

Action Item: Mike is to provide a table (shorten Table 3-9) summarizing the results of optimizing the sampling program.

Action Item: Alan is to provide Tom an information card to be given to the public if questions are asked when sampling and Tom is to coordinate approval with PAO.

Will P. stated that one comment from GA DNR will be to review the 108 Cottage Court and 122 Plantation Court wells to ensure they are suitable for the monitoring program and screened at an appropriate depth interval to monitor contamination migrating offsite. 122 Plantation Court is a deep well that had one exceedance of VC (in 2006) since 2003, probably as a result of plume drawdown induced by historical pumping of this irrigation well before the plume receded. 122 Plantation can be replaced with USGS-7 as opposed to installing a new monitoring well to monitor side gradient migration of the plume in lieu of 122 Plantation Court. Alan indicated 108 Cottage Court was dry during the April 2011 sampling event and a sample could not be taken as planned. A new monitoring well will be installed between KBA-11-16 and KBA-11-37 to replace 108 Cottage Court if it is determined the well at 108 Cottage Court is not usable.

Action Item: Alan is to verify the usability of 108 Cottage Court and location of replacement well if needed and discuss the findings with the team during a conference call on December 5, 2011.

Action Item: Mike is to replace (deep) well 122 Plantation Court in the optimization plan with USGS-7 to monitor side gradient migration of the plume in lieu of 122 Plantation Court.

1.3 Review Agenda

Team members reviewed the remaining agenda items and made adjustments to the agenda as necessary.

1.4 Site 11 Discussions Continued

1.4.1 Next Step in RCRA Process – Revise the UFP-SAP, update the CAP (addendum), and then send Amy permit application update information by March 2012.

1.4.2 RCRA Permit Mod Requirements – The permit has expired, but is being continued. Amy is talking with CH2M HILL regarding revisions necessary for the detonation areas. Amy is hoping to have a

new permit by June 2012. Changes to the groundwater monitoring program resulting from the optimization review will be detailed in the new optimized UFP-SAP, which will become the new Groundwater Monitoring Plan (GWMP) that needs to be included by reference in the RCRA Permit. Referencing the GWMP in the permit will allow future optimization of the GWMP provisions without the need to continually revise the RCRA Permit for future optimization changes in well locations, monitoring frequency, or analyte adjustments. There is a section (SWMU section) in the permit application (Section L) to include updates.

Action Item: Amy is to send Alan a checklist for what needs to be in the permit application.

Action Item: Alan is to send Amy updated information for the permit application (snapshot of the current plume, references to and brief highlights of the USGS final MNA report (2009), the ISCO and vegetable oil injection construction completion reports, and the optimization report, including tables and figures of the optimized monitoring plan. The information should be sent to Amy) after the January 2012 sampling event, but before March 2012.

1.5 Sample Planning

1.5.1 UFP-SAP – The UFP-SAP will need to be revised based on the optimization recommendations and reviewed before the January 9, 2012 sampling event. The team discussed whether the UFP-SAP will require significant revisions that require review by the Navy Chemist or if the revisions can be incorporated into the UFP-SAP with a Field Modification Form. The revisions will include monitoring well locations, frequencies, and perhaps the MNA parameter list, as well as the decision rules, or DQOs, for how future results will be used to annually optimize the monitoring plan. Comments from GA DNR on the optimization report will be addressed to finalize the report, which will be the basis for the revised UFP-SAP. Will and Mo indicated their written comments will be similar to the verbal comments they presented during the meeting but there may be some additional written comments. It may be about two weeks before written comments are submitted. In the interest of meeting the schedule for the next sampling event (currently January 9, 2012), Tetra Tech will begin revising the optimization report and updating the UFP-SAP based on verbal comments received during the meeting. Mike requested if DNR has any other significant comments about the optimization report to call him to discuss so any necessary changes can be expedited. Mike will coordinate any changes with Alan and Dana before implementing and schedule a team call if necessary to discuss further.

Action Item: Dana is to get with Ken Bowers to determine if the revised UFP-SAP has to be reviewed by the Navy chemist or if a Field Modification Form can be used.

1.5.2 Schedule

- GA DNR submit written comments on the optimization report
- Address comments and finalize the optimization report
- Revise the UFP-SAP (also serves as GWMP in revised RCRA Permit)
  - Perform next sampling event (currently scheduled for January 9, 2012)
- Update the CAP (prepare CAP addendum)
- Send Amy permit application update information

1.6 Meeting Wrap-Up

<u>Action and Consensus Item Review</u>

Action and consensus items and the parking were reviewed and are provided on the next page(s).

<u>Conference Call</u>

Monday, December 5, 1:30 p.m. to discuss 108 Cottage Court well

Action Item: Libby is to set up a conference call for Monday, December 5, at 1:30 p.m.

Next Meeting

No meeting was scheduled at this time. When a face-to-face meeting is warranted, a meeting notice will be sent to Team members.

Plus/Delta

+	Δ
Good use of charts, graphs, tables, etc. in Site 11 discussion	
Team discussion, information flow, and communication	
Dana's vision for the Team is to be adaptive and reactive to conditions and progress	
General attitude of Team positive	
Completed agenda efficiently	
Attendees were prepared and organized	
Training good and utilized during meeting	
Good dynamics	

The RAPIDGate identification base access system will be initiated at NSB Kings Bay. Tom will check on how regulators are to get onto the base.

Action Items
NSB Kings Bay Partnering Meeting
November 29, 2011

Action Items Developed November 2011

11.11.1.1 Dana, Alan, and Brian are to discuss contract status by November 30, 2011. **Done.**

11.11.1.2.1 Alan is to check well KBA-11-36 and determine what type of well it is by December 5, 2011. **Done. This well was also sampled January 31, 2012 and had no exceedances of GWPS. See RTC to GA DNR written comments (April 27, 2012) for discussion of results.**

11.11.1.2.2 Amy is to review the MNA parameters that were sampled for in April 2011 by December 12, 2011. **In progress. However, the Navy has since reviewed and updated the MNA parameter list recommended in the optimization report for consistency with current guidance and other naval installations in Georgia, including MCLB Albany. The current MNA parameters listed in the optimization report include:**

11.11.1.2.3 Alan is to obtain USGS well installation information (documentation from Frank Chappelle) by December 12, 2011. **Done. See Table "xx" in the optimization report.**

11.11.1.2.4 Mike is to provide a table (shorten Table 3-9) summarizing the sampling program (what wells when and what wells will be dropped) by December 9, 2011. **Done. See table "xx" in the optimization report.**

11.11.1.2.5 Alan is to provide Tom an information card to be given to the public when sampling and Tom is to coordinate with PAO by January 9, 2012. **In progress. Alan will provide Tom a draft information card for PAO approval before the next sampling event.**

11.11.1.2.6 Alan is to verify the usability of 108 Cottage Court and location of replacement well if needed by December 5, 2011. **Done. The well at 108 Cottage Court has been replaced.**

11.11.1.2.7 Mike is to replace (deep) well 122 Plantation Court in the optimization plan with USGS-7 to monitor side gradient migration of the plume in lieu of 122 Plantation Court. Done.

11.11.1.4.1 Amy is to send Alan a checklist for what needs to be in the permit application by December 5, 2011**. In progress. Currently scheduling a conference call to discuss further.**

11.11.1.4.2 Alan is to send Amy updated information for the permit application after the January 2012 sampling event by March 2012. **. In progress. Currently scheduling a conference call to discuss further.**

11.11.1.5 Dana is to get with Ken Bowers to determine if the revised UFP-SAP has to be reviewed by the Navy chemist or if a Field Modification Form can be used by November 30, 2011. **OBE. The extent of changes to the monitoring plan and related optimization decision rules recommended in the optimization report are beyond the scope of a Field Modification Reform and a revised UFP-SAP will be required to incorporate these significant changes.**

11.11.1.6 Libby is to set up a conference call for Monday, December 5, at 1:30 p.m. **Done.**

11.11.1.6 Tom is to check on how regulators are to get onto the base after RAPIDGate is initiated. **In progress.**

<u>Action Items Developed August 2010</u>

08.10.1.3.2.1 Mike is to add another column for Engineer Comments in the Mann Kendall Results Summary (Table 3-6) by September 15. **Done**

08.10.1.3.2.2 Mike is to save Appendix B spreadsheets (Albany Report) in Microsoft Excel 2003 format for GA DNR by September 15. **Done**

08.10.1.3.2.3 Mike is to add another row to Table 3-1, Decision Criteria for Optimizing Monitoring Locations, for monitoring the effectiveness of MNA by September 15. **Done**

08.10.1.3.2.4 Mike is to change Table 3-3, Decision Criteria for Optimizing Analytes, to clarify statement regarding degradation products by September 15. **Done**

08.10.1.3.2.5 Mike is to create a pie chart in the Optimization Report depicting the Mann Kendall results/progress by September 15. **Done**

08.10.1.5.1 Amy is to investigate how to terminate the Consent Order by August 31. **Ongoing – needs further investigation**

08.10.1.5.2.1 Dana is to check to see if there is a Statement of Basis for SWMU 3 by the next meeting. **Done – cannot find a Statement of Basis for SWMU 3**

08.10.1.5.2.2 Tetra Tech is to prepare an amended CAP for Site 11. **Ongoing – will happen after the optimization update**

08.01.2.2.3 Alan is to arrange a conference call with Team members after receiving Site 11 analytical data to discuss the Optimization Report. **OBE**

08.01.2.2.4 Amy is to send Alan the link to the EPA MNA monitoring document by August 20. **Done**

08.01.2.2.5 Tetra Tech (Mike) is to modify the Response to Comments and Optimization Report to include the four bulleted items from Section 3.0 Exit Strategy from the Site 11 Groundwater Monitoring Plan by August 31. **Done**

08.01.2.4.1 Gus is to update the Ground Rules and Team Charter per Team comments and email to the Team by August 31. **Done**

08.01.2.4.2 Gus is to send Team members a .pdf file of the presentation by August 31. **Done**

08.01.2.5 Libby is to create a NSB Kings Bay Partnering Team listing and send to Team members by next meeting. **Ongoing – need further information before sending and need to add Brian Syme.**

Consensus Items
NSB Kings Bay Partnering Meeting
November 29, 2011

Team members reached consensus to approve the August 2010 meeting minutes as final.

Parking Lot Items
NSB Kings Bay Partnering Meeting
November 29, 2011

Building 1039 status

Document status update

NSB KINGS BAY SITE 11
CONFERENCE CALL MEETING MINUTES

Discussion of RCRA Permit Provisions

February 13, 2013 (Amended March 20, 2013)

Participants:	Dana Hayworth	NAVFAC SE
	Will Powell	Georgia DNR
	Mike Maughon	Tetra Tech

The purpose of these conference call meeting minutes is to document our common understanding and resolution of the Navy's verbal questions concerning the RCRA permit for NSB Kings Bay Site 11.

Initial conference calls were held on February 11 and February 13, 2013 and a follow up call was held on March 20, 2013,

February 11 and February 13, 2013 Conference Calls

In a teleconference with Will Powell on February 11, Mike Maughon on behalf of the Navy RPM, Dana Hayworth, discussed three primary comments and questions related to the NSB Kings Bay permit as listed below. Will indicated he would further discuss the questions with Amy Potter and let Mike know the resolution. A subsequent conference call was held on February 13 between Will, Mike, and Dana, in which Will provided GA DNR's responses to the comments listed below based on his discussion with Amy.

Navy Comment 1:
Section V of the permit references the 1998 CAP without mention of the optimization report conclusions that MNA has been adequately demonstrated, etc.
Does the Navy need to amend the CAP, perhaps Section 7.0, Contingencies and Exit Strategy Based Upon Long Term Monitoring Results, to reference and summarize results and conclusions of the 2012 optimization report prepared by Tetra Tech, the remedial action completion reports prepared by other contractors for previous source reduction projects (ISCO injections and Excavation), and the Final MNA Monitoring Report prepared by USGS in 2009, which also demonstrated the effectiveness of MNA?

GADNR Response:
The CAP does not need to be amended. MNA, as well as source reduction, is already specified as a remedy in the CAP and the optimization report demonstrated the effectiveness of MNA. The permit is intended to list requirements and not to provide documentation of previous reports or conclusions. The optimization report proposed sampling plan (Figure 3-13) is specified in the permit (Sections V.C.2 and V.C.4) as the basis for the monitoring requirements listed in the permit. The optimization report provides a summary of the previous source reduction remedies, the USGS MNA report, and the demonstrated effectiveness of MNA. The project email correspondence, including this record of discussion, and related project files provide sufficient documentation of the project history and effectiveness of previous source reduction and MNA remedies.

Navy Comment 2:
Paragraph V.C.5 of the permit indicates the Navy can petition the Director to cease sampling any well (except sentinel wells) if COCs measured in that well do not exceed specified GPSs for three consecutive years.
Is there a prescribed method that the Navy should use to petition the Director?

GADNR Response:
Recommendations and supporting information provided in the periodic monitoring reports are sufficient to request GA DNR's approval to cease sampling such wells.

Navy Comment 3:
Paragraphs in the permit seem to have conflicting requirements for the compliance period, demonstrating compliance with the GPS, and how the exit strategy was defined in the optimization report in response to GA DNR's review comments on the optimization report. The exit strategy requested and approved by GA DNR in the final optimization report (Section 3.5) states:

> *"Site 11 currently is still in the phase of corrective action (under MNA) until Groundwater Protection Standards (GWPS) are met, which is equal to the Maximum Contaminant Levels (MCLs) for all remaining contaminants. Once the GWPS is met, three consecutive years of semi-annual monitoring of the compliance wells is required to demonstrate compliance with GWPS. A well with an exceedance of a particular GWPS may be resampled within 30 days to determine if the initial result was valid. After demonstration of compliance with GWPS, a no further action (NFA) status request will be submitted to the Georgia Environmental Protection Division for approval."*

The Navy's interpretation, of this was that only the five "compliance" wells designated in the optimization report sampling plan (Figure 3-13) would be required to be sampled semi-annually for three years after COCs in all wells had not exceeded GPSs for three consecutive years.

However, paragraph V.C.4.c of the permit seems to state that all wells shall be sampled semi-annually for another three years:

> *"The Permittee shall sample all monitoring wells on a semi-annual basis once GPSs as defined in Permit Section V.D have been met in all wells until the end of the Compliance Period as defined in Permit Section V.E."*

Should the permit be clarified for consistency with the exit strategy listed in the optimization report?

GADNR Response: (As clarified by Will Powell in email dated March 15, 2013, and during the team's follow up conference call on March 20, 2013.)
No revision to the Permit is required at this time. When COCs in all wells in the monitoring program have not exceeded GPSs, EPD will work with the Navy to review historical data and identify the specific wells that will require semi-annual monitoring, and the Permit may be modified at that time. The Permit requirement of three consecutive years of COC concentrations below GPSs to demonstrate compliance remains the same.

The discussion concluded with the understanding that only an administrative change will be made to the permit to update the references to the optimization report completion status in paragraphs V.C.2 and V.C.4, i.e., from "August 2012 Draft" report to "October 2012 Final" report.

March 20, 2013 Conference Call

A follow up conference call was held on March 20, 2013 between Mike Maughon (on behalf of Dana Hayworth), Amy Potter, and Will Powell to further clarify the response to Comment No. 3 and our common understanding of permit provisions regarding compliance period and monitoring necessary to achieve NFA.

The primary purpose of the call was to acknowledge the clarified response provided by Will Powell on March 15 to Comment No. 3 as noted above, and to discuss clarifying, as much as possible, the criteria that will be used to determine the specific wells that will require semi-annual compliance monitoring to demonstrate compliance with GPS for three consecutive years, and also limiting the number of these specific wells.

The team agreed that the clarified response to Comment 3 was important as it made clear that specific wells will be selected for semi-annual compliance monitoring when COCs in all wells in the monitoring program have not exceeded GPSs. (The previous response to Comment No. 3 seemed to erroneously suggest that COCs in all wells must meet GPS for three years before the specific wells were selected for semi-annual compliance monitoring to demonstrate compliance with GPS for another three years.)

The team then discussed general criteria that may be used when the time comes for selecting the specific wells for semi-annual monitoring to demonstrate compliance with GPS for three consecutive years. The team agreed in principle with the general criteria listed below with the understanding there could always be an exception depending on what the data shows when we get to that point.

General Criteria for Selecting the Specific Wells for Semi-Annual Compliance Monitoring:

1) Remaining Wells: Monitoring may have already ceased in some wells, other than sentinel wells, based on Permit Condition V.C.5 , i.e., wells where COC sampling results have not exceeded GPS for three consecutive years. When sampling results in all of the wells remaining in the monitoring program do not exceed GPS, the specific wells that will require semi-annual compliance monitoring will be selected from these remaining wells.

2) Historical Data: The specific wells that will require semi-annual compliance monitoring will be selected based on historical data, including relative variability of sampling results and persistence of COCs.

3) Location of Wells: The specific wells that will require semi-annual compliance monitoring will be selected considering typical criteria for compliance wells, i.e., downgradient, beyond the SWMU boundary.

To better focus the proposed well selection criteria, the Navy proposed limiting the number of specific wells that will require the semi-annual compliance monitoring to up to five wells. The team agreed that the selected wells for semi-annual compliance monitoring would likely be five or less. Amy indicated that the specific wells to be selected at this point usually come down to the remaining few "hold out" wells that have not already met GPS for three years.

The team acknowledged the need to retain sentinel wells in the monitoring program but agreed that the improving COC data at that point may warrant designating sentinel wells closer to the SWMU boundary as was recently done as a result of the optimization study. Sentinel wells potentially could also serve as wells selected for the semi-annual compliance monitoring.

With regard to Criteria 3 above, the team discussed and acknowledged that the wells selected for semi-annual compliance monitoring will be located downgradient, beyond the SWMU boundary. However, if COCs in the one well that is being monitored within the SWMU source area, i.e., well KBA-11-34, has not achieved the GPSs then appropriate land use controls (LUCs) would need to be in place to restrict groundwater use, potentially resulting in an NFA with LUCs.

The conference call concluded with Amy suggesting the team schedule another partnering meeting when we get to that point (i.e., no exceedances of GPS) to review the historical data and agree on the specific wells to be monitored semi-annually to demonstrate compliance with GPS for three consecutive years.

APPENDIX B

FIELD DOCUMENTATION FORMS AND STANDARD OPERATING PROCEDURES

Tetra Tech NUS, Inc.

CONTAINER SAMPLE & INSPECTION SHEET

Page_____ of _____

Project Site Name: _____
Project Number: _____
Site Identification: _____
Container Number(s): _____
Sample Type: [] Grab
[] Composite

Sample ID No. _____
Sampled By: _____
C.O.C. No.: _____
Concentration: [] High
[] Medium
[] Low

CONTAINER SOURCE

DRUM:
[] Bung Top
[] Lever Lock
[] Bolted Ring
[] Other _____

TANK:
[] Plastic
[] Metal
[] Other _____

OTHER: _____

CONTAINER DESCRIPTION

COLOR: _____

CONDITION: _____

MARKINGS: _____

VOL. OF CONTENTS: _____

OTHER: _____

CONTAINER DISPOSITION

SAMPLED: _____

OPENED BUT NOT SAMPLED:
Reason _____
_____

NOT OPENED:
Reason _____
_____

CONTENTS DESCRIPTION

SINGLE PHASED: _____
_____

MULTIPHASE :

	Layer 1	Layer 2	Layer 3
Phase (Sol. or Liq.)	_____	_____	_____
Color	_____	_____	_____
Viscosity	L, M or H	L, M or H	L, M orH
% of Total Volume	_____	_____	_____

MONITOR READING:

SAMPLE and /or INSPECTION DATE & TIME:
_____HRS.
METHOD:_____

SAMPLER(S) and / or INSPECTOR(S) SIGNATURE:

ANALYSIS:

Tetra Tech NUS, Inc.

EQUIPMENT CALIBRATION LOG

PROJECT NAME : _____ INSTRUMENT NAME/MODEL: _____

SITE NAME: _____ MANUFACTURER: _____

PROJECT No.: _____ SERIAL NUMBER: _____

Date of Calibration	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
			Pre-calibration	Post-calibration	Pre-calibration	Post-calibration		

TETRA TECH NUS
FIELD TASK MODIFICATION REQUEST FORM

Project/Installation Name _____ CTO & Project Number _____ Task Mod. Number _____

Modification To (e.g. Work Plan) _____ Site/Sample Location _____ Date _____

Activity Description: _____

Reason for Change: _____

Recommended Disposition: _____

Field Operations Leader (Signature) _____ Date _____

Approved Disposition:

Project/Task Order Manager (Signature) _____ Date _____

Distribution:

Program/Project File –
Project/Task Order Manager –
Field Operations Leader –

Other: _____

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

Sampled By: _____ Duplicate: ☐

Field Analyst: _____ Blank: ☐

Field Form Checked as per QA/QC Checklist (initials): _____

SAMPLING DATA:

Date: / Time:	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (^{0}C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	Other
Method:								

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv):_____ Electrode Make & Model:_____

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:

Equipment: HACH Digital Titrator OX-DT CHEMetrics (Range: _____mg/L) Analysis Time: _____

Range Used:	Range	Sample Vol.	Cartridge	Multiplier	Titration Count	Multiplier	Concentration
☐	1-5 mg/L	200 ml	0.200 N	0.01	_____	x 0.01	= mg/L
☐	2-10 mg/L	100 ml	0.200 N	0.02	_____	x 0.02	= mg/L

CHEMetrics: _____mg/L

Notes:

Alkalinity:

Analysis Time: _____

Equipment: HACH Digital Titrator AL-DT CHEMetrics (Range: _____mg/L) Filtered: ☐

Range Used:	Range	Sample Vol.	Cartridge	Multiplier	Titration Count	Multiplier	Concentration
☐	10-40 mg/L	100 ml	0.1600 N	0.1	_____ & _____	x 0.1	= mg/L
☐	40-160 mg/L	25 ml	0.1600 N	0.4	_____ & _____	x 0.4	= mg/L
☐	100-400 mg/L	100 ml	1.600 N	1.0	_____ & _____	x 1.0	= mg/L
☐	200-800 mg/L	50 ml	1.600 N	2.0	_____ & _____	x 2.0	= mg/L
☐	500-2000 mg/L	20 ml	1.600 N	5.0	_____ & _____	x 5.0	= mg/L
☐	1000-4000 mg/L	10 ml	1.600 N	10.0	_____ & _____	x 10.0	= mg/L

Parameter:	Hydroxide	Carbonate	Bicarbonate
Relationship:			

CHEMetrics: _____mg/L

Notes:

Standard Additions: ☐ Titrant Molarity:_____ Digits Required: 1st.:_____ 2nd.:_____ 3rd.:_____

Carbon Dioxide:

Equipment: HACH Digital Titrator CA-DT CHEMetrics (Range: _____mg/L) Analysis Time: _____

Range Used:	Range	Sample Vol.	Cartridge	Multiplier	Titration Count		Concentration
☐	10-50 mg/L	200 ml	0.3636 N	0.1	_____	x 0.1	= mg/L
☐	20-100 mg/L	100 ml	0.3636 N	0.2	_____	x 0.2	= mg/L
☐	100-400 mg/L	200 ml	3.636 N	1.0	_____	x 1.0	= mg/L
☐	200-1000 mg/L	100 ml	3.636 N	2.0	_____	x 2.0	= mg/L

CHEMetrics: _____mg/L

Notes:

Standard Additions: ☐ Titrant Molarity:_____ Digits Required: 1st.:_____ 2nd.:_____ 3rd.:_____

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

Sampled By: _____ Duplicate: ☐

Field Analyst: _____ Blank: ☐

Field Form Checked as per QA/QC Checklist (initials): ☐

SAMPLE COLLECTION/ANALYSIS INFORMATION:

Sulfide (S^{2-}):

Equipment: DR-700 DR-8 _ _ HS-WR Color Wheel Other: _____ Analysis Time: _____

Program/Module: 610nm 93

Concentration: _____ mg/L Filtered: ☐

Notes:

Sulfate ($S0_4^{2-}$):

Equipment: DR-700 DR-8 _ _ Other: _____ Analysis Time: _____

Program/Module: 91

Concentration: _____ mg/L Filtered: ☐

Standard Solution: ☐ Results: _____

Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Notes:

Nitrite (NO_2^--N):

Analysis Time: _____

Equipment: DR-700 DR-8 _ _ Other: _____ Filtered: ☐

Program/Module: 60

Concentration: _____ mg/L Reagent Blank Correction: ☐

Standard Solution: ☐ Results: ☐

Notes:

Nitrate (NO_3^--N):

Analysis Time: _____

Equipment: DR-700 DR-8 _ _ Other: _____ Filtered: ☐

Program/Module: 55

Concentration: _____ mg/L

Nitrite Interference Treatment: ☐

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Notes:

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

Sampled By: _____ Duplicate: ☐

Field Analyst: _____ Blank: ☐

Field Form Checked as per QA/QC Checklist (initials): ☐

SAMPLE COLLECTION/ANALYSIS INFORMATION:

Manganese (Mn^{2+}):

Equipment: DR-700 DR-8 _ _ HACH MN-5 Other: _____ Analysis Time: _____

Program/Module: 525nm 41

Concentration: _____ mg/L Filtered: ☐

Digestion: ☐

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Notes: _____

Ferrous Iron (Fe^{2+}):

Equipment: DR-700 DR-8 _ _ IR-18C Color Wheel Other: _____ Analysis Time: _____

Program/Module: 500nm 33

Concentration: _____ mg/L Filtered: ☐

Notes: _____

Hydrogen Sulfide (H_2S):

Equipment: HS-C Other: _____ Analysis Time: _____

Concentration: _____ mg/L Exceeded 5.0 mg/L range on color chart: ☐

Notes: _____

QA/QC Checklist:

All data fields have been completed as necessary: ☐

Correct measurement units are cited in the SAMPLING DATA block: ☐

Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☐

Mulitplication is correct for each *Multiplier* table: ☐

Final calulated concentration is within the appropriate *Range Used* block: ☐

Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☐

QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☐

Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: ☐

Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☐

Tetra Tech NUS, Inc.

GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name: _____ **Project No.:** _____

Location: _____ **Personnel:** _____

Weather Conditions: _____ **Measuring Device:** _____

Tidally Influenced: Yes ____ No ____ **Remarks:** _____

Well or Piezometer Number	Date	Time	Elevation of Reference Point (feet)*	Total Well Depth (feet)*	Water Level Indicator Reading (feet)*	Thickness of Free Product (feet)*	Groundwater Elevation (feet)*	Comments

* All measurements to the nearest 0.01 foot

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: _____
Project No.: _____

[] Domestic Well Data
[] Monitoring Well Data
[] Other Well Type: _____
[] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____
Type of Sample:
[] Low Concentration
[] High Concentration

SAMPLING DATA:

Date:	**Color**	**pH**	**S.C.**	**Temp.**	**Turbidity**	**DO**	**Salinity**	Other
Time:	(Visual)	(S.U.)	(mS/cm)	(^{0}C)	(NTU)	(mg/l)	(%)	
Method:								

PURGE DATA:

Date:	**Volume**	**pH**	**S.C.**	**Temp.**	**Turbidity**	**DO**	**Salinity**	Other
Method:								
Monitor Reading (ppm):								
Well Casing Diameter & Material								
Type:								
Total Well Depth (TD):								
Static Water Level (WL):								
One Casing Volume(gal/L):								
Start Purge (hrs):								
End Purge (hrs):								
Total Purge Time (min):								
Total Vol. Purged (gal/L):								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES:

Circle if Applicable:

MS/MSD	**Duplicate ID No.:**

Signature(s):

HYDRAULIC CONDUCTIVITY TESTING DATA SHEET

Tetra Tech NUS, Inc.

PROJECT NAME: ..... WELL/BORING NO.: .....

PROJECT NO.: ..... GEOLOGIST: .....

WELL DIAMETER: ..... SCREEN LENGTH/DEPTH: ..... TEST NO.: .....

STATIC WATER LEVEL (Depth/Elevation): ..... DATE: .....

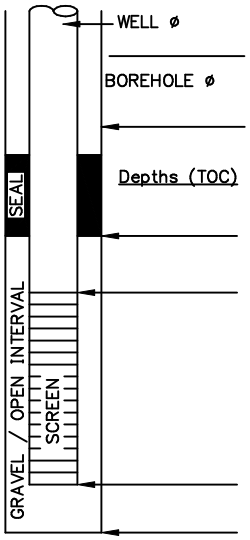
TEST TYPE (Rising/Falling/Constant Head): ..... CHECKED: .....

METHOD OF INDUCING WATER LEVEL CHANGE: ..... PAGE ..... OF .....

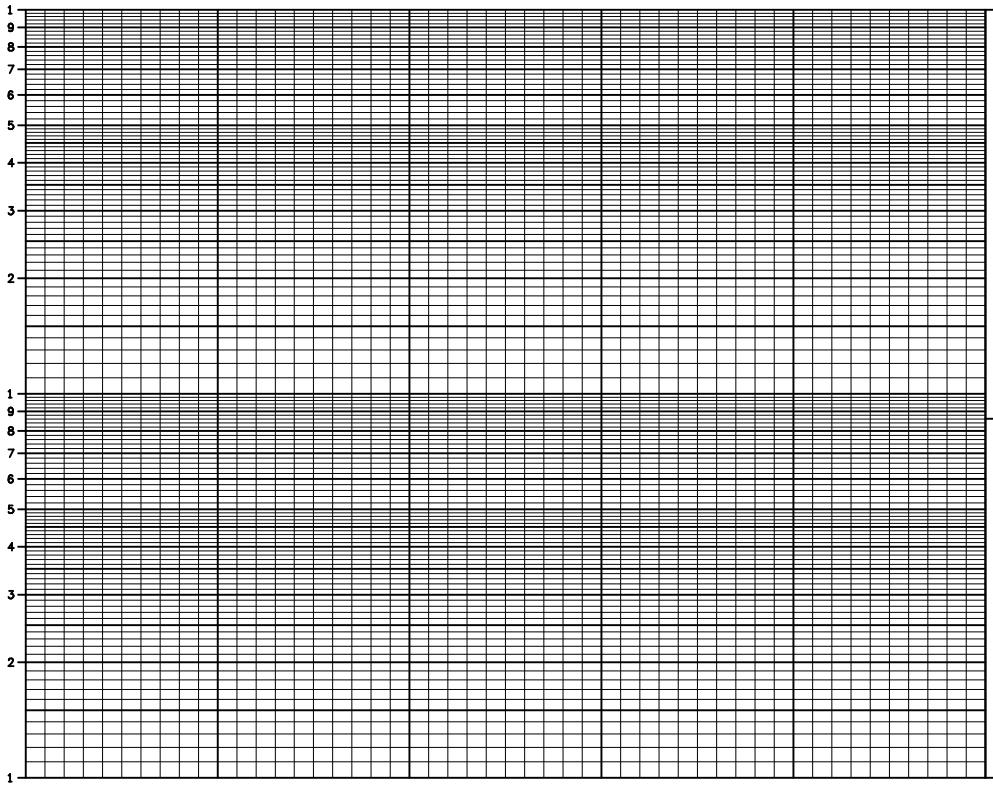
REFERENCE PT. FOR WL MEAS. (Top of Casing, Transducer, etc.): .....

ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)	ELAPSED TIME (min. or sec.)	MEASURED WATER LEVEL (feet)	DRAWDOWN OR HEAD (ΔH) (feet)

WELL SCHEMATIC



▽ Indicate SWL Depth on Drawing



REMARKS:

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CALCS,SKETCH MAPS, ETC.:

ACAD:FORM_HYDCONTST.dwg 07/06/99 INL

LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: _____ WELL ID.: _____

PROJECT NUMBER: _____ DATE: _____

Time (Hrs.)	Water Level (Ft. below TOC)	Flow (mL/Min.)	pH (S.U.)	S. Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celcius)	ORP mV	Salinity % or ppt	Comments

SIGNATURE(S): _____ PAGE___OF___

Tetra Tech NUS, Inc.

QA SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____ Sample ID Number: _____
Project Number: _____ Sampled By: _____
Sample Location: _____ C.O.C. Number: _____
QA Sample Type:

[] Trip Blank [] Rinsate Blank
[] Source Water Blank [] Other Blank _____

SAMPLING DATA:

Date: _____
Time: _____
Method: _____

WATER SOURCE:

[] Laboratory Prepared [] Tap
[] Purchased [] Fire Hydrant
[] Other _____

PURCHASED WATER INFORMATION (If Applicable as Source or Rinsate Water):

Product Name: _____
Supplier: _____
Manufacturer: _____
Order Number: _____
Lot Number: _____
Expiration Date: _____

RINSATE INFORMATION (If Applicable):

Media Type: _____
Equipment Used: _____
Equipment Type:

[] Dedicated
[] Reusable

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
Volatiles	Cool 4°C & HCl		YES / NO
Semivolatiles	Cool 4°C		YES / NO
Pesticide / PCB	Cool 4°C		YES / NO
Metals	Cool 4°C & HNO_3		YES / NO
Cyanide	Cool 4°C & NaOH		YES / NO

OBSERVATIONS / NOTES:

Signature(s):

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6.0 DEVIATIONS 7

1.0 PURPOSE

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

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

2.0 SCOPE

The methods described in this SOP shall be used consistently for all projects requiring electronic data. Other contract- or project-specific sample nomenclature requirements may also be applicable.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES AND PERSONNEL QUALIFICATIONS

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

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

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

General personnel qualifications for sample nomenclature activities in the field include the following:

- Occupational Safety and Health Administration (OSHA) 40-hour and applicable refresher training.
- Capability of performing field work under the expected physical and environmental (i.e., weather) conditions.
- Familiarity with appropriate procedures for field documentation, handling, packaging, and shipping.

5.0 PROCEDURES

5.1 INTRODUCTION

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

A or N 3 or 4 Characters	**AAA 2 or 3 Characters**	**A or N 3 to 6 Characters**
Site Identifier	Sample Type	Sample Location

Additional segments may be added as needed. For example:

(1) Soil and sediment sample ID

A or N 3 or 4 Characters	**AAA 2 or 3 Characters**	**A or N 3 to 6 Characters**	**NNNN 4 Characters**
Site identifier	Sample type	Sample location	Sample depth

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

A or N 3 or 4 Characters	**AAA 2 or 3 Characters**	**A or N 3 to 6 Characters**	**NN 2 Characters**	**-A 1 Character**
Site identifier	Sample type	Sample location	Round number	Filtered sample only

(3) Biota sample ID

A or N 3 or 4 Characters	**AAA 2 or 3 Characters**	**A or N 3 to 6 Characters**	**AA 2 Characters**	**NNN 3 Characters**
Site identifier	Sample type	Sample location	Species identifier	Sample group number

5.2 SAMPLE IDENTIFICATION FIELD REQUIREMENTS

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

- Site identifier
- Sample type
- Sample location
- Sample depth
- Sampling round number
- Filtered
- Species identifier
- Sample group number

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

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

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

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

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

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

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

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

5.3 EXAMPLE SAMPLE FIELD DESIGNATIONS

Examples of each of the fields are as follows:

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

A01 - Area of Concern (AOC) 1
125 - SWMU 125
000 - Base- or facility-wide sample (e.g., upgradient well)
BBG - Base background

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

Sample type - Examples of sample types are as follows:

AH - Ash Sample

AS - Air Sample
BM - Building Material Sample
BSB - Biota Sample Full Body
BSF - Biota Sample Fillet
CP - Composite Sample
CS - Chip Sample
DS - Drum Sample
DU - Dust Sample
FP - Free Product
IDW - Investigation-Derived Waste Sample
LT - Leachate Sample
MW - Monitoring Well Groundwater Sample
OF - Outfall Sample
RW - Residential Well Sample
SB - Soil Boring Sample
SD - Sediment Sample
SC - Scrape Sample
SG - Soil Gas Sample
SL - Sludge Sample
SP - Seep Sample
SS - Surface Soil Sample
ST - Storm Sewer Water Sample
SW - Surface Water Sample
TP - Test Pit Sample
TW - Temporary Well Sample
WC - Well Construction Material Sample
WP - Wipe Sample
WS - Waste/Solid Sample
WW - Wastewater Sample

Sample location - Examples of the location field are as follows:

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

Species identifier - Examples of species identifier are as follows:

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

5.4 EXAMPLES OF SAMPLE NOMENCLATURE

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

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

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

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

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

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

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

Note: No dash (-) or spacing is used between the segments with the exception of the filtered segment. The "F" used for a filtered aqueous sample is preceded by a dash (-F).

5.5 FIELD QA/QC SAMPLE NOMENCLATURE

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

AA	NNNNNN	NN	-F
QC type	Date	Sequence number (per day)	Filtered (aqueous only, if needed)

The QC types are identified as:

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

The sampling time recorded on the chain-of-custody form, labels, and tags for duplicate samples will be 0000 so that the samples are "blind" to the laboratory. Notes detailing the sample number, time, date, and type will be recorded on the routine sample log sheets and will document the location of the duplicate sample (sample log sheets are not provided to the laboratory). Documentation for all other QC types (TB, RB, AB, and WB) will be recorded on the QC Sample Log Sheet (see SOP SA-6.3, Field Documentation).

5.6 EXAMPLES OF FIELD QA/QC SAMPLE NOMENCLATURE

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

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

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

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

6.0 DEVIATIONS

Any deviation from this SOP must be addressed in detail in the site-specific planning documents.

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A MIS REQUEST FORM **7**

1.0 PURPOSE

The purpose of this document is to specify a consistent procedure for the quality assurance review of electronic and hard copy databases. This SOP outlines the requirements for establishment of a Database Record File, Quality Assurance review procedures, and documentation of the Quality Assurance Review Process.

2.0 SCOPE

The methods described in this Standard Operating Procedure (SOP) shall be used consistently for all projects managed by Tetra Tech NUS (TtNUS).

3.0 GLOSSARY

Chain-of-Custody Form - A Chain-of-Custody Form is a printed form that accompanies a sample or a group of samples from the time of sample collection to the laboratory. The Chain-of-Custody Form is retained with the samples during transfer of samples from one custodian to another. The Chain-of-Custody Form is a controlled document that becomes part of the permanent project file. Chain-of-Custody and field documentation requirements are addressed in SOP SA-6.1.

Electronic Database - A database provided on a compact laser disk (CD). Such electronic databases will generally be prepared using public domain software such as DBase, RBase, Oracle, Visual FoxPro, Microsoft Access, Paradox, etc.

Hardcopy Database - A printed copy of a database prepared using the software discussed under the definition of an electronic database.

Form I - A printed copy of the analytical results for each sample.

Sample Tracking Summary - A printed record of sample information including the date the samples were collected, the number of samples collected, the sample matrix, the laboratory to which the samples were shipped, the associated analytical requirements for the samples, the date the analytical data were received from the laboratory, and the date that validation of the sample data was completed.

4.0 RESPONSIBILITIES

Database Records Custodian - It shall be the responsibility of the Database Records Custodian to update and file the Sample Tracking Summaries for all active projects on a weekly basis. It shall be the responsibility of the Database Records Custodian to ensure that the most recent copies of the Sample Tracking Summaries are placed in the Database Records file. It shall be the responsibility of the Database Records Custodian to ensure that a copy of all validation deliverables is provided to the Project Manager (for placement in the project file). It shall be the responsibility of the Database Records Custodian to ensure that photocopies of all validation deliverables and historical data and reports (as applicable) are placed in the Database Records file.

Data Validation Coordinator - It shall be the responsibility of the Data Validation Coordinator (or designee) to ensure that the Sample Tracking Summaries are maintained by the Database Records Custodian. It shall be the responsibility of the Data Validation Coordinator (or designee) to ensure that photocopies of all data validation deliverables are placed in the applicable Database Records file by the Database Records Custodian.

Earth Sciences Department Manager - It shall be the responsibility of the Earth Sciences Department Manager (or equivalent) to ensure that all field personnel are familiar with the requirements of this Standard Operating Procedure (specifically Section 5.5).

FOL - It shall be the responsibility of the FOL (FOL) of each project to ensure that all field technicians or sampling personnel are thoroughly familiar with this SOP, specifically regarding provision of the Chain-of-Custody Forms to the Database Records Custodian. Other responsibilities of the FOL are described in Sections 5.4 and 5.5.

Management Information Systems (MIS) Manager - It shall be the responsibility of the MIS Manager to ensure that copies of original electronic deliverables (CDs) are placed in both the project files and the Database Records File. It shall be the responsibility of the MIS Manager (or designee) to verify the completeness of the database (presence of all samples) in both electronic and hardcopy form in the Database Records File. It shall be the responsibility of the MIS Manager to ensure that Quality Assurance Reviews are completed and are attested to by Quality Assurance Reviewers. It shall be the responsibility of the MIS Manager to ensure that records of the Quality Assurance review process are placed in the Database Records File. It shall be the responsibility of the MIS Manager to ensure that both electronic and hardcopy forms of the final database are placed in both the project and the Database Record File. It shall be the responsibility of the MIS Manager to ensure that data validation qualifiers are entered in the database.

Furthermore, it shall be the responsibility of the MIS Manager to participate in project planning at the request of the Project Manager, specifically with respect to the generation of level of effort and schedule estimates. To support the project planning effort, the MIS Manager shall provide a copy of the MIS Request From included as Attachment A to the project manager. It shall be the responsibility of the MIS Manager to generate level of effort and budget estimates at the time database support is requested if a budget does not exist at the time of the request. The MIS Request Form shall be provided to the Project Manager at the time of any such requests. It shall be the responsibility of the MIS Manager to notify the Project Manager of any anticipated level of effort overruns or schedule noncompliances as soon as such problems arise along with full justification for any deviations from the budget estimates (provided they were generated by the MIS Manager). It shall be the responsibility of the MIS Manager to document any changes to the scope of work dictated by the Project Manager, along with an estimate of the impact of the change on the level of effort and the schedule.

Program/Department Managers - It shall be the responsibility of the Department and/or Program Managers (or designees) to inform their respective department's Project Managers of the existence and requirements of this SOP.

Project Manager - It shall be the responsibility of each Project Manager to determine the applicability of this SOP based on: (1) program-specific requirements, and (2) project size and objectives. It shall be the responsibility of the Project Manager (or designee) to ensure that the FOL is familiar with the requirements regarding Chain-of-Custody Form provision to the Database Records Custodian. It shall be the responsibility of the Project Manager (or designee) to determine which, if any, historical data are relevant and to ensure that such data (including all relevant information such as originating entity, sample locations, sampling dates, etc.) are provided to the Database Records Custodian for inclusion in the Database Records File. It shall be the responsibility of the Project Manager to obtain project planning input regarding the level of effort and schedule from the MIS Manager. It shall be the responsibility of the Project Manager to complete the database checklist (Attachment A) to support the level of effort and schedule estimate and to facilitate database preparation and subroutine execution.

Risk Assessment Department Manager - It shall be the responsibility of the Risk Assessment Department Manager to monitor compliance with this Standard Operating Procedure, to modify this SOP as necessary, and to take corrective action if necessary. Monitoring of the process shall be completed on a quarterly basis.

Quality Assurance Reviewers - It shall be the responsibility of the Quality Assurance Reviewers to verify the completeness of the sample results via review of the Chain-of-Custody Forms and Sample Tracking Summaries. It shall be the responsibility of the Quality Assurance Reviewers to ensure the correctness of the database via direct comparison of the hardcopy printout of the database and the hardcopy summaries of the original analytical data (e.g., Form Is provided in data validation deliverables). Correctness includes the presence of all relevant sample information (all sample information fields), agreement of the laboratory and database analytical results, and the presence of data validation qualifiers.

Quality Manager - It shall be the responsibility of the Quality Manager to monitor compliance with this Standard Operating Procedure via routine audits.

5.0 PROCEDURES

5.1 Introduction

Verification of the accuracy and completeness of an electronic database can only be accomplished via comparison of a hardcopy of the database with hardcopy of all relevant sample information. The primary purposes of this SOP are to ensure that 1) all necessary hardcopy information is readily available to Quality Assurance Reviewers; 2) ensure that the Quality Assurance review is completed in a consistent and comprehensive manner, and; 3) ensure that documentation of the Quality Assurance review process is maintained in the project file.

5.2 File Establishment

A Database Record file shall be established for a specific project at the discretion of the Project Manager. Initiation of the filing procedure will commence upon receipt of the first set of Chain-of-Custody documents from a FOL or sampling technician. The Database Record Custodian shall establish a project-specific file for placement in the Database Record File. Each file in the Database Record File shall consist of standard components placed in the file as the project progresses. Each file shall be clearly labeled with the project number, which shall be placed on the front of the file drawer and on each and every hanging file folder relevant to the project. The following constitute the minimum components of a completed file:

- Electronic Deliverables
- Sample Tracking Forms
- Chain-of-Custody Forms
- Data Validation Letters
- Quality Assurance Records

5.3 Electronic Deliverables

The format of electronic deliverables shall be specified in the laboratory procurement specification and shall be provided by the laboratory. The integrity of all original electronic data deliverables shall be maintained. This shall be accomplished via the generation of copies of each electronic deliverable provided by the laboratory. The original electronic deliverable shall be provided to the project manager for inclusion in the project file. A copy of the original electronic deliverable shall be placed in the Database Record File. The second copy shall be maintained by the MIS Manager (or designee) to be used as a working copy.

5.4 Sample Tracking Forms

Updated versions of the sample tracking form for each relevant project shall be maintained by the Database Record Custodian. The Sample Tracking Forms shall be updated any time additional Chain-of-Custody Forms are received from a FOL or sampling technician, or at any time that data are received from a laboratory, or at any time that validation of a given data package (sample delivery group) is completed. The Data Validation Coordinator shall inform the Database Record Custodian of the receipt of any data packages from the laboratory and of completion of validation of a given data package to facilitate updating of the Sample Tracking Form. The Database Record Custodian shall place a revised copy of the Sample Tracking Form in the Database Record File anytime it has been updated. Copies of the updated Sample Tracking Form shall also be provided to the project manager to apprise the project manager of sample package receipt, completion of validation, etc.

5.5 Chain-of-Custody Forms

The Chain-of-Custody Forms for all sampling efforts will be used as the basis for (1) updating the Sample Tracking Form, and (2) confirming that all required samples and associated analyses have been completed. It shall be the responsibility of the FOL (or sample technician) to provide a photocopy of all Chain-of-Custody Forms to the Database Record Custodian immediately upon completion of a sampling effort. The Database Record Custodian shall then place the copies of the Chain-of-Custody Form(s) in the Database Record File. Upon receipt of a sample data package from an analytical laboratory, the Data Validation Coordinator shall provide a copy of the laboratory Chain-of-Custody Form to the Database Record Custodian. The Database Record Custodian shall use this copy to update the Sample Tracking Summary and shall place the copy of the laboratory-provided Chain-of-Custody Form in the Database Record File. The photocopy of the laboratory-provided Chain-of Custody Form shall be stapled to the previously filed field copy. Upon receipt of all analytical data, two copies of the Chain-of-Custody will therefore be in the file. Review of the Chain-of-Custody Forms will therefore be a simple mechanism to determine if all data have been received. Chain-of-Custody is addressed in SOP SA-6.1.

5.6 Data Validation Letters

All data validation deliverables (or raw data summaries if validation is not conducted) shall be provided for inclusion in both the Database Record File and the project file. If USEPA regional- or client-specific requirements are such that Form Is (or similar analytical results) need not be provided with the validation deliverable, copies of such results must be appended to the deliverable. It is preferable, although not essential that the validation qualifiers be hand-written directly on the data summary forms. The data validation deliverables (and attendant analytical summaries) will provide the basis for direct comparison of the database printout and the raw data and qualifiers.

5.7 Historical Data

At the direction of the Project Manager, historical data may also be included in a project-specific analytical database. In the event that historical data are germane to the project, hardcopy of the historical data must be included in the Database Record File. Historical data may be maintained in the form of final reports or as raw data. The information contained in the historical data file must be sufficient to identify its origin, its collection date, the sample location, the matrix, and any and all other pertinent information. All available analytical data, Chain-of-Custody Forms, boring logs, well construction logs, sample location maps, shall be photocopied by the Project Manager (or designee) and placed in one or more 3-ring binders. All information shall be organized chronologically by matrix. It shall be the responsibility of the Project Manager (or designee) to ensure that all inconsistencies between analytical data, Chain-of-Custody Forms, boring logs, sample log sheets, and field logbooks are identified and corrected. The Project Manager (or designee) shall decide which nomenclature is appropriate and edit, initial and date all relevant forms. Data entry may only be performed on information that has undergone the aforementioned

editing process, thereby having a direct correlation between hardcopy information and what will become the electronic database.

6.0 RECORDS

Records regarding database preparation and quality assurance review include all those identified in the previous section. Upon completion of the database task, records from the file will be forwarded to the Project Manager for inclusion in the project file, or will be placed in bankers boxes (or equivalent) for storage. The final records for storage shall include the following minimum information on placards placed on both the top and end of the storage box:

Database Record File
PROJECT NUMBER: ____
SITE NAME: _____
DATE FILED: __/__/__
SUMMARY OF CONTENTS ENCLOSED
BOX _ OF _

Project- or program-specific record keeping requirements shall take precedence over the record keeping requirements of this SOP.

ATTACHMENT A

MIS REQUEST FORM

Tetra Tech NUS, Inc.

Project Name: _____ Request Date: _____
CTO: _____ Date Data Available for Production: _____
Project Manager: _____ Request in Support of: _____
Requestor: _____ Database Lead: _____
Program/Client: _____ GIS Lead: _____
State/EPA Region: _____ Statistics Lead: _____
Risk Lead: _____
Site Name(s) (Area, OU, etc.): _____
Sampling Date(s): _____
Matrix: ☐ GW ☐ SO ☐ SD ☐ SW ☐ Other: _____

Labels: ☐ Labels needed for an upcoming sampling event _____ Total # of Samples
_____ Estimated Hours
_____ Due Date
_____ Complete ETS Charge No.
_____ FOL
Additional Instructions: _____

Data Entry:
☐ Chemical data needs to be entered from hardcopy _____ Estimated # of Samples
☐ Chemical data needs to be formated electronically
☐ Field analytical data needs to be entered from hardcopy
☐ Geologic data needs to be entered from hardcopy
☐ Hydrology data needs to be entered from hardcopy
_____ Estimated Hours
_____ Due Date
_____ Complete ETS Charge No.
Additional Instructions: _____

Tables:
☐ Full Data Printout
☐ Summary of Positive Hits
☐ Occurance and Distribution ☐ with criteria
☐ Sampling Analytical Summary
☐ Other: _____
_____ Estimated Hours
_____ Due Date
_____ Complete ETS Charge No.
Additional Instructions: _____

GIS:
☐ General Facility Location
☐ Site Location
☐ Potentiometric Contours/Groundwater Flow
☐ Sample Location Proposed
☐ Sample Location Existing
☐ Tag Map Single Round
☐ Tag Map Multiple Round
☐ Isoconcentrations
☐ Chart Map
☐ 3D Visualization
☐ EGIS CD
☐ Other: _____
_____ Estimated Hours
_____ Due Date
_____ Complete ETS Charge No.
Additional Instructions: _____

Statistics: ☐ Yes
_____ Estimated Hours
_____ Due Date
_____ Complete ETS Charge No.
Additional Instructions: _____

Geostatistics: ☐ Yes
_____ Estimated Hours
_____ Due Date
_____ Complete ETS Charge No.
Additional Instructions: _____

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B GROUNDWATER LEVEL MEASUREMENT SHEET 9

1.0 PURPOSE

The purpose of this procedure is to provide reference information regarding the proper methods for evaluating the physical condition and project utility of existing monitoring wells and determining water levels.

2.0 SCOPE

The procedures described herein are applicable to all existing monitoring wells and, for the most part, are independent of construction materials and methods.

3.0 GLOSSARY

Hydraulic Head - The height to which water will rise in a well.

Water Table - A surface in an unconfined aquifer where groundwater pressure is equal to atmospheric pressure (i.e., the pressure head is zero).

4.0 RESPONSIBILITIES

Site Geologist/Hydrogeologist - Has overall responsibility for the evaluation of existing wells, obtaining water level measurements and developing groundwater contour maps. The site geologist/hydrogeologist (in concurrence with the Project Manager) shall specify the reference point from which water levels are measured (usually a specific point on the upper edge of the inner well casing), the number and location of data points which shall be used for constructing a contour map, and how many complete sets of water levels are required to adequately define groundwater flow directions (e.g., if there are seasonal variations).

Field Personnel - Must have a basic familiarity with the equipment and procedures involved in obtaining water levels and must be aware of any project-specific requirements or objectives.

5.0 PROCEDURES

Accurate, valid and useful groundwater monitoring requires that four important conditions be met:

- Proper characterization of site hydrogeology.
- Proper design of the groundwater monitoring program, including adequate numbers of wells installed at appropriate locations and depths.
- Satisfactory methods of groundwater sampling and analysis to meet the project data quality objectives (DQOs).
- The assurance that specific monitoring well samples are representative of water quality conditions in the monitored interval.

To insure that these conditions are met, adequate descriptions of subsurface geology, well construction methods and well testing results must be available. The following steps will help to insure that the required data are available to permit an evaluation of the utility of existing monitoring wells for collecting additional samples.

5.1 Preliminary Evaluation

A necessary first step in evaluating existing monitoring well data is the study and review of the original work plan for monitoring well installation (if available). This helps to familiarize the site geologist/hydrogeologist with site-specific condition, and will promote an understanding of the original purpose of the monitoring wells.

The next step of the evaluation should involve a review of all available information concerning borehole drilling and well construction. This will allow interpretation of groundwater flow conditions and area geology, and will help to establish consistency between hydraulic properties of the well and physical features of the well or formation. The physical features which should be identified and detailed, if available, include:

- The well identification number, permit number and location by referenced coordinates, the distance from prominent site features, or the location of the well on a map.
- The installation dates, drilling methods, well development methods, past sampling dates, and drilling contractors.
- The depth to bedrock -- where rock cores were not taken, auger refusal, drive casing refusal or penetration test results (blow counts for split-barrel sampling) may be used to estimate bedrock interface.
- The soil profile and stratigraphy.
- The borehole depth and diameter.
- The elevation of the top of the protective casing, the top of the well riser, and the ground surface.
- The total depth of the well.
- The type of well materials, screen type, slot size, and length, and the elevation/depths of the screen, interval, and/or monitored interval.
- The elevation/depths of the tops and bottom of the filter pack and well seals and the type and size.

5.2 Field Inspection

During the onsite inspection of existing monitoring wells, features to be noted include:

- The condition of the protective casing, cap and lock.
- The condition of the cement seal surrounding the protective casing.
- The presence of depressions or standing water around the casing.
- The presence of and condition of dedicated sampling equipment.
- The presence of a survey mark on the inner well casing.

If the protective casing, cap and lock have been damaged or the cement collar appears deteriorated, or if there are any depressions around the well casing capable of holding water, surface water may have infiltrated into the well. This may invalidate previous sampling results unless the time when leakage started can be precisely determined.

The routine physical inspection must be followed by a more detailed investigation to identify other potential routes of contamination or sampling equipment malfunction. Any of these occurrences may invalidate

previously-collected water quality data. If the monitoring well is to be used in the future, considerations shown in the steps described above should be rectified to rehabilitate the well.

After disconnecting any wires, cables or electrical sources, remove the lock and open the cap. Check for the presence of organic vapors with a photoionization detector (PID) or flame-ionization detector (FID) to determine the appropriate worker safety level. The following information should be noted:

- Cap function.
- Physical characteristics and composition of the inner casing or riser, including inner diameter and annular space.
- Presence of grout between the riser and outer protective casing and the existence of drain holes in the protective casing.
- Presence of a riser cap, method of attachment to casing, and venting of the riser.
- Presence of dedicated sampling equipment; if possible, remove such equipment and inspect size, materials of construction and condition.

The final step of the field inspection is to confirm previous hydraulic or physical property data and to obtain data not previously available. This includes the determination of static water levels, total well depth and well obstruction. This may be accomplished using a weighted tape measure which can also be used to check for sediment (the weight will advance slowly if sediment is present, and the presence of sediment on the weight upon removal should be noted). If sediment is present and/or the well has not been sampled in 12 or more months, it should be redeveloped before sampling.

Lastly, as a final step, the location, condition and expected water quality of the wells should be reviewed in light of their usefulness for the intended purpose of the investigation.

See Attachment A, Monitoring Well Inspection Sheet.

5.3 Water Level (Hydraulic Head) Measurements

5.3.1 General

Groundwater level measurements can be made in monitoring wells, private or public water wells, piezometers, open boreholes, or test pits (after stabilization). Groundwater measurements should generally not be made in boreholes with drilling rods or auger flights present. If groundwater sampling activities are to occur, groundwater level measurements shall take place prior to well purging or sampling.

All groundwater level measurements shall be made to the nearest 0.01 foot, and recorded in the site geologist/hydrogeologist's field notebook or on the Groundwater Level Measurement Sheet (Attachment B), along with the date and time of the reading. The total depth of the well shall be measured and recorded, if not already known. Weather changes that occur over the period of time during which water levels are being taken, such as precipitation and barometric pressure changes, should be noted.

In measuring groundwater levels, there shall be a clearly-established reference point of known elevation, which is normally identified by a mark on the upper edge of the inner well casing. To be useful, the reference point should be tied in with an established USGS benchmark or other properly surveyed elevation datum. An arbitrary datum could be used for an isolated group of wells, if necessary.

Cascading water within a borehole or steel well casings can cause false readings with some types of sounding devices (chalked line, electrical). Oil layers may also cause problems in determining the true water level in a well. Special devices (interface probes) are available for measuring the thickness of oil layers and true depth to groundwater, if required.

Water level readings shall be taken regularly, as required by the site geologist/hydrogeologist. Monitoring wells or open-cased boreholes that are subject to tidal fluctuations should be read in conjunction with a tidal chart (or preferably in conjunction with readings of a tide staff or tide level recorder installed in the adjacent water body); the frequency of such readings shall be established by the site hydrogeologist. All water level measurements at a site used to develop a groundwater contour map shall be made in the shortest practical time to minimize affects due to weather changes.

5.3.2 Water Level Measuring Techniques

There are several methods for determining standing or changing water levels in boreholes and monitoring wells. Certain methods have particular advantages and disadvantages depending upon well conditions. A general description of these methods is presented, along with a listing of various advantages and disadvantages of each technique. An effective technique shall be selected for the particular site conditions by the site geologist/hydrogeologist.

In most instances, preparation of accurate potentiometric surface maps require that static water level measurements be obtained to a precision of 0.01 feet. To obtain such measurements in individual accessible wells, electrical water level indicator methods have been found to be best, and thus should be utilized. Other, less precise methods, such as the popper or bell sound, or bailer line methods, should be avoided. When a large number of (or continuous) readings are required, time-consuming individual readings are not usually feasible. In such cases, it is best to use a pressure transducer.

5.3.3 Methods

Water levels can be measured by several different techniques, but the same steps shall be followed in each case. The proper sequence is as follows:

1. Check operation of recording equipment above ground. Prior to opening the well, don personal protective equipment, as required. Never remove an air-tight lock (such as a J-plug) with your face over the well. Pressure changes within the well may explosively force the cap off once loosened.

2. Record all information specified below in the geologist/hydrogeologist's field notebook or on the Groundwater Level Measurement Sheet (Attachment B):

   - Well number.
   - Water level (to the nearest 0.01 foot). Water levels shall be taken from the surveyed reference mark on the top edge of the inner well casing. If the J-plug was on the well very tightly, it may take several minutes for the water level to stabilize.
   - Time and day of the measurement.
   - Thickness of free product if present.

Water level measuring devices with permanently marked intervals shall be used. The devices shall be free of kinks or folds which will affect the ability of the equipment to hang straight in the well pipe.

5.3.4 Water Level Measuring Devices

Electric Water Level Indicators

These are the most commonly used devices and consist of a spool of small-diameter cable and a weighted probe attached to the end. When the probe comes in contact with the water, an electrical circuit is closed and a meter, light, and/or buzzer attached to the spool will signal the contact.

There are a number of commercial electric sounders available, none of which is entirely reliable under all conditions likely to occur in a contaminated monitoring well. In conditions where there is oil on the water, groundwater with high specific conductance, water cascading into the well, steel well casing, or a turbulent water surface in the well, measuring with an electric sounder may be difficult.

For accurate readings, the probe shall be lowered slowly into the well adjacent to the survey mark on the inner well casing. The electric tape is read (to the nearest 0.01 ft.) at the measuring point and recorded where contact with the water surface was indicated.

Popper or Bell Sounder

A bell- or cup-shaped weight that is hollow on the bottom is attached to a measuring tape and lowered into the well. A "plopping" or "popping" sound is made when the weight strikes the surface of the water. An accurate reading can be determined by lifting and lowering the weight in short strokes, and reading the tape when the weight strikes the water. This method is not sufficiently accurate to obtain water levels to 0.01 feet, and thus is more appropriate for obtaining only approximate water levels quickly.

Pressure Transducer

Pressure transducers can be lowered into a well or borehole to measure the pressure of water and therefore the water elevation above the transducer. The transducer is wired into a recorder at the surface to record changes in water level with time. The recorder digitizes the information and can provide a printout or transfer the information to a computer for evaluation (using a well drawdown/recovery model). The pressure transducer should be initially calibrated with another water level measurement technique to ensure accuracy. This technique is very useful for hydraulic conductivity testing in highly permeable material where repeated, accurate water level measurements are required in a very short period of time. A sensitive transducer element is required to measure water levels to 0.01 foot accuracy.

Borehole Geophysics

Approximate water levels can be determined during geophysical logging of the borehole (although this is not the primary purpose for geophysical logging and such logging is not cost effective if used only for this purpose). Several logging techniques will indicate water level. Commonly-used logs which will indicate saturated/unsaturated conditions include the spontaneous potential (SP) log and the neutron log.

5.3.5 Data Recording

Water level measurements, time, data, and weather conditions shall be recorded in the geologist/hydrogeologist's field notebook or on the Groundwater Level Measurement Sheet. All water level measurements shall be measured from a known reference point. The reference point is generally a marked point on the upper edge of the inner well casing that has been surveyed for an elevation. The exact reference point shall be marked with permanent ink on the casing since the top of the casing may not be entirely level. It is important to note changes in weather conditions because changes in the barometric pressure may affect the water level within the well.

5.3.6 Specific Quality Control Procedures for Water Level Measuring Devices

All groundwater level measurement devices must be cleaned before and after each use to prevent cross contamination of wells. Manufacturer's instructions for cleaning the device shall be strictly followed. Some devices used to measure groundwater levels may need to be calibrated. These devices shall be calibrated to 0.01 foot accuracy and any adjustments/corrections shall be recorded in the field logbook/notebook. After the corrections/adjustments are made to the measuring device and entered in the field logbook/notebook, the corrected readings shall be entered onto the Groundwater Level Measurement Sheet (Attachment B). Elevations will be entered on the sheet when they become available.

5.4 Equipment Decontamination

Equipment used for water level measurements provide a mechanism for potentially cross contaminating wells. Therefore, all portions of a device which project down the well casing must be decontaminated prior to advancing to the next well. Decontamination procedures vary based on the project objectives but must be defined prior to conducting any field activities including the collection of water level data. Consult the project planning documents and SA-7.1 Decontamination of Field Equipment.

5.5 Health and Safety Considerations

Groundwater contaminated by volatile organic compounds may release toxic vapors into the air space inside the well pipe. The release of this air when the well is initially opened is a health/safety hazard which must be considered. Initial monitoring of the well headspace and breathing zone concentrations using a PID or FID shall be performed to determine required levels of protection. Under certain conditions, air-tight well caps may explosively fly off the well when the pressure is relieved. Never stand directly over a well when uncapping it.

6.0 RECORDS

A record of all field procedures, tests and observations must be recorded in the site logbook or designated field notebook. Entries in the log/notebook should include the individuals participating in the field effort, and the date and time. The use of annotated sketches may help to supplement the evaluation.

ATTACHMENT A
MONITORING WELL INSPECTION SHEET

Monitoring Well Inspection Sheet

Project Name: _____ Date: _____

Location: _____ Time: _____

Tidally Influenced: Y / N Personnel: _____

Field Measurements				
Well ID	PID Reading PPM	Depth to Water *	Total Depth *	Flush Mt./ Stick-up

Well Construction Details (Taken from construction logs)		
Total Depth *	Ground Elev.	Top/Btm Screen *

Check List:

Riser Pipe Material:
Riser Notched for Surveyors:
Well ID Tag In-place:
Well security:
Photo taken:

Condition of Well:

Protective Case:
Riser:
Well Pad:
Other:

Presence/Evidence of:

Standing Water Around Well:
Existing Sampling Equipment:
Sediment build-up in Well Btm:

Comments:

** = Measurements are from the top of the inner case to the nearest 0.01'*

ATTACHMENT B
GROUNDWATER LEVEL MESUREMENT SHEET

Tetra Tech NUS, Inc.

GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name: _____ **Project No.:** _____
Location: _____ **Personnel:** _____
Weather Conditions: _____ **Measuring Device:** _____
Tidally Influenced: Yes ____ No ____ **Remarks:** _____

Well or Piezometer Number	Date	Time	Elevation of Reference Point (feet)*	Water Level Indicator Reading (feet)*	Thickness of Free Product (feet)*	Comments

* All measurements to the nearest 0.01 foot, from surveyed mark (unless noted)

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1.0 PURPOSE

This procedure provides general guidance and information pertaining to proper monitoring well design, installation, and development.

2.0 SCOPE

This procedure is applicable to the construction of monitoring wells. The methods described herein may be modified by project-specific requirements for monitoring well construction. In addition, many regulatory agencies have specific regulations pertaining to monitoring well construction and permitting. These requirements must be determined during the project planning phases of the investigation, and any required permits must be obtained before field work begins. Innovative monitoring well installation techniques, which typically are not used, will be discussed only generally in this procedure.

3.0 GLOSSARY

Monitoring Well - A well which is screened, cased, and sealed which is capable of providing a groundwater level and groundwater sample representative of the zone being monitored. Some monitoring wells may be constructed as open boreholes.

Piezometer - A pipe or tube inserted into the water bearing zone, typically open to water flow at the bottom and to the atmosphere at the top, and used to measure water level elevations. Piezometers may range in size from 1/2-inch-diameter plastic tubes to well points or monitoring wells.

Potentiometric Surface - The surface representative of the level to which water will rise in a well cased to the screened aquifer.

Well Point (Drive Point) - A screened or perforated tube (Typically 1-1/4 or 2 inches in diameter) with a solid, conical, hardened point at one end, which is attached to a riser pipe and driven into the ground with a sledge hammer, drop weight, or mechanical vibrator. Well points may be used for groundwater injection and recovery, as piezometers (i.e., to measure water levels) or to provide groundwater samples for water quality data.

4.0 RESPONSIBILITIES

Driller - The driller provides adequate and operable equipment, sufficient quantities of materials, and an experienced and efficient labor force capable of performing all phases of proper monitoring well installation and construction. The driller may also be responsible for obtaining, in advance, any required permits for monitoring well installation and construction.

Field Geologist - The field geologist supervises and documents well installation and construction performed by the driller, and insures that well construction is adequate to provide representative groundwater data from the monitored interval. Geotechnical engineers, field technicians, or other suitable trained personnel may also serve in this capacity.

5.0 PROCEDURES

5.1 Equipment/Items Needed

Below is a list of items that may be needed when installing a monitoring well or piezometer:

- Health and safety equipment (hard hats, safety glasses, etc.) as required by the Site Safety Officer.
- Well drilling and installation equipment with associated materials (typically supplied by the driller).
- Hydrogeologic equipment (weighted engineer's tape, water level indicator, retractable engineers rule, electronic calculator, clipboard, mirror and flashlight - for observing downhole activities, paint and ink marker for marking monitoring wells, sample jars, well installation forms, and a field notebook).
- Drive point installation tools (sledge hammer, drop hammer, or mechanical vibrator; tripod, pipe wrenches, drive points, riser pipe, and end caps).

5.2 Well Design

The objectives and intended use for each monitoring well must be clearly defined before the monitoring system is designed. Within the monitoring system, different monitoring wells may serve different purposes and, therefore, require different types of construction. During all phases of the well design, attention must be given to clearly documenting the basis for design decisions, the details of well construction, and the materials used. The objectives for installing the monitoring wells may include:

- Determining groundwater flow directions and velocities.
- Sampling or monitoring for trace contaminants.
- Determining aquifer characteristics (e.g., hydraulic conductivity).

Siting of monitoring wells shall be performed after a preliminary estimation of the groundwater flow direction. In most cases, groundwater flow directions and potential well locations can be determined by an experienced hydrogeologist through the review of geologic data and the site terrain. In addition, data from production wells or other monitoring wells in the area may be used to determine the groundwater flow direction. If these methods cannot be used, piezometers, which are relatively inexpensive to install, may have to be installed in a preliminary investigative phase to determine groundwater flow direction.

5.2.1 Well Depth, Diameter, and Monitored Interval

The well depth, diameter, and monitored interval must be tailored to the specific monitoring needs of each investigation. Specification of these items generally depends on the purpose of the monitoring system and the characteristics of the hydrogeologic system being monitored. Wells of different depth, diameter, and monitored interval can be employed in the same groundwater monitoring system. For instance, varying the monitored interval in several wells, at the same location (cluster wells) can help to determine the vertical gradient and the depths at which contaminants are present. Conversely, a fully penetrating well is usually not used to quantify or vertically locate a contaminant plume, since groundwater samples collected in wells that are screened over the full thickness of the water-bearing zone will be representative of average conditions across the entire monitored interval. However, fully penetrating wells can be used to establish the existence of contamination in the water-bearing zone. The well diameter desired depends upon the hydraulic characteristics of the water-bearing zone, sampling requirements, drilling method and cost.

The decision concerning the monitored interval and well depth is based on the following (and possibly other) information:

- The vertical location of the contaminant source in relation to the water-bearing zone.
- The depth, thickness and uniformity of the water-bearing zone.
- The anticipated depth, thickness, and characteristics (e.g., density relative to water) of the contaminant plume.
- Fluctuation in groundwater levels (due to pumping, tidal influences, or natural recharge/discharge events).
- The presence and location of contaminants encountered during drilling.
- Whether the purpose of the installation is for determining existence or non-existence of contamination or if a particular stratigraphic zone is being investigated.
- The analysis of borehole geophysical logs.

In most situations where groundwater flow lines are horizontal, depending on the purpose of the well and the site conditions, monitored intervals are 20 feet or less. Shorter screen lengths (5 feet or less) are usually required where flow lines are not horizontal, (i.e., if the wells are to be used for accurate measurement of the potentiometric head at a specific point).

Many factors influence the diameter of a monitoring well. The diameter of the monitoring well depends on the application. In determining well diameter, the following needs must be considered:

- Adequate water volume for sampling.
- Drilling methodology.
- Type of sampling device to be used.
- Costs.

Standard monitoring well diameters are 2, 4, 6, or 8 inches. Drive points are typically 1-1/4 or 2 inches in diameter. For monitoring programs which require screened monitoring wells, either a 2-inch or 4-inch-diameter well is preferred. Typically, well diameters greater than 4 inches are used in monitoring programs in which open-hole bedrock monitoring wells are used. With smaller diameter wells, the volume of stagnant water in the well is minimized, and well construction costs are reduced; however, the sampling devices that can be used are limited.

In specifying well diameter, sampling requirements must be considered (up to a total of 4 gallons of water may be required for a single sample to account for full organic and inorganic analyses, and split samples), particularly if the monitored formation is known to be a low-yielding formation. The unit volume of water contained within a monitoring well is dependent on the well diameter as follows:

Casing Inside Diameter (Inch)	Standing Water Length to Obtain 1 Gallon Water (Feet)
2	6.13
4	1.53
6	0.68

If a well recharges quickly after purging, then well diameter may not be an important factor regarding sample volume requirements.

Pumping tests for determining aquifer characteristics may require larger diameter wells (for installation of high capacity pumps); however, in small-diameter wells in-situ permeability tests can be performed during drilling or after well installation is completed.

5.2.2 Riser Pipe and Screen Materials

Well materials are specified by diameter, type of material, and thickness of pipe. Well screens require an additional specification of slot size. Thickness of pipe is referred to as "Schedule" for polyvinyl chloride (PVC) casing and is usually Schedule 40 (thinner wall) or 80 (thicker wall). Steel pipe thickness is often referred to as "Strength". Standard Strength is usually adequate for monitoring well purposes. With larger diameter pipe, the wall thickness must be greater to maintain adequate strength. The required thickness is also dependent on the method of installation; risers for drive points require greater strength than wells installed inside drilled borings.

The selection of well screen and riser materials depends on the method of drilling, the type of subsurface materials the well penetrates, the type of contamination expected, and natural water quality and depth. Cost and the level of accuracy required are also important. The materials generally available are Teflon, stainless steel, PVC galvanized steel, and carbon steel. Each has advantages and limitations (see Attachment A of this guideline for an extensive presentation on this topic). The two most commonly used materials are PVC and stainless steel. Properties of these two materials are compared in Attachment B. Stainless steel is a good choice where trace metals or organic sampling is required; however, costs are high. Teflon materials are extremely expensive, but are relatively inert and provide the least opportunity for water contamination due to well materials. PVC has many advantages, including low cost, excellent availability, light weight, ease of manipulation, and widespread acceptance. The crushing strength of PVC may limit the depth of installation, but the use of Schedule 80 materials may overcome some of the problems associated with depth. However, the smaller inside diameter of Schedule 80 pipe may be an important factor when considering the size of bailers or pumps required for sampling or testing. Due to this problem, the minimum well pipe size recommended for Schedule 80 wells is 4-inch I.D.

Screens and risers may have to be decontaminated before use because oil-based preservatives and oil used during thread cutting and screen manufacturing may contaminate samples. Metal pipe may corrode and release metal ions or chemically react with organic constituents, but this is considered a minor issue. Galvanized steel is not recommended where samples may be collected for metals analyses, as zinc and cadmium levels in groundwater samples may become elevated from leaching of the zinc coating.

Threaded, flush-joint casing is most often preferred for monitoring well applications. PVC, Teflon, and steel can all be obtained with threaded joints. Welded-joint steel casing is also acceptable. Glued PVC may release organic contaminants into the well, and therefore, should not be used if the well is to be sampled for organic constituents.

When the water-bearing zone is in consolidated bedrock, such as limestone or fractured granite, a well screen is often not necessary (the well is simply an open hole in bedrock). Unconsolidated materials, such as sands, clay, and silts require a screen. A screen slot size of 0.010 or 0.020 inch is generally used when a screen is necessary, and the annular borehole space around the screened interval is artificially packed with an appropriately sized sand, selected based on formation grain size. The slot size controls the quantity of water entering the well and prevents entry of natural materials or sand pack. The screen shall pass no more than 10 percent of the pack material, or in-situ aquifer material. The site geologist shall specify the combination of screen slot size and sand pack which will be compatible with the water-bearing zone, to maximize groundwater inflow and minimize head losses and movement of fines into the wells. For example, as a standard procedure, a Morie No. 1 or No. 10 to No. 20 U.S. Standard Sieve size filter pack is typically appropriate for a 0.020-inch slot screen; however, a No. 20 to No. 40 U.S. Standard Sieve size filter pack is typically appropriate for a 0.010-inch slot screen.

5.2.3 Annular Materials

Materials placed in the annular space between the borehole and riser pipe and screen include a sand pack when necessary, a bentonite seal, and cement-bentonite grout. The sand pack is usually a medium- to coarse-grained poorly graded, silica sand and should relate to the grain size of the aquifer sediments. The quantity of sand placed in the annular space is dependent upon the length of the screened interval, but should always extend at least 1 foot above the top of the screen. At least 1 to 3 feet of bentonite pellets or equivalent shall be placed above the sand pack. Cement-bentonite grout (or equivalent) is then placed to extent from the top of the bentonite pellets to the ground surface.

On occasion, and with the concurrence of the involved regulatory agencies, monitoring wells may be packed naturally (i.e., no artificial sand pack installed). In this case, the natural formation material is allowed to collapse around the well screen after the well is installed. This method has been used where the formation material itself is a relatively uniform grain size, or when artificial sand packing is not possible due to borehole collapse.

Bentonite expands by absorbing water and provides a seal between the screened interval and the overlying portion of the annular space and formation. Cement-bentonite grout is placed on top of the bentonite pellets, extending to the surface. The grout effectively seals the remaining borehole annulus and eliminates the possibility for surface infiltration reaching the screened interval. Grouting also replaces material removed during drilling and prevents hole collapse and subsidence around the well. A tremie pipe should be used to introduce grout from the bottom upward, to prevent bridging, and to provide a better seal. In shallow boreholes that don't collapse, it may be more practical to pour the grout from the surface without a tremie pipe.

Grout is a general term which has several different connotations. For all practical purposes within the monitoring well installation industry, grout refers to the solidified material which is installed and occupies the annular space above the bentonite pellet seal. Grout, most of the time, is made up of one or two assemblages of material, (e.g., cement and/or bentonite). A cement-bentonite grout, which is the most common type of grout used in monitoring well completions, normally is a mixture of cement, bentonite, and water at a ratio of one 90-pound bag of Portland Type I cement, plus 3 to 5 pounds of granular or flake-type bentonite, and 6-7 gallons of water. A neat cement consists of one ninety-pound bag of Portland Type I cement and 6-7 gallons of water. A bentonite slurry (bentonite and water mixed to a thick but pumpable mixture) is sometimes used instead of grout for deep well installations where placement of bentonite pellets is difficult. Bentonite chips are also occasionally used for annular backfill in place of grout.

In certain cases, the borehole may be drilled to a depth greater than the anticipated well installation depth. For these cases, the well shall be backfilled to the desired depth with bentonite pellets/chips or sand. A short (1- to 2-foot) section of capped riser pipe sump is sometimes installed immediately below the screen, as a silt reservoir, when significant post-development silting is anticipated. This will ensure that the entire screen surface remains unobstructed.

5.2.4 Protective Casing

When the well is completed and grouted to the surface, a protective steel casing is typically placed over the top of the well. This casing generally has a hinged cap and can be locked to prevent vandalism. The protective casing has a larger diameter than the well and is set into the wet cement grout over the well upon completion. In addition, one hole is drilled just above the cement collar through the protective casing which acts as a weep hole for the flow of water which may enter the annulus during well development, purging, or sampling.

A protective casing which is level with the ground surface (flush-mounted) is used in roadway or parking lot applications where the top of a monitoring well must be below the pavement. The top of the riser pipe is placed 4 to 5 inches below the pavement, and a locking protective casing is cemented in place to 3 inches below the pavement. A large diameter, manhole-type protective collar is set into the wet cement around the well with the top set level with or slightly above the pavement. An appropriately-sized id is placed over the protective sleeve. The cement should be slightly mounded to direct pooled water away from the well head.

5.3 Monitoring Well Installation

Pertinent data regarding monitoring well installation shall be recorded on log sheets as depicted and discussed in SOP SA-6.3. Attachments to this referenced SOP illustrate terms and physical construction of various types of monitoring wells.

5.3.1 Monitoring Wells in Unconsolidated Sediments

After the borehole is drilled to the desired depth, well installation can begin. The procedure for well installation will partially be dictated by the stability of the formation in which the well is being placed. If the borehole collapses immediately after the drilling tools are withdrawn, then a temporary casing must be installed and well installation will proceed through the center of the temporary casing, and continue as the temporary casing is withdrawn from the borehole. In the case of hollow-stem auger drilling, the augers will act to stabilize the borehole during well installation.

Before the screen and riser pipe are lowered into the borehole, all pipe and screen sections should be measured with an engineer's rule to ensure proper placement. When measuring sections, the threads on one end of the pipe or screen must be excluded while measuring, since the pipe and screen sections are screwed flush together.

After the screen and riser pipe are lowered through the temporary casing, the sand pack can be installed. A weighted tape measure must be used during the installation procedure to carefully monitor installation progress. The sand is slowly poured into the annulus between the riser pipe and temporary casing, as the casing is withdrawn. Sand should always be kept within the temporary casing during withdrawal in order to ensure an adequate sand pack. However, if too much sand is within the temporary casing (greater than 1 foot above the bottom of the casing) bridging between the temporary casing and riser pipe may occur. Centralizers may be used at the geologist's discretion, one above and one below the screen, to assure enough annular space for sand pack placement.

After the sand pack is installed to the desired depth (at least 1 foot above the top of the screen), then the bentonite pellet seal (or equivalent), can be installed in the same manner as the sand pack. At least 1 to 3 feet of bentonite pellets should be installed above the sand pack. Pellets should be added slowly and their fall monitored closely to ensure that bridging does not occur.

The cement-bentonite grout is then mixed and tremied into the annulus as the temporary casing or augers are withdrawn. Finally, the protective casing can be installed as detailed in Section 5.2.4.

5.3.2 Confining Layer Monitoring Wells

When drilling and installing a well in a confined aquifer, proper well installation techniques must be applied to avoid cross contamination between aquifers. Under most conditions, this can be accomplished by installing double-cased wells. This is accomplished by drilling a large-diameter boring through the upper aquifer, 1 to 5 feet into the underlying confining layer, and setting and pressure grouting or tremie grouting a large-diameter casing into the confining layer. The grout material must fill the space between the native material and the outer casing. A smaller diameter boring is then continued through the confining layer for

installation of the monitoring well as detailed for overburden monitoring wells. Sufficient time (determined by the field geologist), must be allowed for setting of the grout prior to drilling through the confined layer.

5.3.3 Bedrock Monitoring Wells

When installing bedrock monitoring wells, a large diameter boring is drilled through the overburden and approximately 5 –10 feet into bedrock. A casing (typically steel) is installed and either pressure grouted or tremie grouted in place. After the grout has cured, a smaller diameter boring is continued into bedrock to the desired depth. If the boring does not collapse, the well can be left open, and a screen is not necessary. If the boring collapses, then a screen is required and can be installed as detailed for overburden monitoring wells. If a screen is to be used, then the casing which is installed through the overburden and into the bedrock does not require grouting and can be removed when the final well installation is completed.

5.3.4 Drive Points

Drive points can be installed with either a sledge hammer, drop hammer, or a mechanical vibrator. The screen section is threaded and tightened onto the riser pipe with pipe wrenches. The drive point is simply pounded into the subsurface to the desired depth. If a heavy drop hammer is used, then a tripod and pulley setup is required to lift the hammer. Drive points typically cannot be manually driven to depths exceeding 10 feet.

Direct push sampling/monitoring point installation methods, using a direct push rig or drilling rig, are described in SOP SA-2.5.

5.3.5 Innovative Monitoring Well Installation Techniques

Certain innovative sampling devices have proven advantageous. These devices are essentially screened samplers installed in a borehole with only small-diameter tubes extending to the surface. This reduces drilling costs, decreases the volume of stagnant water, and provides a sampling system that minimizes cross-contamination from sampling equipment. Four manufacturers of these samplers include Timco Manufacturing Company, Inc., of Prairie du Sac, Wisconsin, BARCAD Systems, Inc., of Concord, Massachusetts, Westbay Instruments Ltd. of Vancouver, British Columbia, Canada and the University of Waterloo at Waterloo, Ontario, Canada.. Each manufacturer offers various construction materials.

5.4 Well Development Methods

The purpose of well development is to stabilize and increase the permeability of the gravel pack around the well screen, and to restore the permeability of the formation which may have been reduced by drilling operations. Wells are typically developed until all fine material and drilling water is removed from the well. Sequential measurements of pH, conductivity, turbidity, and temperature taken during development may yield information (stabilized values) regarding whether sufficient development has been performed. The selection of the well development method shall be made by the field geologist and is based on the drilling methods, well construction and installation details, and the characteristics of the formation that the well is screened in. The primary methods of well development are summarized below. A more detailed discussion may be found in Driscoll (1986).

5.4.1 Overpumping and Backwashing

Wells may be developed by alternatively drawing the water level down at a high rate (by pumping or bailing) and then reversing the flow direction (backwashing) so that water is passing from the well into the formation. This back and forth movement of water through the well screen and gravel pack serves to

remove fines from the formation immediately adjacent to the well, while preventing bridging (wedging) of sand grains. Backwashing can be accomplished by several methods, including pouring water into the well and then bailing, starting and stopping a pump intermittently to change water levels, or forcing water into the well under pressure through a water-tight fitting ("rawhiding"). Care should be taken when backwashing not to apply too much pressure, which could damage or destroy the well screen.

5.4.2 Surging with a Surge Plunger

A surge plunger (also called a surge block) is approximately the same diameter as the well casing and is aggressively moved up and down within the well to agitate the water, causing it to move in and out of the screens. This movement of water pulls fine materials into the well, where they may be removed by any of several methods, and prevents bridging of sand particles in the gravel pack. There are two basic types of surge plungers; solid and valved surge plungers. In formations with low yields, a valved surge plunger may be preferred, as solid plungers tend to force water out of the well at a greater rate than it will flow back in. Valved plungers are designed to produce a greater inflow than outflow of water during surging.

5.4.3 Compressed Air

Compressed air can be used to develop a well by either of two methods: backwashing or surging. Backwashing is done by forcing water out through the screens, using increasing air pressure inside a sealed well, then releasing the pressurized air to allow the water to flow back into the well. Care should be taken when using this method so that the water level does not drop below the top of the screen, thus introducing air into the formation and reducing well yield. Surging, or the "open well" method, consists of alternately releasing large volumes of air suddenly into an open well below the water level to produce a strong surge by virtue of the resistance of water head, friction, and inertia. Pumping of the well is subsequently done using the air lift method.

5.4.4 High Velocity Jetting

In the high velocity jetting method, water is forced at high velocities from a plunger-type device and through the well screen to loosen fine particles from the sand pack and surrounding formation. The jetting tool is slowly rotated and raised and lowered along the length of the well screen to develop the entire screened area. Jetting using a hose lowered into the well may also be effective. The fines washed into the screen during this process can then be bailed or pumped from the well.

6.0 RECORDS

A critical part of monitoring well installation is recording of all significant details and events in the site logbook or field notebook. The geologist must record the exact depths of significant hydrogeological features, screen placement, gravel pack placement, and bentonite placement.

A Monitoring Well Sheet (see Attachments to SOP SA-6.3) shall be completed, ensuring the uniform recording of data for each installation and rapid identification of missing information. Well depth, length, materials of construction, length and openings of screen, length and type of riser, and depth and type of all backfill materials shall be recorded. Additional information shall include location, installation date, problems encountered, water levels before and after well installation, cross-reference to the geologic boring log, and methods used during the installation and development process. Documentation is very important to prevent problems involving questionable sample validity. Somewhat different information will need to be recorded, depending on whether the well is completed in overburden (single- or double-cased), as a cased well in bedrock, or as an open hole in bedrock.

The quantities of sand, bentonite, and grout placed in the well are also important. The geologist shall calculate the annular space volume and have an idea of the quantity of material needed to fill the annular

space. Volumes of backfill significantly higher than the calculated volume may indicate a problem such as a large cavity, while a smaller backfill volume may indicate a cave-in or bridging of the backfill materials. Any problems with rig operation or down-time shall be recorded and may affect the driller's final fee.

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ATTACHMENT A

RELATIVE COMPATIBILITY OF RIGID WELL CASING MATERIAL (PERCENT)

Potentially-Deteriorating Substance	Type of Casing Material						
	PVC 1	Galvanized Steel	Carbon Steel	Lo-carbon Steel	Stainless Steel 304	Stainless Steel 316	Teflon*
Buffered Weak Acid	100	56	51	59	97	100	100
Weak Acid	98	59	43	47	96	100	100
Mineral Acid/ High Solids Content	100	48	57	60	80	82	100
Aqueous/Organic Mixtures	64	69	73	73	98	100	100
Percent Overall Rating	91	58	56	59	93	96	100

Preliminary Ranking of Rigid Materials:

1 Teflon®
2 Stainless Steel 316
3. Stainless Steel 304
4 PVC 1
5 Lo-Carbon Steel
6 Galvanized Steel
7 Carbon Steel

* Trademark of DuPont

RELATIVE COMPATIBILITY OF SEMI-RIGID OR ELASTOMERIC MATERIALS (PERCENT)

Potentially-Deteriorating Substance	Type of Casing Material								
	PVC Flexible	PP	PE Conv.	PE Linear	PMM	Viton®*	Silicone	Neoprene	Teflon®*
Buffered Weak Acid	97	97	100	97	90	92	87	85	100
Weak Acid	92	90	94	96	78	78	75	75	100
Mineral Acid/ High Solids Content	100	100	100	100	95	100	78	82	100
Aqueous/Organic Mixtures	62	71	40	60	49	78	49	44	100
Percent Overall Rating	88	90	84	88	78	87	72	72	100

Preliminary Ranking of Semi-Rigid or Elastomeric Materials:

1 Teflon®
2 Polypropylene (PP)
3. PVC Flexible/PE Linear
4 Viton®
5 PE Conventional
6 Plexiglas/Lucite (PMM)
7 Silicone/Neoprene

* Trademark of DuPont

Source: Barcelona et al., 1983

ATTACHMENT B

COMPARISON OF STAINLESS STEEL AND PVC FOR MONITORING WELL CONSTRUCTION

Characteristic	Stainless Steel	PVC
Strength	Use in deep wells to prevent compression and closing of screen/riser.	Use when shear and compressive strength are not critical.
Weight	Relatively heavier.	Light-weight; floats in water.
Cost	Relatively expensive.	Relatively inexpensive.
Corrosivity	Deteriorates more rapidly in corrosive water.	Non-corrosive -- may deteriorate in presence of ketones, aromatics, alkyl sulfides, or some chlorinated hydrocarbons.
Ease of Use	Difficult to adjust size or length in the field.	Easy to handle and work with in the field.
Preparation for Use	Should be steam cleaned if organics will be subsequently sampled.	Never use glue fittings -- pipes should be threaded or pressure fitted. Should be steam cleaned when used for monitoring wells.
Interaction with Contaminants*	May sorb organic or inorganic substances when oxidized.	May sorb or release organic substances.

* See also Attachment A.

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUND WATER SAMPLES FROM MONITORING WELLS

July 30, 1996
Revision 2

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUND WATER SAMPLES FROM MONITORING WELLS

I. SCOPE & APPLICATION

This standard operating procedure (SOP) provides a general framework for collecting ground water samples that are indicative of mobile organic and inorganic loads at ambient flow conditions (both the dissolved fraction and the fraction associated with mobile particulates). The SOP emphasizes the need to minimize stress by low water-level drawdowns, and low pumping rates (usually less than 1 liter/min) in order to collect samples with minimal alterations to water chemistry. This SOP is aimed primarily at sampling monitoring wells that can accept a submersible pump and have a screen, or open interval length of 10 feet or less (this is the most common situation). However, this procedure is flexible and can be used in a variety of well construction and ground-water yield situations. Samples thus obtained are suitable for analyses of ground water contaminants (volatile and semi-volatile organic analytes, pesticides, PCBs, metals and other inorganics), or other naturally occurring analytes.

This procedure does not address the collection of samples from wells containing light or dense non-aqueous phase liquids (LNAPLs and DNAPLs). For this the reader may wish to check: Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation; C.K. Smoley (CRC Press), Boca Raton, Florida and U.S. Environmental Protection Agency, 1992, RCRA Ground-Water Monitoring: Draft Technical Guidance; Washington, DC (EPA/530-R-93-001).

The screen, or open interval of the monitoring well should be optimally located (both laterally and vertically) to intercept existing contaminant plume(s) or along flowpaths of potential contaminant releases. It is presumed that the analytes of interest move (or potentially move) primarily through the more permeable zones within the screen, or open interval.

Use of trademark names does not imply endorsement by U.S.EPA but is intended only to assist in identification of a specific type of device.

Proper well construction and development cannot be overemphasized, since the use of installation techniques that are appropriate to the hydrogeologic setting often prevents "problem well" situations from occurring. It is also recommended that as part of development or redevelopment the well should be tested to determine the appropriate pumping rate to obtain stabilization of field indicator parameters with minimal drawdown in shortest amount of time. With this information field crews can then conduct purging and sampling in a more expeditious manner.

The mid-point of the saturated screen length (which should not exceed 10 feet) is used by convention as the location of the pump intake. However, significant chemical or permeability contrast(s) within the screen may require additional field work to determine the optimum vertical location(s) for the intake, and appropriate pumping rate(s) for purging and sampling more localized target zone(s). Primary flow zones (high(er) permealability and/or high(er) chemical concentrations) should be identified in wells with screen lengths longer than 10 feet, or in wells with open boreholes in bedrock. Targeting these zones for water sampling will help insure that the low stress procedure will not underestimate contaminant concentrations. The Sampling and Analysis Plan must provide clear instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the remaining criteria in this procedure are met. If after 4 hours of purging indicator field parameters have not stabilized, one of 3 optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization) c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may not meet the sampling objectives).

Changes to this SOP should be proposed and discussed when the site Sampling and Analysis Plan is submitted for approval. Subsequent requests for modifications of an approved plan must include adequate technical justification for proposed changes. All changes and modifications must be approved before implementation in field.

II.EQUIPMENT

A. Extraction device

Adjustable rate, submersible pumps are preferred (for example, centrifugal or bladder pump constructed of stainless steel or

Teflon).

Adjustable rate, peristaltic pumps (suction) may be used with caution. Note that EPA guidance states: "Suction pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" (EPA/540/P-87/001, 1987, page 8.5-11).

The use of inertial pumps is discouraged. These devices frequently cause greater disturbance during purging and sampling and are less easily controlled than the pumps listed above. This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

B. Tubing

Teflon or Teflon lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for inorganics analyses. However, these materials should be used with caution when sampling for organics. If these materials are used, the equipment blank (which includes the tubing) data must show that these materials do not add contaminants to the sample.

Stainless steel tubing may be used when sampling for VOCs, SVOCs, pesticides, and PCBs. However, it should be used with caution when sampling for metals.

The use of 1/4 inch or 3/8 inch (inner diameter) tubing is preferred. This will help ensure the tubing remains liquid filled when operating at very low pumping rates.

Pharmaceutical grade (Pharmed) tubing should be used for the section around the rotor head of a peristaltic pump, to minimize gaseous diffusion.

C. Water level measuring device(s), capable of measuring to 0.01 foot accuracy (electronic “tape”, pressure transducer). Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level “tape” at the start and end of each record.

D. Flow measurement supplies (e.g., graduated cylinder and stop watch).

E. Interface probe, if needed.

F. Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate the samples.

G. Indicator field parameter monitoring instruments - pH, Eh, dissolved oxygen (DO), turbidity, specific conductance, and temperature. Use of a flow-through-cell is required when measuring all listed parameters, except turbidity. Standards to perform field calibration of instruments. Analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846. For Eh measurements, follow manufacturer's instructions.

H. Decontamination supplies (for example, non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.).

I. Logbook(s), and other forms (for example, well purging forms).

J. Sample Bottles.

K. Sample preservation supplies (as required by the analytical methods).

L. Sample tags or labels.

M. Well construction data, location map, field data from last sampling event.

N. Well keys.

O. Site specific Sample and Analysis Plan/Quality Assurance Project Plan.

P. PID or FID instrument (if appropriate) to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

III.PRELIMINARY SITE ACTIVITIES

Check well for security damage or evidence of tampering, record pertinent observations.

Lay out sheet of clean polyethylene for monitoring and sampling equipment.

Remove well cap and immediately measure VOCs at the rim of the well with a PID or FID instrument and record the reading in the field logbook.

If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook.

A synoptic water level measurement round should be performed (in the shortest possible time) before any purging and sampling activities begin. It is recommended that water level depth (to 0.01 ft.) and

total well depth (to 0.1 ft.) be measured the day before, in order to allow for re-settlement of any particulates in the water column. If measurement of total well depth is not made the day before, it should not be measured until after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe are usually not needed unless analytical data or field head space information signal a worsening situation. Note: procedures for collection of LNAPL and DNAPL samples are not addressed in this SOP.

IV.PURGING AND SAMPLING PROCEDURE

Sampling wells in order of increasing chemical concentrations (known or anticipated) is preferred.

1. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the midpoint of the zone to be sampled. The Sampling and Analysis Plan should specify the sampling depth, or provide criteria for selection of intake depth for each well (see Section I). If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well. Collection of turbid free water samples may be especially difficult if there is two feet or less of standing water in the well.

2. Measure Water Level

Before starting pump, measure water level. If recording pressure transducer is used-initialize starting condition.

3. Purge Well

3a. Initial Low Stress Sampling Event

Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs. Check water level. Adjust pump speed until there is little or no water level drawdown (less than 0.3 feet). If the minimal drawdown that can be achieved exceeds 0.3 feet but remains stable, continue purging until indicator field parameters stabilize.

Monitor and record water level and pumping rate every three to five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump (for example, 0.1 - 0.4 l/min) to ensure stabilization of indicator

parameters. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. Do not allow the water level to fall to the intake level (if the static water level is above the well screen, avoid lowering the water level into the screen). The final purge volume must be greater than the stabilized drawdown volume plus the extraction tubing volume.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (bladder, peristaltic), and/or the use of dedicated equipment. If the recharge rate of the well is lower than extraction rate capabilities of currently manufactured pumps and the well is essentially dewatered during purging, then the well should be sampled as soon as the water level has recovered sufficiently to collect the appropriate volume needed for all anticipated samples (ideally the intake should not be moved during this recovery period). Samples may then be collected even though the indicator field parameters have not stabilized.

3b. Subsequent Low Stress Sampling Events

After synoptic water level measurement round, check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). Perform purging operations as above.

4. Monitor Indicator Field Parameters

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, Eh, DO) every three to five minutes (or less frequently, if appropriate). Note: during the early phase of purging emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken at three (3) to five (5) minute intervals, are within the following limits:

turbidity (10% for values greater than 1 NTU),
DO (10%),
specific conductance (3%),
temperature (3%),
pH (± 0.1 unit),
ORP/Eh (± 10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values

measured within the cell and may also cause an underestimation of turbidity values measured after the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities.

The flow-through-cell must be designed in a way that prevents air bubble entrapment in the cell. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must be submerged in water at all times. If two flow-through-cells are used in series, the one containing the dissolved oxygen probe should come first (this parameter is most susceptible to error if air leaks into the system).

5. Collect Water Samples

Water samples for laboratory analyses must be collected before water has passed through the flow-through-cell (use a by-pass assembly or disconnect cell to obtain sample).

VOC samples should be collected first and directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

During purging and sampling, the tubing should remain filled with water so as to minimize possible changes in water chemistry upon contact with the atmosphere. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use one of the following procedures to collect samples: (1) add clamp, connector (Teflon or stainless steel) or valve to constrict sampling end of tubing; (2) insert small diameter Teflon tubing into water filled portion of pump tubing allowing the end to protrude beyond the end of the pump tubing, collect sample from small diameter tubing; (3) collect non-VOC samples first, then increase flow rate slightly until the water completely fills the tubing, collect sample and record new drawdown, flow rate and new indicator field parameter values.

Add preservative, as required by analytical methods, to samples immediately after they are collected if the sample containers are not pre-preserved. Check analytical methods (e.g. EPA SW-846, water supply, etc.) for additional information on preservation. Check pH for all samples requiring pH adjustment to assure proper pH value. For VOC samples, this will require that a test sample be collected during purging to determine the amount of preservative that needs to be added to the sample containers prior to sampling.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter is required, and the filter

size (0.45 um is commonly used) should be based on the sampling objective. Pre-rinse the filter with approximately 25 - 50 ml of ground water prior to sample collection. Preserve filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in ground water for human health risk calculations.

Label each sample as collected. Samples requiring cooling (volatile organics, cyanide, etc.) will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

6. Post Sampling Activities

If recording pressure transducer is used, remeasure water level with tape.

After collection of the samples, the pump tubing may either be dedicated to the well for resampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth is optional after the initial low stress sampling event. However, it is recommended if the well has a “silting” problem or if confirmation of well identity is needed.

Secure the well.

V. DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well and following sampling of each subsequent well. Pumps will not be removed between purging and sampling operations. The pump and tubing (including support cable and electrical wires which are in contact with the well) will be decontaminated by one of the procedures listed below.

Procedure 1

The decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump or the pump can be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and isopropyl alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Flush with isopropyl alcohol (pesticide grade). If equipment blank data from the previous sampling event show that the level of contaminants is insignificant, then this step may be skipped.

Flush with distilled/deionized water. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

VI. FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the ground water samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples shall be collected for each batch of samples (a batch may not exceed 20 samples). Trip blanks are required for the VOC samples at a frequency of one set per VOC sample cooler.

Field duplicate.

Matrix spike.

Matrix spike duplicate.

Equipment blank.

Trip blank (VOCs).

Temperature blank (one per sample cooler).

Equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank will only include the pump in subsequent sampling rounds.

Collect samples in order from wells with lowest contaminant concentration to highest concentration. Collect equipment blanks after sampling from contaminated wells and not after background wells.

Field duplicates are collected to determine precision of sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

If split samples are to be collected, collect split for each analyte group in consecutive order (VOC original, VOC split, etc.). Split sample should be as identical as possible to original sample.

All monitoring instrumentation shall be operated in accordance with EPA analytical methods and manufacturer's operating instructions. EPA analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846 with exception of Eh, for which the manufacturer's instructions are to be followed. Instruments shall be calibrated at the beginning of each day. If a measurement falls outside the calibration range, the instrument should be re-calibrated so that all measurements fall within the calibration range. At the end of each day, check calibration to verify that instruments remained in calibration. Temperature measuring equipment, thermometers and thermistors, need not be calibrated to the above frequency. They should be checked for accuracy prior to field use according to EPA Methods and the manufacturer's instructions.

VII.FIELD LOGBOOK

A field log shall be kept to document all ground water field monitoring activities (see attached example matrix), and record all of the following:

Well identification.

Well depth, and measurement technique.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and

detection method.

Pumping rate, drawdown, indicator parameters values, and clock time, at the appropriate time intervals; calculated or measured total volume pumped.

Well sampling sequence and time of each sample collection.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analysis.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling equipment used, including trade names, model number, diameters, material composition, etc.

VIII. DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, and whatever field logbook information is needed to allow for a full evaluation of data useability.

EXAMPLE (Minimum Requirements) Page____of____

Well PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Location (Site/Facility Name)_____ Depth to _____/_____ of screen
Well Number_____Date_____ (below MP) top bottom
Field Personnel_____ Pump Intake at (ft. below MP)_____
Sampling Organization_____ Purging Device; (pump type)_____
Identify MP_____

Clock Time 24 HR	Water Depth below MP ft	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. °C	Spec. Cond.[2] µS/cm	pH	ORP/ Eh[3] mv	DO mg/L	Turb-idity NTU	Comments

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. µSiemens per cm(same as µmhos/cm)at 25 °C.
3. Oxidation reduction potential (stand in for Eh).

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D LOW FLOW PURGE DATA SHEET 34

1.0 PURPOSE

This Standard Operating Procedure (SOP) describes the process to be used for purging groundwater monitoring wells prior to sampling, for collecting groundwater samples, and for measuring groundwater quality parameters.

2.0 SCOPE

This document provides information on proper sampling equipment, onsite water quality testing, safety measures to ensure the safety of the field technician(s), and techniques for groundwater sampling. All personnel are encouraged to review the information contained herein to facilitate planning of the field sampling effort. The techniques described shall be followed whenever applicable, noting that site-specific conditions or project-specific plans may require modifications to methodology.

3.0 GLOSSARY

Conductivity – Conductivity is a numerical expression of the ability of an aqueous solution to carry an electric current. This ability depends on the presence of ions and their total concentration, mobility, valence, and relative concentrations and on temperature. Conductivity is highly dependent on temperature and should be reported at a particular temperature, i.e., 20.2 microSiemens per centimeter (mS/cm) at 14°C.

Dissolved Oxygen (DO) – DO levels in natural and wastewater depend on the physical, chemical, and biochemical activities in the water sample.

Groundwater Sample – A quantity of water removed from the ground, usually via a monitoring well that may or may not be lined with a well casing.

Oxidation-Reduction Potential (ORP) - A measure of the activity ratio of oxidizing and reducing species as determined by the electromotive force developed by a noble metal electrode immersed in water, as referenced against a reference electrode. A reference electrode commonly used in the field is the silver/silver chloride electrode, which has a voltage offset of about 210 mV from the standard hydrogen electrode (SHE). To convert field ORP measurements to equivalent SHE values, approximately 210 mV must be added to the ORP values obtained using the silver/silver chloride electrode. The actual offset depends on the concentration of the potassium chloride (KCl) in the field reference electrode and the temperature. Offsets typically range from 199 (saturated KCl) to 205 (3.5 Molar KCl) to 222 mV (1 Molar KCl) at 25°C and are greater at lower temperatures.

pH - The negative logarithm (base 10) of the hydrogen ion activity. The hydrogen ion activity is related to the hydrogen ion concentration, and, in a relatively weak solution, the two are nearly equal. Thus, for all practical purposes, pH is a measure of the hydrogen ion concentration.

pH Paper - Indicator paper that turns different colors depending on the pH of the solution to which it is exposed. Comparison with color standards supplied by the manufacturer will then give an indication of the solution's pH.

Representativeness – A qualitative description of the degree to which an individual sample accurately reflects population characteristics or parameter variations at a sampling point. It is therefore an important characteristic not only of assessment and quantification of environmental threats posed by the site, but also for providing information for engineering design and construction. Proper sample location selection and proper sample collection methods are important to ensure that a truly representative sample has been collected.

Salinity – The measurement of dissolved salts in a given mass of solution. Note: most field meters determined salinity automatically from conductivity and temperature. The value will be displayed in either parts per thousand (ppt) or percent (e.g., 35 ppt equals 3.5 percent). The parts per thousand symbol ($^0/_{00}$) is not the same as the percent symbol (%).

Turbidity – Turbidity in water is caused by suspended matter such as clay, silt, and fine organic and inorganic matter. Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through the sample.

4.0 RESPONSIBILITIES AND PERSONNEL QUALIFICATIONS

Project Manager - The Project Manager is responsible for determining the sampling objectives, initial sampling locations, and field procedures used in the collection of groundwater samples. Additionally, in consultation with other project personnel (geologist, hydrogeologist, etc.), the Project Manager identifies sampling locations.

Site Safety Officer (SSO) - The SSO (or a qualified designee) is responsible for providing the technical support necessary to implement the project Health and Safety Plan (HASP). This includes but is not be limited to performing air quality monitoring during sampling, boring and excavation activities, and ensuring that workers and offsite (downwind) individuals are not exposed to hazardous levels of airborne contaminants. The SSO or SSO designee may also be required to advise the FOL on other safety-related matters regarding sampling, such as mitigative measures to address potential hazards from hazardous objects or conditions.

Project Geologist/Sampler - The project geologist/sampler is responsible for the proper acquisition of samples in accordance with this SOP or other project-specific documents. In addition, this individual is responsible for the completion of all required paperwork (e.g., sample log sheets, field notebook, boring logs, container labels, custody seals, and chain-of-custody forms) associated with the collection of those samples.

Project Hydrogeologist – This individual is responsible for selecting and detailing the specific groundwater sampling techniques, onsite water quality testing (type, frequency, and location), equipment to be used, and providing detailed input in this regard to the project planning documents. The project hydrogeologist is also responsible for properly briefing and overseeing the performance of site sampling personnel.

Field Operations Leader (FOL) – This individual is primarily responsible for the execution of the planning document containing the Sampling and Analysis Plan (SAP). This is accomplished through management of a field sampling team for the proper acquisition of samples. He or she is responsible for the supervision of onsite analyses; ensuring proper instrument calibration, care, and maintenance; sample collection and handling; the completion and accuracy of all field documentation; and making sure that custody of all samples obtained is maintained according to proper procedures. When appropriate and as directed by the FOL, such responsibilities may be performed by other qualified personnel (e.g., field technicians) where credentials and time permit. The FOL is ultimately responsible for adherence to Occupational Safety and Health Administration (OSHA) regulations during these operations through self acquisition or through the management of a field team of samplers.
General personnel qualifications for groundwater sample collection and onsite water quality testing include the following:

- Occupational Safety and Health Administration (OSHA) 40-hour and applicable refresher training.
- Capability of performing field work under the expected physical and environmental (i.e., weather) conditions.

- Familiarity with appropriate procedures for sample documentation, handling, packaging, and shipping.

5.0 HEALTH AND SAFETY

Specific safety and health precautions are identified throughout this SOP. In addition to those precautions, the following general hazards may be incurred during sampling activities:

- Knee injuries from kneeling on hard surfaces
- Slips, trips, and falls
- Cuts and lacerations
- Traffic hazards associated with sampling in parking areas and roadways and along highways.

Methods of avoiding these hazards are provided below.

Knee injuries – Many monitoring wells are installed as flush mounts. Personnel are required to kneel to open these wells and to take groundwater level measurements, etc. This could result in knee injuries from kneeling on stones/foreign objects and general damage due to stress on the joints. To combat this hazard:

- Clear any foreign objects from the work area.
- Wear hard-sided knee pads.

Slips, Trips, and Falls – These hazards exist while traversing varying terrains carrying equipment to sample wells. To minimize these hazards:

- Pre-survey well locations. Eliminate, barricade, or otherwise mark physical hazards leading to the locations.
- Carry small loads that do not restrict the field of vision.
- Travel the safest and clearest route (not necessarily the shortest).

Cuts and Lacerations – To prevent cuts and lacerations associated with groundwater sampling, the following provisions are required:

- Always cut away from yourself and others when cutting tubing or rope. This will prevent injury to yourself and others if the knife slips.
- Do not place items to be cut in your hand or on your knee.
- Change blades as necessary to maintain a sharp cutting edge. Many accidents result from struggling with dull cutting attachments.
- Whenever practical, wear cut-resistant gloves (e.g., leather or heavy cotton work gloves) at least on the hand not using the knife.
- Keep cutting surfaces clean and smooth.
- Secure items to be cut -- do not hold them against the opposing hand, a leg, or other body part.

- When transporting glassware, keep it in a hard-sided container such as a cooler so that if there is a fall, you will be less likely to get cut by broken glass.

- DO NOT throw broken glass or glass ampoules into garbage bags. Place broken glass and glass ampoules in hard-sided containers such as a cardboard box or directly into a dumpster. DO NOT reach into garbage bags to retrieve any item accidentally thrown away. Empty the contents onto a flat surface to avoid punctures and lacerations from reaching where you cannot see.

Vehicular and Foot Traffic Hazards – When sampling along the roadway or near traffic patterns, follow the following precautions:

- Motorists may be distracted by onsite activities – ASSUME THEY DO NOT SEE YOU OR MEMBERS OF YOUR FIELD CREW.

- DO NOT place obstructions (such as vehicles) along the sides of the road that may cause site personnel to move into the flow of traffic to avoid your activities or equipment or that will create a blind spot.

- **Provide a required free space of travel**. Maintain at least 6 feet of space between you and moving traffic. Where this is not possible, use flaggers and/or signs to warn oncoming traffic of activities near or within the travel lanes.

- Face Traffic. Whenever feasible, if you must move within the 6 feet of the required free space or into traffic, attempt to face moving traffic at all times. Always leave yourself an escape route.

- Wear high-visibility vests to increase visual recognition by motorists.

- Do not rely on the vehicle operator's visibility, judgment, or ability. Make eye contact with the driver. Carefully and deliberately use hand signals so they will not startle or confuse motorists or be mistaken for a flagger's direction before moving into traffic.

- Your movements may startle a motorist and cause an accident, so move deliberately. Do not make sudden movements that might confuse a motorist.

6.0 PROCEDURES

6.1 General

For information derived from a groundwater sample to be useful and accurate, the sample must be representative of the particular zone being sampled. The physical, chemical, and bacteriological integrity of the sample must be maintained from the time of sampling to the time of analysis to keep any changes in water quality parameters to a minimum.

CAUTION

A closed well may generate and accumulate gases due to biological degradation, evolution of volatile chemicals from groundwater into the air, or other chemical actions. These gases may also be artificially generated, such as in the case of air sparging or extraction wells, which may take several days to depressurize. See Section 6.6.2 for safety measures to be employed to protect sampling personnel.

Methods for withdrawing samples from completed wells include the use of pumps, compressed air or nitrogen, bailers, and various types of samplers. The primary considerations in obtaining a representative sample of groundwater are to avoid collection of stagnant (standing) water in the well and to avoid physical or chemical alteration of the water sample due to external influences of the sampling technique(s). In a non-pumping well, there will be little or no vertical mixing of water in the well pipe or casing, and stratification will occur. The well water in the screened section will mix with groundwater due to normal flow patterns, but the well water above the screened section will remain isolated and become stagnant. Concentration gradients resulting from mixing and dispersion processes, layers of variable geologic permeability, and the presence of separate-phase product (e.g., floating hydrocarbons) may cause stratification. Excessive pumping or improper sampling methods can dilute or increase contaminant concentrations in the collected sample compared to what is representative of the integrated water column as it naturally occurs at that point, resulting in the collection of a non-representative sample. To safeguard against collecting non-representative samples, the following approach shall be followed prior to sample acquisition:

CAUTION

Mechanical agitation of well water may cause off-gas generation of volatile contaminants, creating an inhalation exposure to the sampler(s). Where avoiding an inhalation exposure is not possible and mechanical agitation is possible, pump into closed-top containers to control potential air emissions.

1. If possible, position yourself (and the sampling equipment) upwind of the well head.

2. Purge the monitoring well to be sampled prior to obtaining any samples from it. Evacuation of three to five well volumes is recommended prior to sampling, unless low-flow purging and sampling methods are utilized as described in Section 6.7 (Consult the site-specific SAP for exact purging parameters). In a high-yielding groundwater formation and where there is no stagnant water in the well above the screened section, extensive evacuation prior to sample withdrawal is not as critical as it is in a low-yielding well or in wells containing stagnant water.

3. For wells with low yields that are purged dry during sampling, evacuate the well and allow it to recover to 75 percent of full capacity prior to sample acquisition. If the recovery rate is fairly rapid (generally 300 mL per minute or greater), attempt to continue evacuation until the number of well volumes specified in the SAP is achieved. If this cannot be accomplished, allow recovery to 75 percent of capacity and begin sampling.

CAUTION

For moderate to high-yielding monitoring wells, an evacuation rate that does not cause excessive turbulence in the well should be selected. There is no absolute safeguard against contaminating the sample with stagnant water; hence, special techniques are required for purging to minimize the potential for sample contamination (see below).

4. For moderate to high-yielding monitoring wells, use one of the following purge techniques:

   - Place a submersible pump or the intake line of a surface pump or bailer just below the water surface when removing the stagnant water.

   - While purging and as the water level decreases, lower the pump or intake line as the water level drops in the well. Three to five volumes of water shall be removed to provide reasonable assurance that all stagnant water has been evacuated. After this is accomplished, a bailer or other approved device may be used to collect the sample for analysis.

- Unless otherwise directed, place the intake line of the sampling pump (or the submersible pump itself) near the center of the screened section, and pump approximately one casing volume of water from the well at a low purge rate equal to the well's recovery rate (low-flow sampling).

6.2 Sampling, Monitoring, and Evacuation Equipment

Sample containers shall conform to the guidelines in SOP SA-6.1.

The following equipment shall be on hand when sampling groundwater wells (reference SOPs SA-6.1 and SA-7.1):

- Sample packaging and shipping equipment – Coolers for sample shipping and cooling, chemical preservatives, appropriate sampling containers and filler materials, ice, labels, and chain-of-custody documents.
- Field tools and instrumentation
  - Multi-parameter water quality meter with an in-line sample chamber capable of measuring ORP, pH, temperature, DO, specific conductance, turbidity, and salinity, or individual meters (as applicable)
  - pH Paper
  - Camera and film (if appropriate)
  - Appropriate keys (for locked wells)
  - Water level indicator and/or oil-water interface probe if separate-phase product is expected
- Pumps
  - Shallow-well pumps: Centrifugal, bladder, suction, or peristaltic pumps with drop lines and air-lift apparatus (compressor and tubing) where applicable.
  - Deep-well pumps: Submersible pump and electrical power-generating unit, or bladder pumps where applicable.
- Other sampling equipment – Bailers, graduated cylinder, stopwatch, and inert line with tripod-pulley assembly (if necessary).
- Pails – Plastic, graduated.
- Clean paper or cotton towels for cleaning equipment.
- Buckets with lids for collecting purge water.
- Decontamination solutions – Deionized water, potable water, phosphate-free laboratory-grade detergent, and analytical-grade solvent (e.g., pesticide-grade isopropanol), as required.

Ideally, sample withdrawal equipment shall be completely inert, economical, easily cleaned, cleaned prior to use, reusable, able to operate at remote sites in the absence of power sources, and capable of delivering variable rates for well purging and sample collection.

6.3 Calculations of Well Volume

To ensure that the proper volume of water has been removed from the well prior to sampling, it is first necessary to know the volume of standing water in the well pipe (including well screen where applicable). This volume can be easily calculated by the following method. Calculations shall be entered in the site logbook or field notebook or on a sample log sheet form or equivalent electronic form(s) (see SOP SA-6.3):

1. Obtain all available information on well construction (location, casing, screen, etc.).

2. Determine well or inner casing diameter.

3. Measure and record static water level (depth below ground level or top of casing reference point).

4. Determine depth of well by sounding using a clean, decontaminated, weighted tape measure or water level indicator.

5. Calculate number of linear feet of static water (total depth or length of well pipe minus the depth to static water level).

6. Calculate one static well volume in gallons $V = (0.163)(T)(r^2)$

   where: V = Static volume of well in gallons.
   T = Linear feet of water in the well.
   r = Inside radius of well casing in inches.
   0.163 = Conversion factor (compensates for conversion of casing radius from inches to feet and cubic feet to gallons and pi.

7. Per evacuation volumes discussed above, determine the minimum amount to be evacuated before sampling.

Measuring devices may become contaminated when gathering the above information if they are submerged in contaminated water. Decontamination of the tape or water level indicator must be conducted between measurements in different wells as follows:

1. Saturate a paper towel or clean cotton towel with deionized water.

2. As the measuring device is extracted, wipe the tape, changing the cleaning surface frequently.

3. After it is extracted, rinse the probe or tape using a spray bottle of deionized water over a bucket or similar collection container.

Based on the contaminant (oily, etc), it may be necessary to use a soap and water wash and rinse to remove contaminants. Isopropanol can be used on the probe/tape. However, it is recommended that the use of solvents on the tape be minimized because they could degrade the protective covering or possibly remove the scale designations. If isopropanol (or some other solvent) is used, assure that the manufacturer/supplier Material Safety Data Sheet (MSDS) is obtained, kept on site at a readily available location with other MSDSs, and reviewed by personnel prior to the first usage of the solvent. Also, add the substance to the site-specific Hazardous Chemical Inventory list (see Section 5 of the TtNUS Health and Safety Guidance Manual [HSGM], Hazard Communication Program and OSHA Standard 29 CFR 1910.1200).

6.4 Evacuation of Static Water – Purging

6.4.1 General

The amount to be purged from each well will be determined prior to sample collection. This amount will depend on the intent of the monitoring program and the hydrogeologic conditions. Programs to determine overall quality of water resources may require long pumping periods to obtain a sample that is representative of a large volume of the aquifer. The pumped volume may be specified prior to sampling so that the sample can be a composite of a known volume of the aquifer. Alternately, the well can be pumped until parameters such as temperature, specific conductance, pH, and turbidity (as applicable) have stabilized. Onsite measurements of these parameters shall be recorded in the site logbook or field notebook or on standardized data sheets or an equivalent electronic form(s).

6.4.2 Evacuation Devices

The following discussion is limited to those devices commonly used at hazardous waste sites. Attachment A provides guidance on the proper evacuation device to use for given sampling situations. All of these techniques involve equipment that is portable and readily available.

Bailers

Bailers are the simplest evacuation devices used and have many advantages. They generally consist of a length of tubing equipped with a base plate and ball check-valve at the bottom. Bailers are comprised of stainless steel and plastic. They come in a variety of sizes, but the two most often used are 2 inches and 4 inches in diameter. An inert non-absorbent line such as polyethylene rope is used to lower and then raise the bailer to retrieve the sample. As the bailer is lowered into the water column, the ball is pushed up allowing the tube to be filled. When the bailer is pulled upward, the ball seats in the base plate preventing water from escaping.

Advantages of bailers include the following:

- There are few limitations on size and materials used.
- No external power source is needed.
- Bailers are inexpensive and can be dedicated and hung in a well to reduce the chances of cross-contamination.
- Bailers are relatively easy to decontaminate.

Limitations on the use of bailers include the following:

- It is time consuming to remove stagnant water using a bailer.
- Splashing the bailer into the water or transfer of sample may cause aeration.
- The use of a bailer does not permit constant in-line monitoring of groundwater parameters.
- Use of bailers is physically demanding, especially in warm temperatures at personal protection equipment (PPE) levels above Level D.

Safety concerns using a bailer include the following:

- Muscle stress and strain, especially when using 4-inch bailers and when pulling from excessively deep wells.
- Entanglement, possible hand/finger injuries, and rope burns during a sudden release of the bailer back down the well.
- Direct contact with contaminants of concern and sample preservatives when discharging the bailer contents because there is not a high level of control during a direct pour, and splashing and indirect contact with contaminants/preservatives could occur.

Control measures for these hazards are provided in Section 6.6.2.

Suction Pumps

There are many different types of inexpensive suction pumps including centrifugal, diaphragm, and peristaltic pumps. Centrifugal and diaphragm pumps can be used for well evacuation at a fast pumping rate and for sampling at a low pumping rate. The peristaltic pump is a low-volume pump that uses rollers to squeeze flexible tubing to create suction. This tubing can be dedicated to a well to prevent cross-contamination from well to well. Suction pumps are all portable, inexpensive, and readily available. However, because they are based on suction, their use is restricted to areas with water levels within 20 to 25 feet of the ground surface. A significant limitation is that the vacuum created by these pumps can cause loss of dissolved gases and volatile organics. Another limitation of these pumps is that they require a secondary energy source to drive them. Electrically driven pumps may require portable generators as energy sources. Air diaphragm pumps require air compressors and/or compressed gas cylinders to drive them. The advantage of the peristaltic pump is that it will operate from a portable battery source. Safety measures associated with these pumps are provided below.

Air-Lift and Gas-Lift Samplers

This group of pump samplers uses gas pressure either in the annulus of the well or in a venturi to force groundwater up a sampling tube. These pumps are also relatively inexpensive. Air- or gas-lift samplers are more suitable for well development than for sampling because the samples may be aerated as a result of pump action. Aeration can cause pH changes and subsequent trace metal precipitation or loss of volatile organics.

Submersible Pumps

Submersible pumps take in water and push the sample up a sample tube to the surface. The power sources for these samplers may be compressed gas or electricity. Operation principles vary, and displacement of the sample can be by an inflatable bladder, sliding piston, gas bubble, or impeller. Pumps are available for 2-inch-diameter wells and larger. These pumps can lift water from considerable depths (several hundred feet).

Limitations of this class of pumps include the following:

- They may have low delivery rates.
- Many models are expensive.

- Compressed gas or electric power is needed.
- Sediment in water may cause clogging of the valves or eroding of the impellers with some of these pumps.
- Decontamination of internal components can be difficult and time consuming.

Compressed Gases

Safety concerns using compressed gases as an energy source in these pumps are numerous. The nitrogen gas or compressed air is provided in a compressed gas cylinder at a pressure of approximately 2,000 psi. If damaged, these cylinders can become dangerous projectiles. Additionally, a sudden release of a cylinder's contents can involve considerable force that could cause significant damage to the eyes and/or skin. Protective measures include the following:

- Always wear safety impact glasses when handling compressed gases.
- Always administer compressed gases through an appropriate pressure-reducing regulator.
- When clearing the cylinder connection port, open the cylinder valve only enough to clear foreign debris. During this process, always position the cylinder valve so that it faces away from you and others.
- If the cylinder is designed to accept a valve protection cap, always keep that protection cap in place, except the cylinder is connected for use.
- When using the cylinder, lay the cylinder on its side to avoid the potential of it falling and knocking the valve off (and becoming a missile).
- DO NOT use the compressed nitrogen or air to clean clothing or to spray off the skin. Small cuts in the protective layer of the skin may permit the gas to enter into the bloodstream, presenting the potential danger of an embolism.

See the project-specific HASP for additional direction concerning cylinder safe handling procedures pertaining to the safe handling, transportation, and storage of compressed gas cylinders.

Electrical Shock

Even in situations where portable batteries are used, the potential for electrical shock exists. This potential risk is increased in groundwater sampling activities because of the presence of groundwater near the batteries. This potential is also increased in (prohibited) situations where jury-rigging of electrical connections is performed. Other potential hazards occur when field samplers open the hood of a running car to access the battery as a power source. To control these hazards:

- If you are unfamiliar with electrical devices, do not experiment, get help, and get the proper equipment necessary to power your device.
- Use the proper portable power inverters for cigarette lighter connections to minimize the need to access the battery under the hood of your vehicle.
- Use of electrical generators may pose a number of hazards including noise, those associated with fueling, and indirect sample influence.

To minimize or eliminate electrical generator hazards:

- Inspect the generator before use. Ensure that the generator and any extension cords are rated for the intended operation and have a Ground Fault Circuit Interrupter (GFCI) in line to control potential electrical shock.
- Fuel the generator before purging and sampling to avoid loss of power during sampling.
- Fuel engines only when they are turned OFF and have cooled sufficiently to prevent a fire hazard.
- Place the generator and any fuel source at least 50 feet from the well to be sampled to avoid indirect influence to the sample from fuel vapors or emission gases.

Lifting Hazards

This hazard may be experienced when moving containers of purge water, equipment, cylinders, etc. To control these potential hazards:

- Do not fill purge buckets to more than 80 percent of their capacity.
- Obtain a gas cylinder of sufficient size to complete the designated task but not too large to handle. K-size cylinders weigh approximately 135 pounds and are difficult to handle. M-size cylinders weigh approximately 50 pounds and are easier to handle and move.
- When necessary, get help lifting and moving gas cylinders and other heavy objects. Minimize twisting and turning while lifting. If it is necessary to move these cylinders or generators over significant distance, use mechanical means (carts, etc.).
- Use proper lifting techniques as described in Section 4.4 of the HSGM.

6.5 Onsite Water Quality Testing

This section describes the procedures and equipment required to measure the following parameters of an aqueous sample in the field:

- pH
- Specific conductance
- Temperature
- DO
- ORP
- Turbidity
- Salinity

This section is applicable for use in an onsite groundwater quality monitoring program to be conducted at a hazardous or nonhazardous waste site. The procedures and equipment described are applicable to groundwater samples and are not, in general, subject to solution interferences from color, turbidity, or colloidal material or other suspended matter.

This section provides general information for measuring the parameters listed above with instruments and techniques in common use. Because instruments from different manufacturers may vary, review of the manufacturer's literature pertaining to the use of a specific instrument is required before use. Most meters

used to measure field parameters require calibration on a daily basis. Refer to SOP SA-6.3 for an example equipment calibration log.

6.5.1 Measurement of pH

6.5.1.1 General

Measurement of pH is one of the most important and frequently used tests in water chemistry. Practically every phase of water supply and wastewater treatment such as acid-base neutralization, water softening, and corrosion control is pH dependent. Likewise, the pH of leachate can be correlated with other chemical analyses to determine the probable source of contamination. It is therefore important that reasonably accurate pH measurements be taken and recorded on the groundwater sample log sheet (Attachment B) or equivalent electronic form.

Two methods are given for pH measurement: the pH meter and pH indicator paper. Indicator paper is used when only an approximation of the pH is required or when pH meter readings need to be verified, and the pH meter is used when a more accurate measurement is needed. The response of a pH meter can be affected by high levels of colloidal or suspended solids, but the effect is generally of little significance. Consequently, specific methods to overcome this interference are not described. The response of pH paper is unaffected by solution interferences from color, turbidity, or colloidal or suspended materials unless extremely high levels capable of coating or masking the paper are encountered. In such cases, use of a pH meter is recommended.

6.5.1.2 Principles of Equipment Operation

Use of pH papers for pH measurement relies on a chemical reaction caused by the acidity or alkalinity of the solution created by the addition of the water sample reacting with the indicator compound on the paper. Various types of pH papers are available, including litmus (for general acidity or alkalinity determination) and specific, or narrower range, pH range paper.

Use of a pH meter relies on the same principle as other ion-specific electrodes. Measurement relies on establishment of a potential difference across a glass or other type of membrane in response to (in this instance, hydrogen) ion activity (which is usually similar to concentration) across that membrane. The membrane is conductive to ionic species and, in combination with a standard or reference electrode, a potential difference proportional to the ion concentration is generated and measured.

6.5.1.3 Equipment

The following equipment is to be used for obtaining pH measurements:

- A stand-alone portable pH meter or combination meter equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Combination electrode with polymer body to fit the above meter. Alternately, a pH electrode and a reference electrode can be used if the pH meter is equipped with suitable electrode inputs.
- Buffer solutions, as specified by the manufacturer. If the buffer solutions are considered hazardous per 29 Code of Federal Regulations (CFR) 1910.1200 (Hazard Communication) or the volumes used are greater than consumer commodity levels, the SSO shall obtain MSDSs from the manufacturer for the specific buffer solutions (see Section 4 of the HSGM regarding the Hazard Communication Program)

- pH indicator paper to cover the pH range 2 through 12.
- Manufacturer's operation manual. All personnel must be familiar with the equipment operation to ensure that the integrity of samples is preserved and that the equipment is operated safely.

6.5.1.4 Measurement Techniques for Field Determination of pH

pH Meter

The following procedure shall be used for measuring pH with a pH meter (meter standardization is according to manufacturer's instructions):

1. Inspect the instrument and batteries prior to initiation of the field effort.
2. Check the integrity of the buffer solutions used for field calibration. Buffer solutions need to be changed often as a result of degradation upon exposure to the atmosphere.
3. If applicable, make sure all electrolyte solutions within the electrode(s) are at their proper levels and that no air bubbles are present within the electrode(s).
4. Calibrate the meter and electrode(s) on a daily use basis (or as recommended by manufacturer) following manufacturer's instructions. Record calibration data on a water quality meter calibration log sheet (Attachment C) or equivalent electronic form.
5. Immerse the electrode(s) in the sample. Stabilization may take several seconds to minutes. If the pH continues to drift, the sample temperature may not be stable, a physical reaction (e.g., degassing) may be taking place in the sample, or the meter or electrode may be malfunctioning. The failure of the measurements to stabilize must be clearly noted in the logbook or equivalent electronic form.
6. Read and record the pH of the sample. pH shall be recorded to the nearest 0.01 pH standard unit. Also record the sample temperature (unless otherwise specified in the SAP, record temperatures to the nearest whole degree Fahrenheit or 0.5 degree Celsius).
7. Rinse the electrode(s) with deionized water.
8. Store the electrode(s) in an accordance with manufacturer's instructions when not in use.

Any visual observation of conditions that may interfere with pH measurement, such as oily materials or turbidity, shall be noted and avoided as much as possible.

pH Paper

Use of pH paper is very simple and requires no sample preparation, standardization, etc. pH paper is available in several ranges, including wide-range (indicating approximately pH 1 to 12), mid-range (approximately pH 0 to 6, 6 to 9, 8 to 14) and narrow-range (many available, with ranges as narrow as 1.5 pH units). The appropriate range of pH paper shall be selected. If the pH is unknown the investigation shall start with wide-range paper and proceed with successively narrower range paper until the sample pH is determined. To measure the pH with pH paper:

1. Collect a small portion of sample into a clean container.

2. Dip the pH paper into this small portion of sample.

3. Compare the color of the paper to the color chart that is provided with the pH paper and read the corresponding pH from the chart.

4. Record the pH value from the chart on the sampling log sheet.

5. Discard the used pH paper as trash.

6. Discard the small volume of sample that was used for the pH measurement with the other investigative derived waste.

6.5.2 Measurement of Specific Conductance

6.5.2.1 General

Conductance provides a measure of dissolved ionic species in water and can be used to identify the direction and extent of migration of contaminants in groundwater or surface water. It can also be used as a measure of subsurface biodegradation or to indicate alternate sources of groundwater contamination.

Conductivity is a numerical expression of the ability of a water sample to carry an electric current. This value depends on the total concentration of ionized substances dissolved in the water and the temperature at which the measurement is made. The mobility of each of the various dissolved ions, their valences, and their actual and relative concentrations affect conductivity.

It is important to obtain a specific conductance measurement soon after taking a sample because temperature changes, precipitation reactions, and absorption of carbon dioxide from the air all affect specific conductance. Most conductivity meters in use today display specific conductance in units of mS/cm, which is the conductivity normalized to a temperature of 25°C. These are the required units to be recorded on the groundwater sample log field form or equivalent electronic form.

6.5.2.2 Principles of Equipment Operation

An aqueous system containing ions will conduct an electric current. In a direct-current field, the positive ions migrate toward the negative electrode, and the negatively charged ions migrate toward the positive electrode. Most inorganic acids, bases, and salts such as hydrochloric acid, sodium carbonate, and sodium chloride, respectively, are relatively good conductors. Conversely, organic compounds such as sucrose or benzene, which do not dissociate in aqueous solution, conduct a current very poorly if at all.

A conductance cell and a Wheatstone Bridge (for the measurement of potential difference) may be used for measurement of electrical resistance. The ratio of current applied to voltage across the cell may also be used as a measure of conductance. The core element of the apparatus is the conductivity cell containing the solution of interest. Depending on the ionic strength of the aqueous solution to be tested, a potential difference is developed across the cell, which can be converted directly or indirectly (depending on instrument type) to a measurement of specific conductance.

6.5.2.3 Equipment

The following equipment is needed for taking specific conductance measurements:

- Stand-alone portable conductivity meter or combination meter equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Calibration solution, as specified by the manufacturer.
- Manufacturer's operation manual.

A variety of conductivity meters are available that may also be used to monitor salinity and temperature. Probe types and cable lengths vary, so equipment must be obtained to meet the specific requirements of the sampling program.

6.5.2.4 Measurement Techniques for Specific Conductance

The steps involved in taking specific conductance measurements are as follows (calibration shall be conducted according to manufacturer's instructions):

1. Check batteries and calibrate instrument before going into the field.
2. Calibrate on a daily use basis (or as recommended by manufacturer), according to the manufacturer's instructions and record all pertinent information on a water quality meter calibration log sheet or equivalent electronic form. Potassium chloride solutions with a specific conductance closest to the values expected in the field shall be used for calibration.
3. Rinse the cell with one or more portions of the sample to be tested or with deionized water and shake excess water from the cell.
4. Immerse the electrode in the sample and measure the conductivity.
5. Read and record the results in a field logbook or on a sample log sheet or equivalent electronic form.
6. Rinse the electrode with deionized water.

If the specific conductance measurements become erratic, recalibrate the instrument and see the manufacturer's instructions for troubleshooting assistance.

6.5.3 Measurement of Temperature

6.5.3.1 General

In combination with other parameters, temperature can be a useful indicator of the likelihood of biological action in a water sample. It can also be used to trace the flow direction of contaminated groundwater. Temperature measurements shall be taken in situ, or as quickly as possible in the field because collected water samples may rapidly equilibrate with the temperature of their surroundings.

6.5.3.2 Equipment

Temperature measurements may be taken with alcohol-toluene, mercury-filled, dial-type thermometers or combination meters equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22). In addition, various meters such as specific conductance or DO meters that have temperature measurement capabilities may also be used. Using such instrumentation along with suitable probes and cables, in-situ measurements of temperature at great depths can be performed.

6.5.3.3 Measurement Techniques for Water Temperature

If a thermometer is used to determine the temperature for a water sample, use the following procedure:

1. Immerse the thermometer in the sample until temperature equilibrium is obtained (1 to 3 minutes). To avoid the possibility of cross-contamination, the thermometer shall not be inserted into samples that will undergo subsequent chemical analysis.

2. Record values in a field logbook or on a sample log sheet or equivalent electronic form.

If a temperature meter or probe is used:

1. Calibrate the instrument according to manufacturer's recommendations prior to use.

2. Immerse the meter/probe in the sample until temperature equilibrium is obtained (1 to 3 minutes). To avoid the possibility of cross-contamination, the meter/probe shall not be inserted into samples that will undergo subsequent chemical analysis.

3. Record values in a field logbook or on a sample log sheet or equivalent electronic form.

6.5.4 Measurement of Dissolved Oxygen

6.5.4.1 General

DO levels in natural water and wastewater depend on the physical, chemical and biochemical activities in the water body. In addition, the growth of many aquatic organisms and the rate of corrosivity are dependent on DO concentrations. Thus, analysis for DO is a key test in water pollution and waste treatment process control. If at all possible, DO measurements shall be taken in situ because concentrations may show a large change in a short time if the sample is not adequately preserved.

The monitoring method discussed herein is limited to the use of DO meters. Chemical methods of analysis (i.e., Winkler methods) are available but require more equipment and greater sample manipulation. Furthermore, DO meters using a membrane electrode are suitable for highly polluted waters because the probe is completely submersible and is not susceptible to interference caused by color, turbidity, or colloidal material or suspended matter.

6.5.4.2 Principles of Equipment Operation

DO probes are normally electrochemical cells that have two solid metal electrodes of different nobility immersed in an electrolyte. The electrolyte is retained by an oxygen-permeable membrane. The metal of highest nobility (the cathode) is positioned at the membrane. When a suitable potential exists between

the two metals, reduction of oxygen to hydroxide ion (OH^-) occurs at the cathode surface. An electrical current is developed that is directly proportional to the rate of arrival of oxygen molecules at the cathode. This rate is proportional to the oxygen concentration in the water being measured.

Because the current produced in the probe is directly proportional to the rate of arrival of oxygen at the cathode, it is important that a fresh supply of sample always be in contact with the membrane. Otherwise, the oxygen in the aqueous layer along the membrane is quickly depleted and false low readings are obtained. It is therefore necessary to stir the sample (or the probe) constantly to maintain fresh solution near the membrane interface. Stirring, however, shall not be so vigorous that additional oxygen is introduced through the air-water interface at the sample surface. To avoid this possibility, some probes are equipped with stirrers to agitate the solution near the probe, leaving the surface of the solution undisturbed.

DO probes are relatively unaffected by interferences. Interferences that can occur are reactions with oxidizing gases such as chlorine or with gases such as hydrogen sulfide that are not easily depolarized from the indicating electrode. If a gaseous interference is suspected, it shall be noted in the field logbook and checked if possible. Temperature variations can also cause interference because probes exhibit temperature sensitivity. Automatic temperature compensation is normally provided by the manufacturer. This compensation can counteract some of the temperature effects but not all of them.

6.5.4.3 Equipment

The following equipment is needed to measure DO concentrations:

- A stand-alone portable DO meter or combination meter equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Sufficient cable to allow the probe to contact the sample.
- Manufacturer's operation manual.

6.5.4.4 Measurement Techniques for Dissolved Oxygen Determination

DO probes differ as to instructions for use. Follow the manufacturer's instructions to obtain an accurate reading. The following general steps shall be used to measure DO concentrations:

1. Check the DO meter batteries before going to the field.
2. Condition the probe in a water sample for as long a period as practical before use in the field. Long periods of dry storage followed by short periods of use in the field may result in inaccurate readings.
3. Calibrate the instrument in the field according to manufacturer's recommendations or in a freshly air-saturated water sample of known temperature.
4. Record all pertinent information on a water quality meter calibration log sheet or equivalent electronic form.
5. Rinse the probe with deionized water.
6. Immerse the probe in the sample. Be sure to provide for sufficient flow past the membrane by stirring the sample. Probes without stirrers placed in wells may be moved up and down to achieve the required mixing.

7. Record the DO content and temperature of the sample in a field logbook or on a sample log sheet or equivalent electronic form.

8. Rinse the probe with deionized water.

9. Recalibrate the probe when the membrane is replaced, or as needed. Follow the manufacturer's instructions.

Note that in-situ placement of the probe is preferable because sample handling is not involved. This however may not always be practical.

Special care shall be taken during sample collection to avoid turbulence that can lead to increased oxygen solubilization and positive test interferences.

6.5.5 Measurement of Oxidation-Reduction Potential

6.5.5.1 General

ORP provides a measure of the tendency of organic or inorganic chemicals to exist in an oxidized state. The ORP parameter therefore provides evidence of the likelihood of anaerobic degradation of biodegradable organics or the ratio of activities of reduced to oxidized species in the sample.

6.5.5.2 Principles of Equipment Operation

When an inert metal electrode, such as platinum, is immersed in a solution, a potential is developed at that electrode depending on the ions present in the solution. If a reference electrode is placed in the same solution, an ORP electrode pair is established. This electrode pair allows the potential difference between the two electrodes to be measured and is dependent on the concentration of the ions in solution. By this measurement, the ability to oxidize or reduce species in solution may be determined. Supplemental measurements, such as DO, may be correlated with ORP to provide knowledge of the quality of the solution, water, or wastewater.

6.5.5.3 Equipment

The following equipment is needed for measuring the ORP of a solution:

- A combination meter with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).
- Reference solution as specified by the manufacturer.
- Manufacturer's operation manual.

6.5.5.4 Measurement Techniques for Oxidation-Reduction Potential

The following procedure is used for measuring ORP:

1. Check the equipment using the manufacturer's recommended reference solution and check its batteries before going to the field.

2. Thoroughly rinse the electrode with deionized water.

3. If the probe does not respond properly to the recommended reference solution, verify the sensitivity of the electrodes by noting the change in millivolts when the pH of a test solution is altered. The ORP will increase when the pH of a test solution decreases, and the ORP will decrease when the test solution pH is increased. Place the sample in a clean container and agitate the sample. Insert the electrodes and note that the ORP drops sharply when the caustic is added (i.e., pH increases) thus indicating that the electrodes are sensitive and operating properly. If the ORP increases sharply when the caustic is added, the polarity is reversed and must be corrected in accordance with the manufacturer's instructions or the probe should be replaced.

4. Record all pertinent information on a water quality meter calibration log sheet or equivalent electronic form.

6.5.6 Measurement of Salinity

6.5.6.1 General

Salinity is a unitless property of industrial and natural waters. It is the measurement of dissolved salts in a given mass of solution. Most field meters determine salinity automatically from conductivity and temperature. The displayed value will be displayed in either parts per thousand (ppt) or percent (e.g., 35 ppt equals 3.5 percent).

6.5.6.2 Principles of Equipment Operation

Salinity is determined automatically from the meter's conductivity and temperature readings according to algorithms (such as are found in Standard Methods for the Examination of Water and Wastewater). Depending on the meter, the results are displayed in either ppt or percent. The salinity measurements are carried out in reference to the conductivity of standard seawater (corrected to salinity = 35 ppt).

6.5.6.3 Equipment

The following equipment is needed for salinity measurements:

- A multi-parameter water quality meter capable of measuring conductivity and temperature and converting them to salinity (e.g., Horiba U-22 or YSI 600 series).
- Calibration solution as specified by the manufacturer.
- Manufacturer's operation manual.

6.5.6.4 Measurement Techniques for Salinity

The steps involved in taking salinity measurements are as follows (standardization shall be conducted according to manufacturer's instructions):

1. Check the expiration date of the solutions used for field calibration and replace them if they are expired.

2. Check batteries and calibrate the meter before going into the field.

3. Calibrate on a daily use basis, according to the manufacturer's instructions and record all pertinent information on a water quality meter calibration log sheet or equivalent electronic form.

4. Rinse the cell with the sample to be tested. This is typically accomplished as the probe is placed in line during the collection of the purge water up to the time of sample acquisition.

5. Immerse the multi-probe in the sample and measure the salinity. Read and record the results in a field logbook or on a sample log sheet or equivalent electronic form.

6. Rinse the probes with deionized water.

6.5.7 Measurement of Turbidity

6.5.7.1 General

Turbidity is an expression of the optical property that causes light to be scattered and absorbed rather than transmitted in a straight line through the sample. Turbidity in water is caused by suspended matter such as clay, silt, or other finely divided organic and inorganic matter and microscopic organisms including plankton.

It is important to obtain a turbidity reading immediately after taking a sample because irreversible changes in turbidity may occur if the sample is stored too long.

6.5.7.2 Principles of Equipment Operation

Turbidity is measured by the Nephelometric Method, which is based on a comparison of the intensity of light scattered by the sample under defined conditions with the intensity of light scattered by a standard reference suspension under the same conditions. The higher the scattered light intensity, the higher the turbidity.

Formazin polymer is used as the reference turbidity standard suspension because of its ease of preparation combined with a higher reproducibility of its light-scattering properties than clay or turbid natural water. The turbidity of a specified concentration of formazin suspension is defined as 40 nephelometric units. This same suspension has an approximate turbidity of 40 Jackson units when measured on the candle turbidimeter. Therefore, nephelometric turbidity units (NTUs) based on the formazin preparation will approximate units derived from the candle turbidimeter but will not be identical to them.

6.5.7.3 Equipment

The following equipment is needed for turbidity measurements:

- A turbidity meter (e.g., LaMotte 2020) that calibrates easily using test cells with standards of 0.0, 1.0, and 10 NTUs, or a combination meter equipped with an in-line sample chamber (e.g., YSI 600 series and Horiba U-22).

- Calibration solution and sample tubes, as specified by the manufacturer.

- Manufacturer's operation manual.

6.5.7.4 Measurement Techniques for Turbidity

The steps involved in taking turbidity measurements utilizing an electrode (e) or light meter (l) are listed below (standardization shall be done according to manufacturer's instructions):

1. Check the expiration date of the solutions used for field calibration and replace them if they are expired.

2. Check batteries and calibrate the instrument before going into the field.

3. Calibrate on a daily basis according to the manufacturer's instructions, and record all pertinent information on a turbidity meter calibration log sheet (Attachment C) or equivalent electronic form.

4. When using the YSI and/or Horiba U-22, rinse the electrode with one or more portions of the sample to be tested or with deionized water.

5. When using the Lamotte 2020, fill the light meter's glass test cell with approximately 5 mL of sample, screw on the cap, wipe off glass to remove all residue that could intercept the instrument's light beam, place the test cell in the light meter, and close the lid.

6. Immerse the electrode in the sample and measure the turbidity.

7. The reading must be taken immediately because suspended solids will settle over time resulting in a lower, inaccurate turbidity reading.

8. Read and record the results in a field logbook or on a sample log sheet or equivalent electronic form. Include a physical description of the sample, including color, qualitative estimate of turbidity, etc.

9. Rinse the electrode or test cell with deionized water.

6.6 Sampling

6.6.1 Sampling Plan

The sampling approach consisting of the following shall be developed as part of the project planning documents approved prior to beginning work in the field:

- Background and objectives of sampling.

- Brief description of area and waste characterization.

- Identification of sampling locations, with map or sketch, and applicable well construction data (well size, depth, screened interval, reference elevation).

- Intended number, sequence, volumes, and types of samples. If the relative degree of contamination between wells is insignificant, a sampling sequence that facilitates sampling logistics may be followed. Where some wells are known or strongly suspected of being highly contaminated, these shall be sampled last to reduce the risk of cross-contamination between wells. In situations where the well is not well-characterized and the nature or extent of airborne contamination is unknown, it is recommended that head space analysis using a photoionization detector (PID) or flame ionization detector (FID) is performed to rate the wells, sampling from least contaminated to most contaminated.

Refer to the project-specific HASP for appropriate information and direction on air monitoring requirements.

- Sample preservation requirements.
- Work schedule.
- List of team members.
- List of observers and contacts.
- Other information, such as the necessity for a warrant or permission of entry, requirements for split samples, access problems, location of keys, etc.
- The FOL shall ensure that the sampling method(s) to be employed is accurately represented in the HASP, indicating the types of sampling to be employed and the hazards. If the methods are not accurately represented, the FOL should rectify this with the HASP author.
- The FOL shall ensure that sampling teams understand the sampling approach that they are to follow. Where sampling teams are made up of personnel from multiple locations, personal sampling experiences may vary. Therefore the FOL shall review project-specific requirements, SOPs, and protocol to be followed. The FOL will conduct periodic surveys to ensure that these methods are being completed per his/her direction.

6.6.2 Sampling Methods as Related to Low-Flow Sampling

The collection of a groundwater sample consists of the following steps:

1. Ensure the safety of the sample location. Take a few minutes to evaluate the area for physical hazards (trip hazards, uneven ground, overhanging branches, etc.) and natural hazards (snakes, bees, spiders, etc.) that may exist in the area or that may have constructed nests in the well head. Snakes often like to sun themselves on concrete well pads. Follow provisions in the project-specific HASP and/or HSGM for addressing natural hazards.

2. As indicated earlier, some monitoring wells have the potential to contain pressurized headspace (e.g., through the generation of gases form contaminated groundwater, due to biological processes, degradation of contaminants, or simply based on location such as near a landfill or in areas that intersect lithological abnormalities) or through intentional artificial means such as those associated with air sparging systems. Injection or extraction wells may be artificially pressurized and may remain so for several days after the system has been turned off. This presents a hazard to people opening these wells. The Field Sampling Technician shall employ the following practices to minimize these hazards:

   - Wear safety glasses to protect the eyes. If site-specific observations and conditions indicate that the wells may be pressurized, wear a full-face shield over the safety impact eye protection.
   - DO NOT place your face or any other part of your body over the well when opening because this may place you in a strike zone.
   - Open the well cover at arms length, then step away and allow the well to off gas and stabilize.

   Follow directions provided in the project-specific HASP, Work Plan and/or Sampling Plan pertaining to the use of volatile chemical detection equipment (PID or FID) within the breathing zone of the sampler

during sampling to determine the need to retreat from the work area and/or for the use of respiratory protection (as specified in the HASP).

3. When proper respiratory protection has been donned, sound the well for total depth and water level (using clean equipment) and record these data on a groundwater sampling log sheet or equivalent electronic form; then calculate the fluid volume in the well pipe (as previously described in this SOP). It is imperative that downhole equipment be adequately decontaminated between wells to prevent cross-contamination. Just as sampling occurs from the least contaminated to the most contaminated, it is also recommended that groundwater level measurements be taken in this manner.

4. Calculate volume of well water to be removed as described in Section 6.3.

5. Select the appropriate purging equipment (see Attachment A to this SOP) or as designated within your Work Plan/Sampling Plan. If an electric submersible pump with packer is chosen, go to Step 10.

6. Lower the purging equipment or intake into the well to a short distance below the water level or mid-screen as indicated in project-specific documentation and begin water removal. Remember that some contaminants are "bottom dwellers," and in these cases, project-specific direction may specify placing the intake just above (1 to 2 feet) the well bottom. Secure the pump intake at the well and secure the effluent at the collection container and begin pumping. The pumping rate will be determined based on the decrease in the water level (see Section 6.7) or as directed in your project-specific documents or this SOP. Purge water is generally collected in a 5-gallon bucket or similar open- or closed-top container. To minimize the potential for spills and back injuries, do not fill 5-gallon buckets beyond approximately 80 percent of their capacity. Dispose of purge water was as indicated in the planning document(s). Where necessary, slow the pumping rate or lower the pump intake as required to maintain submergence.

7. Estimate the approximate rate of discharge frequently and record it on the Low Flow Purge Data Sheet (see Attachment D). Estimate flow rate by noting the amount of discharge in a bucket or graduated cylinder per unit time using a watch with a second hand or a stopwatch.

8. Observe the peristaltic pump tubing intake for degassing "bubbles." If bubbles are abundant and the intake is fully submerged, this pump is not suitable for collecting samples for volatile organics.

9. Purge a minimum of three to five casing volumes before sampling (or as directed by the site-specific SAP). In low-permeability strata (i.e., if the well is pumped to dryness), one volume will suffice. Allow the well to recover to 75 percent of initial water level before sampling. Do not overfill purge containers because this increases the potential for spills and lifting injuries.

10. If sampling using a submersible pump, lower the pump intake to mid-screen (or the middle of the open section in uncased wells) and collect the sample. If sampling with a bailer, lower the bailer to just below the water surface.

11. For pump and packer assemblies only: Lower the assembly into the well so that the packer is positioned just above the screen or open section. Inflate the packer. Purge a volume equal to at least twice the screened interval (or unscreened open section volume below the packer) before sampling. Packers shall always be tested in a casing section above ground to determine proper inflation pressures for good sealing.

12. If the recovery time of the well is very slow (e.g., 24 hours or greater), sample collection can be delayed until the following day. If the well has been purged early in the morning, sufficient water may be standing in the well by the day's end to permit sample collection. If the well is incapable of producing a sufficient volume of sample at any time, take the largest quantity available and record this

occurrence in the site logbook or equivalent electronic form. When this occurs, contact the analytical laboratory to alert them that a reduced sample volume(s) will be submitted for analysis.

13. Fill sample containers and preserve and label them as described in SOP SA-6.1. Many sample bottles will contain preservative when they are shipped to the field. In those cases, do not add preservative.

14. Replace the well cap and lock it as appropriate. Make sure the well is readily identifiable as the source of the sample.

15. Process sample containers as described in SOP SA-6.1.

16. Decontaminate equipment as described in SOP SA-7.1.

6.7 Low-Flow Purging and Sampling

6.7.1 Scope and Application

Low-flow purging and sampling techniques may be required for groundwater sampling activities. The purpose of low-flow purging and sampling is to collect groundwater samples that contain "representative" amounts of mobile organic and inorganic constituents in the vicinity of the selected open well interval, at or near natural flow conditions. This minimum-stress procedure emphasizes negligible water level drawdown and low pumping rates to collect samples with minimal alterations in water chemistry. This procedure is designed primarily to be used in wells with a casing diameter of 1 inch or more and a saturated screen length, or open interval, of 10 feet or less. Samples obtained are suitable for analyses of common types of groundwater contaminants (volatile and semivolatile organic compounds, pesticides, polychlorinated biphenyls [PCBs], metals and other inorganic ions [cyanide, chloride, sulfate, etc.]). This low-flow procedure is not designed for collection of non-aqueous phase liquid samples from wells containing light or dense non-aqueous phase liquids (LNAPLs or DNAPLs).

This procedure is flexible for various well construction types and groundwater yields. The goal of the procedure is to obtain a turbidity level of less than 10 NTUs and to achieve a water level drawdown of less than 0.3 foot during purging and sampling. If these goals cannot be achieved, sample collection can take place provided that the remaining criteria in this procedure are met.

6.7.2 Equipment

The following equipment is required (as applicable) for low-flow purging and sampling:

- Adjustable rate submersible pump (e.g., centrifugal or bladder pump constructed of stainless steel or Teflon).

- Disposable clear plastic bottom-filling bailers to be used to check for and obtain samples of LNAPLs or DNAPLs.

- Tubing – Teflon, Teflon-lined polyethylene, polyethylene, polyvinyl chloride (PVC), Tygon, or stainless steel tubing can be used to collect samples for analysis, depending on the analyses to be performed and regulatory requirements.

- Water level measuring device with 0.01-foot accuracy (electronic devices are preferred for tracking water level drawdown during all pumping operations).

- Interface probe.
- Flow measurement supplies.
- Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at a safe distance from the well so that the exhaust fumes do not contaminate the samples.
- Indicator parameter monitoring instruments – pH, turbidity, specific conductance, and temperature. Use of a flow-through cell is recommended. Optional indicators - ORP, salinity, and DO. A flow-through cell (also referred to as an in-line sample chamber) is required.
- Standards to perform field calibration of instruments.
- Decontamination supplies.
- Logbook(s) and other forms (see Attachments B through D) or equivalent electronic form(s).
- Sample bottles.
- Sample preservation supplies (as required by the analytical methods).
- Sample tags and/or labels.
- Well construction data, location map, field data from last sampling event (if available).
- Field Sampling Plan.
- PID or FID instrument for measuring volatile organic compounds (VOCs) per the HASP.

6.7.3 Purging and Sampling Procedure

1. Open the monitoring well as stated earlier and step away. Prepare sampling equipment while allowing 3 to 5 minutes to allow the water level to reach equilibrium. In situations where VOCs are the primary contaminants of concern, air monitoring of the samplers' breathing zone areas may be required by the HASP (typically with a PID or FID).

2 Measure the water level immediately prior to placing the pump in the well and record the water level on the Low-Flow Purge Data Form or equivalent electronic form immediately prior to placing the pump or tubing into the well.

3. Lower the measuring device further into the well to collect the total depth measurement. Again wait 3 to 5 minutes to allow the well to equilibrate to the initial water level prior to placing the pump or pump intake in the well.

4. Record the total well depth on the Low-Flow Purge Data Form or equivalent electronic form immediately prior to placing the pump or tubing into the well

5. Lower the pump or tubing slowly into the well so that the pump intake is located at the center of the saturated screen length of the well. If possible, keep the pump intake at least 2 feet above the bottom of the well to minimize mobilization of sediment that may be present in the bottom of the well. Collection of turbidity-free water samples may be difficult if there is 3 feet or less of standing water in the well.

6. Start with the initial pump rate set at approximately 0.1 liter per minute. Use a graduated cylinder and stopwatch to measure the pumping rate. Adjust the pumping rates as necessary to prevent drawdown from exceeding 0.3 foot during purging. If no drawdown is noted, the pump rate may be increased (to a maximum of 0.4 liter per minute) to expedite the purging and sampling event. The pump rate will be reduced if turbidity is greater than 10 NTUs after all other field parameters have stabilized. If groundwater is drawn down below the top of the well screen, purging shall cease or the well shall be pumped to dryness and then allowed to recover before purging continues. Well recovery to 75 percent is necessary prior to sampling. Slow-recovering wells should be identified and purged at the beginning of the workday to maximize field work efficiency. If possible, samples should be collected from these wells within the same workday and no later than 24 hours after the end of purging.

7. Measure the water level in the well every 5 to 10 minutes using the water level meter. Record the well water level on the Low Flow Purge Data Form (Attachment D) or equivalent electronic form.
8. Record on the Low Flow Purge Data Form every 5 to 10 minutes the water quality parameters (pH, specific conductance, temperature, turbidity, ORP, DO, and salinity or as specified by the approved site-specific planning document) measured by the water quality meter and turbidity meter. If the cell needs to be cleaned during purging operations, continue pumping (allow the pump to discharge into a container) and disconnect the cell. Rinse the cell with distilled/deionized water. After cleaning is completed, reconnect the flow-through cell and continue purging. Document the cell cleaning on the Low-Flow Purge Data Form or equivalent electronic form.

9. Estimate the flow rate by noting the amount of discharge in a graduated cylinder per unit time using a watch with a second hand. Remeasure the flow rate any time the pump rate is adjusted and periodically during purging. This will determine if a reduction in rate has occurred due to possible battery depletion.

10. During purging, check for the presence of bubbles in the flow-through cell. The presence of bubbles is an indication that connections are not tight. If bubbles are observed, check for loose connections and tighten, repair, or replace them as necessary to achieve a tight connection.

11. Wait until stabilization is achieved, or a minimum of two saturated screen volumes have been removed and three consecutive readings, taken at 5 to 10 minute intervals, are within the following limits, then begin sampling:

    - pH ±0.2 standard units
    - Specific conductance ±10%
    - Temperature ±10%
    - Turbidity less than 10 NTUs
    - DO ±10%

12. If the above conditions have not been met after the well has been purged for 4 hours, purging will be considered complete and sampling can begin. Record the final well stabilization parameters from the Low-Flow Purge Data Form onto the Groundwater Sample Log Form or equivalent electronic form.

NOTE: VOC samples are preferably collected first, directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

13. If the water column in the pump tubing collapses (water does not completely fill the tubing) before exiting the tubing, use one of the following procedures to collect VOC samples:

- Collect samples for non-VOC analyses first, then increase the flow rate incrementally until the water column completely fills the tubing, collect the sample for VOCs, and record the new flow rate.

- Reduce the diameter of the existing tubing until the water column fills the tubing either by adding a connector (Teflon or stainless steel) or clamp, which should reduce the flow rate by constricting the end of the tubing. Proceed with sample collection.

- Insert a narrow-diameter Teflon tube into the pump's tubing so that the end of the tubing is in the water column and the other end of the tubing protrudes beyond the pump's tubing, then collect the sample from the narrow diameter tubing.

- Prepare samples for shipping as per SOP SA-6.1.

7.0 REFERENCES

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ATTACHMENT A

PURGING EQUIPMENT SELECTION

Diameter Casing		Bailer	Peristaltic Pump	Vacuum Pump	Air-lift	Diaphragm "Trash" Pump	Submersible Diaphragm Pump	Submersible Electric Pump	Submersible Electric Pump w/Packer
1.25-Inch	Water level <25 feet	X	X	X	X	X			
	Water Level >25 feet	X			X				
2-Inch	Water level <25 feet	X	X	X	X	X	X		
	Water Level >25 feet	X			X		X		
4-Inch	Water level <25 feet	X	X	X	X	X	X	X	X
	Water Level >25 feet	X			X		X	X	X
6-Inch	Water level <25 feet				X	X		X	X
	Water Level >25 feet				X			X	X
8-Inch	Water level <25 feet				X	X		X	X
	Water Level >25 feet				X			X	X

ATTACHMENT A

PURGING EQUIPMENT SELECTION

PAGE 2

Manufacturer	Model Name/Number	Principle of Operation	Maximum Outside Diameter/Length (Inches)	Construction Materials (w/Lines and Tubing)	Lift Range (ft)	Delivery Rates or Volumes	1982 Price (Dollars)	Comments
BarCad Systems, Inc.	BarCad Sampler	Dedicated; gas drive (positive displacement)	1.5/16	PE, brass, nylon, aluminum oxide	0-150 with std. tubing	1 liter for each 10-15 feet of submergence	$220-350	Requires compressed gas; custom sizes and materials available; acts as piezometer.
Cole-Parmer Inst. Co.	Master Flex 7570 Portable Sampling Pump	Portable; peristaltic (suction)	<1.0/NA	(not submersible) Tygon®, silicone Viton®	0-30	670 mL/min with 7015-20 pump head	$500-600	AC/DC; variable speed control available; other models may have different flow rates.
ECO Pump Corp.	SAMPLifier	Portable; venturi	<1.5 or <2.0/NA	PP, PE, PVC, SS, Teflon®, Tefzel®	0-100	0-500 mL/min depending on lift	$400-700	AC, DC, or gasoline-driven motors available; must be primed.
Geltek Corp.	Bailer 219-4	Portable; grab (positive displacement)	1.66/38	Teflon®	No limit	1,075 mL	$120-135	Other sizes available.
GeoEngineering, Inc.	GEO-MONITOR	Dedicated; gas drive (positive displacement)	1.5/16	PE, PP, PVC, Viton®	Probably 0-150	Approximately 1 liter for each 10 feet of submergence	$185	Acts as piezometer; requires compressed gas.
Industrial and Environmental Analysts, Inc. (IEA)	Aquarius	Portable; bladder (positive displacement)	1.75/43	SS, Teflon®, Viton®	0-250	0-2,800 mL/min	$1,500-3,000	Requires compressed gas; other models available; AC, DC, manual operation possible.
IEA	Syringe Sampler	Portable; grab (positive displacement)	1.75/43	SS, Teflon®	No limit	850 mL sample volume	$1,100	Requires vacuum and/or pressure from hand pump.
Instrument Specialties Co. (ISCO)	Model 2600 Well Sampler	Portable; bladder (positive displacement)	1.75/50	PC, silicone, Teflon®, PP, PE, Detrin®, acetal	0-150	0-7,500 mL/min	$990	Requires compressed gas (40 psi minimum).
Keck Geophysical Instruments, Inc.	SP-81 Submersible Sampling Pump	Portable; helical rotor (positive displacement)	1.75/25	SS, Teflon®, PP, EPDM, Viton®	0-160	0-4,500 mL/min	$3,500	DC operated.
Leonard Mold and Die Works, Inc.	GeoFilter Small Diameter Well Pump (#0500)	Portable; bladder (positive displacement)	1.75/38	SS, Teflon®, PC, Neoprene®	0-400	0-3,500 mL/min	$1,400-1,500	Requires compressed gas (55 psi minimum); pneumatic or AC/DC control module.
Oil Recovery Systems, Inc.	Surface Sampler	Portable; grab (positive displacement)	1.75/12	acrylic, Detrin®	No limit	Approximately 250 mL	$125-160	Other materials and models available; for measuring thickness of "floating" contaminants.
Q.E.D. Environmental Systems, Inc.	Well Wizard® Monitoring System (P-100)	Dedicated; bladder (positive displacement)	1.66/36	PVC	0-230	0-2,000 mL/min	$300-400	Requires compressed gas; piezometric level indicator; other materials available.

ATTACHMENT A

PURGING EQUIPMENT SELECTION

PAGE 3

Manufacturer	Model Name/Number	Principle of Operation	Maximum Outside Diameter/Length (Inches)	Construction Materials (w/Lines and Tubing)	Lift Range (ft)	Delivery Rates or Volumes	1982 Price (Dollars)	Comments
Randolph Austin Co.	Model 500 Vari-Flow Pump	Portable; peristaltic (suction)	<0.5/NA	(Not submersible) Rubber, Tygon®, or Neoprene®	0-30	See comments	$1,200-1,300	Flow rate dependent on motor and tubing selected; AC operated; other models available.
Robert Bennett Co.	Model 180	Portable; piston (positive displacement)	1.8/22	SS, Teflon®, Delrin® PP, Viton®, acrylic, PE	0-500	0-1,800 mL/min	$2,600-2,700	Requires compressed gas; water level indicator and flow meter; custom models available.
Slope Indicator Co. (SINCO)	Model 514124 Pneumatic Water Sampler	Portable; gas drive (positive displacement)	1.9/18	PVC, nylon	0-1,100	250 mL/flushing cycle	$250-350	Requires compressed gas; SS available; piezometer model available; dedicated model available.
Solinst Csnade Ltd.	5W Water Sampler	Portable; grab (positive displacement)	1.9/27	PVC, brass, nylon, Neoprene®	0-330	500 mL	$1,300-1,800	Requires compressed gas; custom models available.
TIMCO Mfg. Co., Inc.	Std. Bailer	Portable; grab (positive displacement)	1.66/Custom	PVC, PP	No limit	250 mL/ft of bailer	$20-60	Other sizes, materials, models available; optional bottom-emptying device available; no solvents used.
TIMCO	Air or Gas Lift Sampler	Portable; gas drive (positive displacement)	1.66/30	PVC, Tygon®, Teflon®	0-150	350 mL/flushing cycle	$100-200	Requires compressed gas; other sizes, materials, models available; no solvents used.
Tole Devices Co.	Sampling Pump	Portable; bladder (positive displacement)	1.38/48	SS, silicone, Delrin®, Tygon®	0-125	0-4,000 mL/min	$800-1,000	Compressed gas required; DC control module; custom built.

Construction Material Abbreviations:

- PE Polyethylene
- PP Polypropylene
- PVC Polyvinyl chloride
- SS Stainless steel
- PC Polycarbonate
- EPDM Ethylene-propylene diene (synthetic rubber)

Other Abbreviations:

- NA Not applicable
- AC Alternating current
- DC Direct current

NOTE: Other manufacturers market pumping devices which could be used for groundwater sampling, though not expressly designed for this purpose. The list is not meant to be all-inclusive and listing does not constitute endorsement for use. Information in the table is from sales literature and/or personal communication. No skimmer, scavenger-type, or high-capacity pumps are included.

Source: Barcelona et al., 1983.

ATTACHMENT B
GROUNDWATER SAMPLE LOG SHEET

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Page___ of ___

Project Site Name: _____
Project No.: _____

[ ] Domestic Well Data
[x] Monitoring Well Data
[ ] Other Well Type: _____
[ ] QA Sample Type: _____

Sample ID No.: _____
Sample Location: _____
Sampled By: _____
C.O.C. No.: _____
Type of Sample:
[X] Low Concentration
[ ] High Concentration

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	ORP	Other
Date:								
Time:	Visual	Standard	mS/cm	Degrees C	NTU	mg/l	mV	NA
Method:								

PURGE DATA:

Date:	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	ORP	Other
Method:								
Monitor Reading (ppm):			SEE LOW FLOW PURGE DATA SHEET					
Well Casing Diameter & Material								
Type:								
Total Well Depth (TD):								
Static Water Level (WL):								
One Casing Volume(gal/L):								
Start Purge (hrs):								
End Purge (hrs):								
Total Purge Time (min):								
Total Vol. Purged (gal/L):								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected

OBSERVATIONS / NOTES:

Circle If Applicable:		Signature(s):
MS/MSD	Duplicate ID No.:	

ATTACHMENT C
EQUIPMENT CALIBRATION LOG

Tetra Tech NUS, Inc.

EQUIPMENT CALIBRATION LOG

PROJECT NAME : _____ INSTRUMENT NAME/MODEL: _____

SITE NAME: _____ MANUFACTURER: _____

PROJECT No.: _____ SERIAL NUMBER: _____

Date of Calibration	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot No.)	Remarks and Comments
			Pre-calibration	Post-calibration	Pre-calibration	Post-calibration		

ATTACHMENT D
LOW FLOW PURGE DATA SHEET

LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: ____________________ WELL ID: ____________________
PROJECT NUMBER: ____________________ DATE: ____________________

Time (Hrs.)	Water Level (Ft. below TOC)	Flow (mL/Min.)	pH (S.U.)	S. Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celcius)	ORP mV	Salinity % or ppt	Comments

SIGNATURE(S): ____________________ PAGE ___ OF ___

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1.0 PURPOSE

The purpose of this document is to provide general reference information regarding natural attenuation parameter and methodology selection, sample collection, and a general understanding of the sample results.

2.0 SCOPE

This document provides information on selection of appropriate groundwater natural attenuation parameters, selection of sampling methods for these parameters, techniques for onsite field analysis of select parameters, and some basic understanding of the field sample results. Review of the information contained herein will facilitate planning of the field sampling effort by describing standard sampling practices and techniques. To a limited extent, it shall also facilitate the understanding and interpretation of the sampling results. It addresses field procedures for collection of data at sites with organic groundwater contaminants (e.g., chlorinated and petroleum hydrocarbons) to the extent practical. The focus of this document is on natural attenuation, not enhanced bioremediation.

The techniques described shall be followed whenever applicable, noting that site-specific conditions, project-specific objectives, local, state, and federal guidelines may be used as a basis for modification of the procedures noted herein. The intent of this document is to supplement the local, state, and federal guidance documents and manufacturer's analytical methods referenced in Section 6.0. It is not intended for this document to supersede this guidance or information. Please note that natural attenuation is a relatively dynamic science with ongoing research in the science and engineering community. It is important that data collectors and interpreters use the most recent regulatory guidance, which may be updated on a periodic basis from that noted in Section 6.

3.0 GLOSSARY

Aerobe: Bacteria that use oxygen as an electron acceptor.

Anaerobe: Organisms that can use electron acceptors other than molecular oxygen to support their metabolism.

Anoxic groundwater: Groundwater that contains oxygen in concentrations less than about 0.5 mg/L. This term is synonymous with the term anaerobic.

Anthropogenic: Man-made.

Cometabolism: The process in which a compound is fortuitously degraded by an enzyme or cofactor produced during microbial metabolism of another compound.

Daughter product: A compound that results directly from the biotic or abiotic degradation of another. For example, *cis*-1,2-dichloroethene (*cis*-1,2-DCE) is a common daughter product of trichloroethene (TCE).

Diffusion: The process whereby molecules move from a region of higher concentration to a region of lower concentration as a result of Brownian motion.

Dispersion: The tendency for a solute to spread from the path that it would be expected to follow under advective transport.

Electron acceptor: A compound capable of accepting electrons during oxidation-reduction reactions. Microorganisms obtain energy by transferring electrons from an electron donor such as an organic compound (or sometimes a reduced inorganic compound such as sulfide) to an electron acceptor. Electron acceptors are compounds that are relatively oxidized and include oxygen, nitrate, iron(III), manganese(IV), sulfate, carbon dioxide, or in some cases chlorinated aliphatic hydrocarbons such as tetrachloroethene (PCE), TCE, DCE and vinyl chloride (VC).

Electron donor: A compound capable of supplying (giving up) electrons during oxidation-reduction reactions. Microorganisms obtain energy by transferring electrons from an electron donor such as an organic compound (or sometimes a reduced inorganic compound such as sulfide) to an

electron acceptor. Electron donors are compounds that are relatively reduced and include fuel hydrocarbons and native organic carbon.

Metabolic byproduct: A product of the reaction between an electron donor and an electron acceptor. Metabolic byproducts include volatile fatty acids, daughter products of chlorinated aliphatic hydrocarbons, methane, and chloride.

Oxic groundwater: Groundwater that contains oxygen in concentrations greater than about 0.5 mg/L.

Oxidation/reduction reaction: A chemical or biological reaction wherein an electron is transferred from an electron donor (donor is oxidized) to an electron acceptor (acceptor is reduced).

Predominant terminal electron-accepting process: The electron-accepting process (oxygen reduction, nitrate reduction, iron(III) reduction, etc.) that sequesters the majority of the electron flow in a given system.

Reductive dechlorination: Reduction of a chlorine-containing organic compound via the replacement of chlorine with hydrogen.

Respiration: The process of coupling the oxidation of organic compounds with the reduction of inorganic compounds such as oxygen, nitrate, iron(III), manganese(IV), and sulfate.

Seepage velocity: The average velocity of groundwater in a porous medium.

Substrate: A compound used by microorganisms to obtain energy for growth. The term can refer to either an electron acceptor or an electron donor.

4.0 RESPONSIBILITIES

Project Manager (PM) / Task Order Manager (TOM) - Responsible for ensuring that all field activities are conducted in accordance with this standard operating procedure (SOP).

Project Hydrogeologist or Geochemist - Responsible for selecting and detailing the specific groundwater sampling techniques, onsite water quality testing (type, frequency, and location), and equipment to be used, and providing detailed input in this regard to the project plan documents. The project hydrogeologist or geochemist is also responsible for properly briefing and overseeing the performance of the site sampling personnel.

Site Manager (SM) / Field Operations Leader (FOL) - Responsible for the onsite verification that all field activities are performed in compliance with approved SOPs or as otherwise directed by the approved project plan(s).

Project Geologist - is primarily responsible for the proper acquisition of the groundwater samples. He/she is also responsible for the actual analyses of onsite water quality samples, as well as instrument calibration, care, and maintenance. When appropriate, such responsibilities may be performed by other qualified personnel (e.g., field sampling technicians or site personnel).

5.0 PROCEDURES

5.1 General

Natural attenuation includes physical, chemical, and biochemical processes affecting the concentrations of dissolved contaminants in groundwater. These processes may include advection, dispersion, volatilization, dilution, sorption to aquifer solids, and/or precipitation or mineralization of compounds. Of greatest importance are those processes that lead to a reduction in contaminant mass (by degrading or destroying contaminants) such as biodegradation. These biochemical processes remove organic contaminants from the aquifer by destruction. Depending on the type of contaminant, particularly the organic contaminant (e.g., petroleum hydrocarbons or chlorinated organic solvents), the biochemical environment in the aquifer will vary. The biochemical environment within the aquifer influences and is influenced by the activities of aquifer microbiota. Specific types of microbiota, working singly or in complex consortia, may use organic contaminants as part of their normal cell functions. Natural

attenuation monitoring is designed to measure indicators of the biochemical environment within the aquifer and, with direct and indirect lines of evidence and associated chemical concentration data, evaluate the likely fate (i.e., transformation, destruction, dilution, attenuation, etc.) of organic contaminants.

5.2 Planning for Natural Attenuation Sampling

The first step in preparing a natural attenuation investigation is to develop a site-specific conceptual model. The first step in development of this model is the analysis and review of available site-specific characterization data. The development and refinement of this model should be supplemented with additional data as needed. The data should include but is not limited to:

- Geologic and hydrogeologic information in three dimensions
- Nature, extent, and magnitude of contamination
- Location and presence of potential receptors to contamination

Lines of Evidence

Several lines of evidence are used to determine whether natural attenuation is working. The most compelling, primary evidence is decreasing groundwater contaminant concentrations over time. Decreasing concentration trends can be demonstrated in several ways including:

- Isoconcentration maps of the dissolved plume over time wherein the extent of the plume is either stable or decreasing.

- Time series plots of contaminant concentrations within a well illustrating a clear downward trend.

- Contaminant concentration profiles in a series of monitoring wells along a groundwater flow path illustrating decreasing concentrations beyond that attributable to dilution and dispersion.

Secondary, or supporting, lines of evidence include:

- Analytical data showing production and subsequent destruction of primary contaminant breakdown products.

- Geochemical data indicating that the biochemical environment is favorable for the appropriate microbiota.

- Geochemical data that indicate the aquifer microbiota are active.

Monitoring Well Location and Sampling Frequency

The number and locations of wells required to monitor natural attenuation will depend on the physical setting at each location. One possible array of monitoring wells is illustrated in Attachment A. In this scenario, one well is used to monitor conditions upgradient of the source, one well is located in the source area, and several wells are used to define and monitor the downgradient and lateral extent of the dissolved plume. At a minimum, there should be at least one upgradient well (ideally with no contamination present), one well in the source area, one well downgradient from the source area in the dissolved plume, and one downgradient well where contaminant concentrations are below regulatory criteria. Note that the number and locations of monitoring wells will vary depending on the site complexity and site objectives.

Sampling frequency will be dictated by the ultimate use of the data and site-specific characteristics. Contaminant concentrations may be used to define statistically meaningful trends in contaminant concentrations. The sampling frequency may be defined by the hydrogeologic and/or geochemical conditions as well as the proposed statistical method for data analysis. For example, groundwater flow and contaminant characteristics (e.g., seepage velocity and contaminant loading) may dictate the sample frequency. Regardless of the factors, sampling frequency and duration will need to establish the range of natural chemical variability within the aquifer. After a sufficient amount of data has been collected and the geochemical conditions are understood, the frequency of sampling may be reduced. See Section 5.4 for additional information on sample collection and frequency.

5.3 Selection of Natural Attenuation Parameters

Natural attenuation via biodegradation depends on the nature of the organic contaminants and the oxidation-reduction (redox) environment within the aquifer. Simply stated, if the contaminants are fuels, biodegradation will be most effective if the redox conditions are aerobic or oxidizing. If the contaminants are chlorinated solvents, the biodegradation will be most effective (in the source and near source areas) if redox conditions in the aquifer are anaerobic or reducing.

Several parameters are needed to evaluate whether natural attenuation is taking place and, if so, the rate at which it may be occurring. The primary parameter providing direct evidence of natural attenuation is the aqueous concentrations of parent and daughter volatile organic compounds. More specifically, a decrease in percent products, an increase in daughter products, evidence that the plume is stable or shrinking in size, and overall decline in contaminant concentrations is direct evidence of natural attenuation. Natural attenuation or geochemical parameters that provide information about the redox conditions in the aquifer include:

- Dissolved oxygen
- Nitrate/nitrite
- Dissolved manganese
- Iron
- Sulfate/sulfide
- Methane
- Oxidation-reduction potential (ORP)

Secondary parameters that indicate biological activity in the aquifer and thereby support the natural attenuation evaluation include:

- Dissolved hydrogen
- Alkalinity
- Dissolved carbon dioxide

The concentrations of natural attenuation parameters are used to define the aquifer redox conditions. It is important to record and document the presence or absence (i.e., measurable or not measurable concentration) of certain natural attenuation parameters. The presence or absence of a certain substance may be sufficient to indicate the redox condition within the aquifer. By reference to Attachment B, which illustrates the typical sequence of biologically mediated redox reactions in natural systems, it is apparent that, for example, sulfate reduction (producing dissolved sulfide in groundwater) does not operate in an aerobic environment. Therefore, measurable sulfide should not be present if there is also dissolved oxygen at concentrations indicating an aerobic environment. Attachment B also illustrates the redox potential (measured in millivolts) associated with the redox reactions. ORP readings, also in millivolts, measured during well purging, may be compared with the range of values in Attachment B but with caution. Redox potentials measured with a platinum electrode in natural water samples may be misleading, especially when biologically mediated reactions are important, because many of the critical

reactions in Attachment B do not generate a response in the electrode. Dissolved hydrogen concentration ranges associated with important redox reactions are also indicated in Attachment B. Because dissolved hydrogen is actually used by microbiota during redox reactions, its concentration may provide an additional indicator of the overall redox condition in the aquifer.

Attachments C and D tabulate the natural attenuation parameters for chlorinated volatile organic compound and petroleum hydrocarbon plumes, respectively. The parameters listed in these tables are organized in order of importance. Parameters selected for analysis shall be determined based on site conditions, project-specific plans, and/or other criteria established for the project. Based on these criteria, it is possible that all of the parameters may be selected.

5.4 Selection of Natural Attenuation Analytical Methods and Procedures

There are many analytical methods available to measure concentrations of the natural attenuation parameters discussed in the previous sections. Attachment E summarizes the sample methodologies, sampling equipment needed, sample volume, container, preservation, and holding time requirements. This table also summarizes the detection limits and the detection ranges for each method. A number of factors should be considered when selecting the appropriate sample analytical methodology including the required parameters, appropriate detection ranges for each compound, cost, and ease of use in the field. For example, when determining the correct methodology for measuring concentrations of total sulfide, the metabolic byproduct of sulfate reducing conditions, it is important to analyze for each of the forms of sulfide (H_2S, S^{-2}, and HS^-). Also, when the detection limit of the selected method is exceeded, another method may be considered, or the sampler may be able to dilute the sample (per manufacturer's instructions) to quantify it within the detected range. In terms of cost, some parameters are very time consuming when performed in the field. Without sacrificing sample integrity it may be more appropriate to select a methodology performed in a fixed-base laboratory. Finally, in terms of ease of use, certain field methods are generally easier compared to other methods. Using simpler methods may result in better quality sample results and increased sample repeatability without sacrificing sample integrity. For example, in some cases CHEMetrics Titret® Titration Ampule kits may be a good alternative to other hand digital titration methods.

The sample technicians should be aware that based on geochemical conditions recorded in the field, certain geochemical parameters may not have positive detections. For example, if dissolved oxygen concentrations indicate aerobic conditions then it is unlikely that dissolved hydrogen is present (see Section 5.10 for additional information). Another example is alkalinity. If the pH of the groundwater sample is less than 4.5, then it is unlikely that alkalinity will be measurable. Despite the potential for non-detect results, in cases such as those described above, all parameters should be collected in the field based upon project plans. The value in collecting the parameters in the future shall be determined by the project hydrogeologist and/or geochemist in accordance with the projects planning documents data quality objectives (DQO) and the items discussed in Section 5.2.

5.5 Procedures for Sample Collection

Groundwater sample collection for natural attenuation sampling should be performed using low flow purging and sampling techniques. These techniques are described in detail in SOP SA-1.1. Low flow purging and sampling procedures should be used to ensure the collection of a sample that is "representative" of the water present in the aquifer formation. Minimizing stress on the aquifer formation during low flow purging and sample collection ensures that there are minimal alternations to the water chemistry of the sample. The criteria used in the purging process should include minimization of drawdown in the well, stabilization of applicable indicator parameters, and evacuation of a sufficient amount of purge volume in accordance with SOP SA-1.1, project plans, and/or applicable regulatory guidance.

Groundwater purging and sampling for natural attenuation should be performed using submersible pumps (e.g., bladder pumps) in accordance with SOP SA-1.1. However, in accordance with project plans and applicable regulatory guidance, peristaltic pumps may also be used for this purpose. Limitations of and factors associated with using these devices should be considered (see SOP SA-1.1 for more information). As a result of difficulties in collecting "representative" groundwater samples, bailers should not be used for the collection of natural attenuation samples.

It is critical that disturbance and aeration of samples monitored and collected at the well head are minimized. As a result, a flow-through sampling cell and a direct reading meter shall be used for the measurement of well stabilization indicator parameters (e.g., pH, conductivity, temperature, dissolved oxygen, turbidity, and ORP) at the well head. The pump effluent tubing should be placed at the bottom of the flow-through cell allowing effluent water from the cell to discharge at the top of the meter (above the detector probes) to minimize the agitation of water in the cell.

Documentation of the purging process shall be recorded during and at the completion of purging as discussed in Section 5.8. Immediately following the purging process and before sampling, all applicable indicator parameters must be measured and recorded on the appropriate sample log sheets as discussed in Section 5.8.

After all of the purging requirements have been met, groundwater sampling and natural attenuation data collection can begin. Monitoring wells will be sampled using the same pump and tubing used during well purging.

5.6 Procedures for Field Sample Analysis

Each of the field and fixed-base laboratory sample parameters requires different sampling procedures and holding times. Attachment E presents parameter-specific requirements for sampling, analysis, and storage of all of the parameters and methods sampled as part of natural attenuation analysis.

Due to parameter procedure and holding times, it is important to consider the sequence of sample collection and analysis. Generally speaking, with the exception of volatile organic compounds, field parameters shall be analyzed first followed by fixed-base laboratory sample collection. All samples will be collected in a sequence and manner that minimizes volatilization, oxidation, and/or chemical transformation of compounds. As a result, the following sample and analysis order should be followed:

1. Volatile organic compounds
2. Dissolved oxygen
3. Alkalinity
4. Dissolved carbon dioxide
5. Dissolved ferrous iron
6. Dissolved sulfide (hydrogen sulfide and sulfide)
7. Dissolved hydrogen, methane, ethene, and ethane
8. Nitrate / Nitrite
9. Dissolved manganese
10. Semivolatile organic compounds
11. Other dissolved metals
12. Total metals
13. All other constituents

Field-analyzed parameters should be collected and immediately analyzed directly from the pump effluent per the requirements on Attachment E and manufacturer's recommendations. Care should be taken to minimize any unnecessary disturbance, aeration, or agitation of the sample prior to analysis. It is not acceptable to collect and store samples that are to be analyzed immediately at the well head in a temporary holding container (e.g., open topped pitcher) to be analyzed at a later time.

The manufacturer's procedure manual for each of the field-based analyses shall be maintained in the field during the entire sampling program. The procedures give a detailed explanation of how to perform each particular method and include information on sampling, storage, accuracy checks, interferences, reagents, and apparatus needed to perform each analysis.

5.7 Procedures for Quality Assurance and Quality Control Field Sample Analysis

Accuracy and precision checks shall be performed to check the performance of the reagents, apparatus, and field analytical procedures per the manufacturer's recommendations. The accuracy checks should include the use of standard solutions (i.e., standard addition), as appropriate. The manufacturer's field test kit manual provides details on how to perform each of the accuracy checks for each parameter where applicable. Refer to Section 6.0 for manufacturer contact information.

Precision checks must include the performance of duplicate analysis. When using a colorimeter, precision checks may also include reagent blank corrections and standard curve adjustments as recommended by the manufacturer. Field duplicate results shall be performed and evaluated for relative percent difference (RPD) at a rate of 1 per 10 samples or as determined by the project plans. The RPD can be calculated as follows:

$$RPD = \left| \frac{\text{First result - Second result}}{\text{Mean arithmetic (average) of first and second result}} \right| \times 100$$

If the RPD exceeds 50 percent, it is required that the test be performed again to verify the result. The duplicate results shall be documented in the 'Notes' section for that specific parameter on the appropriate sample logsheet (see Section 5.8).

If a colorimeter (e.g., HACH DR-890 or equivalent) is used for parameter analysis, an instrument performance verification test using absorbance standards may also be performed to ensure the meter is providing accurate measurements.

The following table lists examples of the types and frequencies of accuracy checks required for each parameter. Refer to the manufacturer's instructions for information regarding other analyses.

Parameter	Method	Standard Solution	Field Duplicate	Reagent Blank Correction
Alkalinity	CHEMetrics K-9810, -15, -20	None	1 per 10	None
Carbon dioxide	CHEMetrics K-1910, -20, -25	None	1 per 10	None
Dissolved oxygen	CHEMetrics K-7501, -12	None	1 per 10	None
Ferrous iron	HACH DR-890	None	1 per 10	None
Nitrite	HACH DR-890	1 per round	1 per 10	1 per lot
Nitrate	HACH DR-890	1 per round	1 per 10	1 per lot
Sulfide	HACH DR-890	None	1 per 10	None
Hydrogen sulfide	HACH HS-C	None	1 per 10	None

Prior to analysis, the expiration dates of reagents shall be checked. If the reagents have exceeded their expiration date or shelf life, the reagents shall be replaced. If deviations from the applicable analytical procedure are identified, the deviations shall be corrected and the associated samples re-analyzed. If problems are identified with the reagents, apparatus, or procedures, data interferences may be present. Interferences may also be due to other factors (e.g., pH, presence or concentration of other ions, turbidity, temperature, etc.) that may interfere with the sample result. The manufacturer's procedures (e.g., Hach, 1999) should be reviewed prior to analysis to avoid or minimize such interferences. Associated problems

or suspected interferences shall be documented in the 'Notes' section of the sample logsheet. Often, interferences cannot be avoided. In these cases, the sampler should be aware of these potential interferences and document them properly.

5.8 Documentation Procedures for Field Sample Analysis

Field results shall be properly documented in the field as noted in SOP SA-6.3. The sample log sheet titled "Field Analytical Log Sheet, Geochemical Parameters" shall be prepared for each sample collected and analyzed in the field. A copy of this form can be found as Attachment F of this SOP. Other field log sheets (e.g., low flow purge log sheet, groundwater sample logsheet, etc.) shall also be completed in accordance with SOP SA-6.3.

Specific information shall also be recorded in the project logbook. This information shall include, but is not limited to, the test kit name and model number, lot number and expiration date of the test kit and reagents used, serial number of the instrument (e.g., colorimeter) used for the analysis, and results of the quality assurance and quality control field sample analysis. Because environmental conditions and changes in those conditions may affect the field analytical results, it is important to document the site conditions (weather, temperature, etc.) at the time of sampling in the logbook in accordance with SOP SA-6.3.

5.9 Waste Handling and Disposal

Several of the test kits listed in Attachment E require the use of chemicals and materials that must be properly handled and disposed of in a proper and responsible manner. Refer to specific manufacturer's guidance for handling and disposal practices. See also Section 6.0 for more detailed and complete information. Handling and disposal of these items should be conducted in accordance with all local, state, and federal guidelines.

5.10 Understanding Field Sample Analytical Results

Natural attenuation data interpretation is complicated by the complex inter-relationships of various parameters. The complexity reflects the myriad of biochemical processes. Real-time evaluation of field analytical data can be misleading because a full interpretation often requires combining the field analytical results with fixed-base laboratory results. Regardless, some simple observations and data interpretations in the field may provide insights about the monitoring system or early warnings about sample collection and handling problems.

Data collected from the designated upgradient monitoring well is the baseline from which other interpretations are made. Field analytical data will indicate that the upgradient environment is either oxidizing or reducing. The redox condition within the upgradient area of the aquifer may be natural or impacted by other contaminant source areas (see Section 5.2 for upgradient well selection). Regardless, the redox condition of the upgradient groundwater will influence the source area. Changes in field analytical results from the upgradient well to the source area well will be reflected in samples from monitoring wells further downgradient.

The general characteristics of the two redox environments are summarized in the following table.

Aerobic/Oxidizing	Anaerobic/Reducing
• Measurable dissolved oxygen (>1 to 2 ppm)	• No measurable dissolved oxygen (<1 ppm)
• Measurable nitrate	• No measurable nitrate
• No measurable dissolved manganese	• Measurable dissolved manganese
• No measurable dissolved ferrous iron	• Measurable dissolved ferrous iron
• Measurable dissolved sulfate	• No measurable dissolved sulfate
• No measurable dissolved sulfide	• Measurable dissolved sulfide
• No measurable dissolved methane	• Measurable dissolved methane
• No measurable dissolved hydrogen	• Measurable dissolved hydrogen

Transitional environments between these two extremes may have intermediate characteristics and are actually quite common. Because reactions are mediated by biological systems, equilibrium (the basis for the figure in Attachment B) conditions within the aquifer should not be expected. For example, sulfate reduction environments may occur in close proximity to methanogenic environments, and this natural attenuation data may be difficult to interpret. Carefully collected and analyzed field measurements and sample collections for fixed-base laboratory analyses are designed to characterize the aquifer environment along the continuum between strongly aerobic and strongly anaerobic. Because the land surface environment is generally more oxidizing than any groundwater environment, sample handling at the point of collection and analysis is extremely important in preserving the chemical integrity of the groundwater sample.

6.0 REFERENCES

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ATTACHMENT A

HYPOTHETICAL LONG-TERM MONITORING STRATEGY

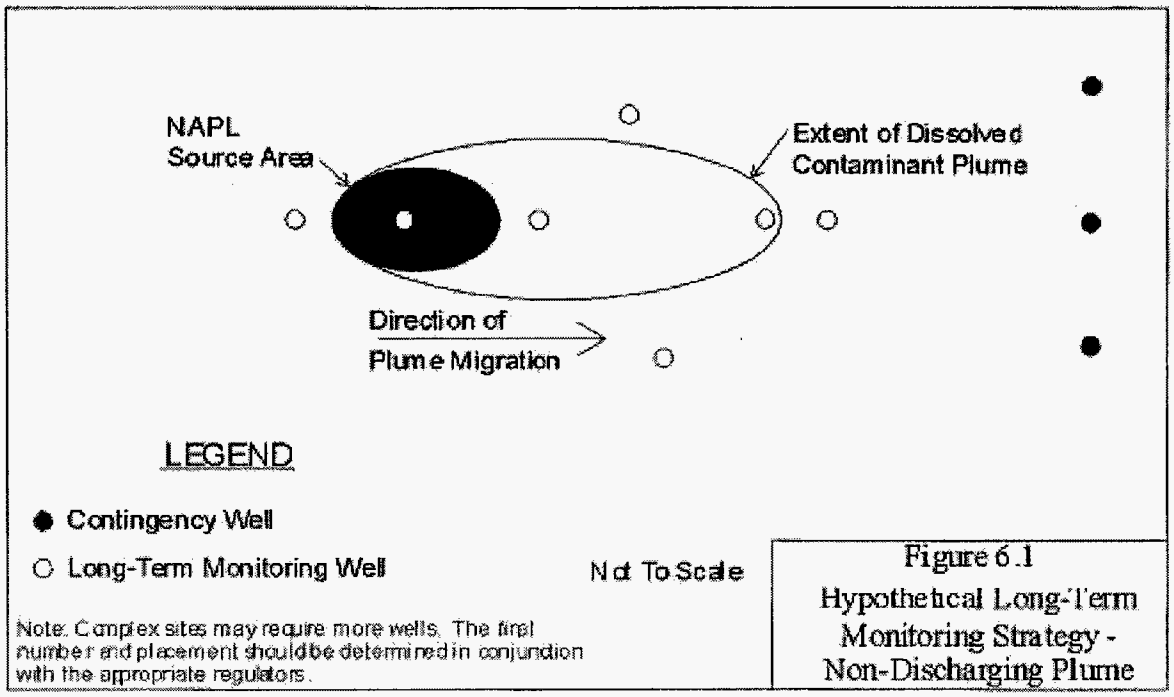
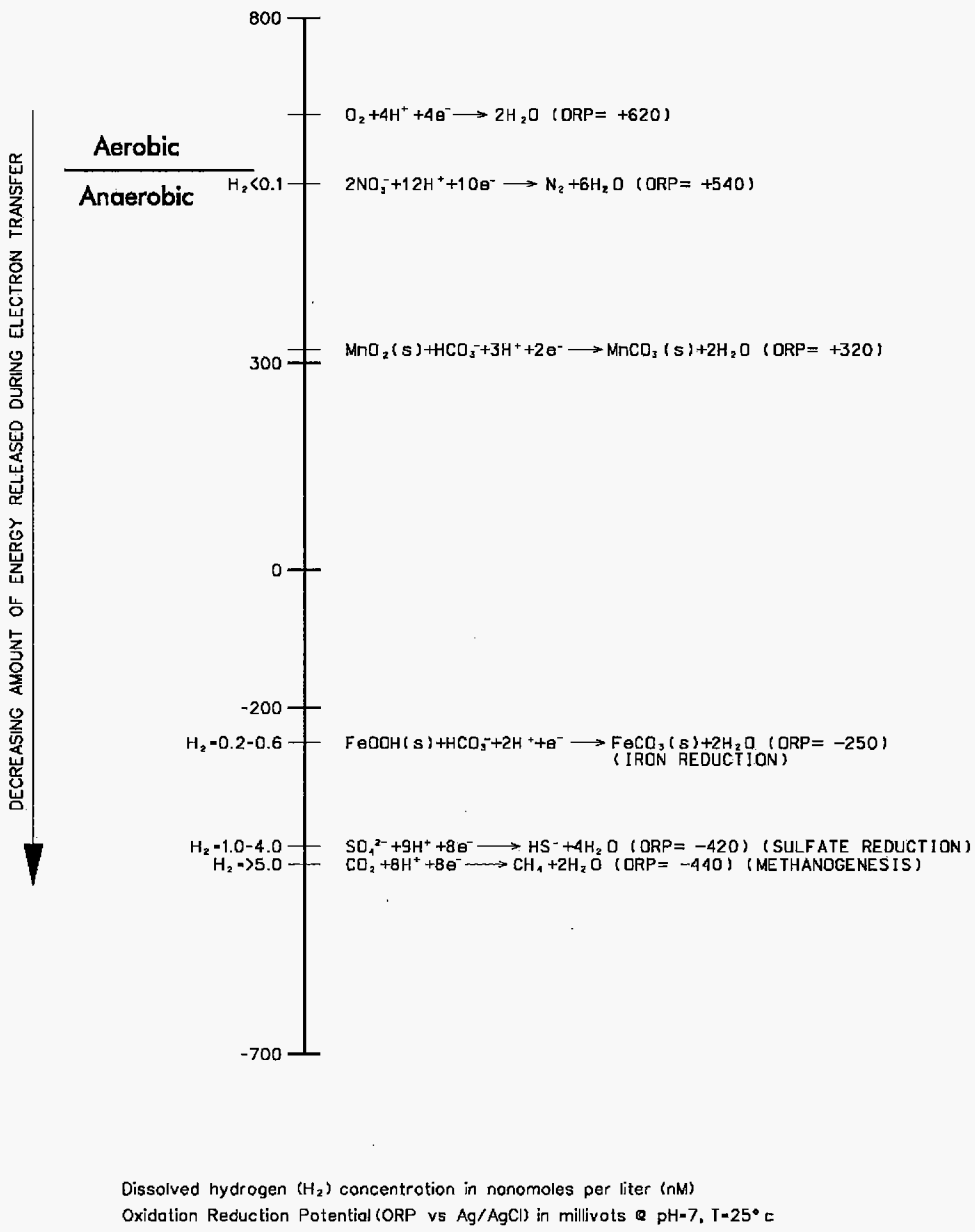


Figure 6.1
Hypothetical Long-Term Monitoring Strategy - Non-Discharging Plume

Taken from: Department of the Navy, 1998, Technical Guidelines for Evaluating Monitored Natural Attenuation of Petroleum Hydrocarbons and Chlorinated Solvents in Ground Water at Naval and Marine Corps Facilities, Prepared by Todd Weidemeier and Francis Chappelle.

ATTACHMENT B

REDOX POTENTIALS FOR VARIOUS ELECTRON ACCEPTORS



Dissolved hydrogen (H_2) concentration in nanomoles per liter (nM)
Oxidation Reduction Potential (ORP vs Ag/AgCl) in millivots @ pH=7, T=25° c

FIGURE B
REDOX POTENTIALS
FOR VARIOUS ELECTRON ACCEPTORS

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ATTACHMENT C

NATURAL ATTENUATION PARAMETERS FOR CHLORINATED VOLATILE ORGANIC COMPOUND PLUMES SCREENING PROCESS SUMMARY FOR REDUCTIVE (ANAEROBIC) DECHLORINATION

Potential Electron Donors	Electron Acceptors:		Reduced Species:		Related Dechlorination Pathway:
	Dissolved Oxygen	⇒	Carbon Dioxide (CO_2)	~	DCE → VC → CO_2
Native total organic carbon (TOC)	Manganese (Mn^{4+})	⇒	Manganese (Mn^{2+})	~	DCE → VC
Anthropogenic carbon (e.g., leachate)	Nitrate (NO_3)	⇒	Nitrite (NO_2)	~	DCE → VC
Fuel hydrocarbons (e.g., BTEX)	Ferric Iron (Fe^{3+})	⇒	Ferrous Iron (Fe^{2+})	~	DCE → VC → CO_2
Lightly chlorinated solvents (DCE/VC)	Sulfate (SO_4)	⇒	Sulfide (S^{2-}, HS^-, H_2S)	~	TCE → DCE → VC → Ethene
	Carbon Dioxide (CO_2)	⇒	Methane (CH_4)	~	PCE → TCE → DCE → VC → Ethene

Geochemical Parameter List:

Parameter	Field or Lab	Rationale	Importance
Volatile organic compounds	L	Source products; daughter products; electron donors (e.g., benzene, toluene, ethylbenzene, and xylene; BTEX)	1
Dissolved oxygen	F	Primary electron acceptor (respiration); an/aerobic indicator	1
Nitrate (and nitrite), dissolved	F or L	Anaerobic electron acceptor (product of nitrate reduction)	1
Manganese, dissolved	F or L	Anaerobic electron acceptor	1
Ferrous Iron (Fe^{2+})	F	Product of iron reduction	1
Sulfate [and sulfide (S^{-2})]	F or L	Common anaerobic electron acceptor (product of sulfate reduction)	1
Sulfide (H_2S)	F	Common product of sulfate reduction	1
Methane, ethane, ethene	L	Product of methanogenesis; daughter products of reductive dechlorination	1
Chloride	L	Ultimate daughter product of reductive dechlorination	1
TOC - upgradient groundwater	L	Electron donor	1
ORP, pH, specific conductance, temperature, turbidity	F	General water quality determination	1
Carbon dioxide (CO_2)	F	Anaerobic electron acceptor (methanogenesis); biotic respiration indicator	2
Alkalinity/DIC	F	Buffering capacity; biotic respiration indicator	2
Hydrogen, dissolved	L	Fingerprint for characterizing electron acceptor pathway - indicator of what redox is occurring	2
TOC - upgradient soil	L	Input to analytical NA models; quantifies soil-water distribution coefficient and retardation factor	2
Volatile fatty acids	L	Determination of anthropogenic carbon used as an electron donor	3

Importance: 1=Most important; 3=Least important (depending on DQOs, all may be recommended).
See Attachment E for details regarding analytical methods.

ATTACHMENT D

NATURAL ATTENUATION PARAMETERS FOR PETROLEUM HYDROCARBON PLUMES SCREENING PROCESS SUMMARY FOR OXIDATIVE (AEROBIC) DEGRADATION

Parameter	Field or Lab	Rationale	Importance
Volatile organic compounds	L	Source products; daughter products; electron donors (BTEX)	1
Dissolved oxygen	F	Primary electron acceptor (respiration); an/aerobic indicator	1
Nitrate (and nitrite), dissolved	F or L	Anaerobic electron acceptor (and product of nitrate reduction)	1
Manganese, dissolved	F or L	Anaerobic electron acceptor	1
Ferrous Iron (Fe^{2+})	F	Product of iron reduction	1
Sulfate [and Sulfide (S^{-2})]	F or L	Common anaerobic electron acceptor (product of sulfate reduction)	1
Sulfide (H_2S)	F	Common product of sulfate reduction	1
TOC - upgradient groundwater	L	Electron donor	1
ORP, pH, specific conductance temperature, turbidity	F	General water quality determination	1
Dissolved methane (CH_4)	L	Product of methanogenesis	1
Anions: chloride (Cl), nitrate (NO_3), nitrite (NO_2), phosphate (PO_4), sulfate (SO_4)	L		1
TOC - Upgradient soil	L	Input to analytical NA models; quantifies soil-water distribution coefficient and retardation factor	2
Biological oxygen demand (BOD)	L	Understanding of aquifer oxygen demand	3
Chemical oxygen demand (COD)	L	Understanding of aquifer oxygen demand	3

Importance: 1=Most important; 3=Least important (depending on DQOs, all may be recommended).

See Attachment E for details regarding analytical methods.

ATTACHMENT E
GEOCHEMICAL SAMPLING PARAMETERS - METHODS, EQUIPMENT, VOLUMES, CONTAINERS, PRESERVATION, HOLDING TIMES, AND DETECTION RANGES
PAGE 1 OF 4

Parameter	Method / Reference	Equipment / Method Chemistry	Sample Volume, Container, Preservation, & Holding Time	Range (mg/L)	Precision (mg/L)	Estimated Detection Limit (mg/L)
Alkalinity	CHEMetrics K-9810, K-9815, K-9820 -ASTM D 1067-92 -EPA 310.1	Titret® Titration Ampules / Hydrochloric Acid, Phenolphthalein	Field. Follow test kit instructions. Avoid agitation and analyze at well head to determine total alkalinity. Filter if turbid (>10 NTU).	10-100 (K-9810) 50-500 (K-9815) 100-1000 (K-9820)	N/A	10 50 100-
Alkalinity	Fixed-base lab -EPA 310.1	N/A	100 to 250 mL in glass or plastic container. Cool to 4°C. Analyze within 14 days. Filter if turbid.	N/A	N/A	N/A
Alkalinity / Dissolved Inorganic Carbon	HACH AL-DT -HACH 8203 -SM 2320 / SM 403	Digital Titration / Hydrochloric Acid, Phenolphthalein (P) and Total (M)	Field. Follow test kit instructions. Avoid agitation and analyze at well head to determine carbonate, bicarbonate, and hydroxide ions. Filter if turbid as recommended by manufacture. May use a pH meter for colored samples.	10-4000	N/A	10
Arsenic	Fixed-base lab -SW-6010 B	N/A	1 liter glass or polyethylene container, HNO_3 to pH $\leq$ 2, 6 months.	N/A	N/A	N/A
Biochemical Oxygen Demand	Fixed-base lab -EPA 410.1	N/A	2 liter HDPE. Cool to 4°C. Analyze within 48 hours.	N/A	N/A	N/A
Carbon Dioxide, dissolved	CHEMetrics K-1910, K-1920, K-1925 -ASTM D 513.82 -SM 4500-CO_2-C	Titret® Titration Ampules / Sodium Hydroxide, Phenolphthalein	Field. Follow test kit instructions. Avoid agitation and analyze at well head.	10-100 (K-1910) 100-1000 (K-1920) 250-2500 (K-1925)	N/A	10 100 250
Carbon Dioxide, dissolved	Fixed-base lab - VOA water sample (Vaportech)	GC-ECD/RGD/FID Detector	40 mL in VOA vial. 2 to 3 vials by (Vaportech).	N/A	N/A	N/A
Carbon Dioxide, dissolved	Fixed-base lab -Microseeps gas stripping cell	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial (Microseeps only).	N/A	N/A	N/A
Carbon Dioxide, dissolved	HACH CA-DT -HACH 8205 -Mod. SM 406	Digital Titration / Sodium Hydroxide, Phenolphthalein	Field. Follow test kit instructions. Do not aerate or agitate. Analyze at well head.	10-1000	N/A	10
Chemical Oxygen Demand	Fixed-base lab -EPA 410.1	N/A	125 mL HDPE. H_2SO_4 to pH <2.0. Cool to 4°C. Analyze within 28 days.	N/A	N/A	N/A
Chloride (Cl)	Fixed-base lab -EPA 300	N/A	100 to 250 mL in glass or plastic container. Cool to 4°C. Analyze within 28 days.	N/A	N/A	N/A
Chlorine - Total (Cl_2)	HACH DR-850 -HACH 8167 -SM 4500-Cl	Colorimeter / DPD Method	Field. Follow test kit instructions.	0.02-2.00	$\pm$ 0.01 mg/L with a 1.00 mg/L chlorine solution.	1
Conductance, Specific	Field Meter -SW-9050 A	Direct Reading Meter	100 to 250 mL in glass or plastic container. Analyze immediately.	N/A	N/A	N/A
Ethane, dissolved	Fixed-base lab -VOA water sample, Vaportech -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	40 mL in VOA vial. 2 toi 3 vials by (Vaportech).	N/A	N/A	N/A
Ethane, dissolved	Fixed-base lab -Microseeps gas stripping cell -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial (Microseeps only).	N/A	N/A	N/A

ATTACHMENT E

GEOCHEMICAL SAMPLING PARAMETERS - METHODS, EQUIPMENT, VOLUME, CONTAINER, PRESERVATION, HOLDING TIME, AND DETECTION RANGES

Parameter	Method / Reference	Equipment / Method Chemistry	Sample Volume, Container, Preservation, & Holding Time	Range (mg/L)	Precision (mg/L)	Estimated Detection Limit (mg/L)
Ethene, dissolved	Fixed-base lab -VOA water sample, Vaportech -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	40 mL in VOA vial. 2 to 3 vials by (Vaportech).	N/A	N/A	N/A
Ethene, dissolved	Fixed-base lab -Microseeps gas stripping cell -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial (Microseeps only).	N/A	N/A	N/A
Fraction Organic Carbon (foc) -Soil Upgradient Saturated Soil	Fixed-base lab -Walk-Black -SW-846 9060	N/A	200 gram glass jar. Cool to 4°C. Analyze within 14 days.	N/A	N/A	N/A
Hydrogen, dissolved	Fixed-base lab -Microseeps or Vapor Tech gas stripping cell -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial.	N/A	N/A	N/A
Iron, ferrous (Fe^{+2})	HACH DR-850 -HACH 8146 -Mod. SM 315 B	Colorimeter 1, 10 Phenanthrolein	Field. Follow test kit instructions. Analyze immediately at well head. Filter if turbid (>10 NTU) as recommended by the manufacture.	0-3.00	±0.017 mg/L with a 2.00 mg/L Fe^{2+} solution.	0.03
Iron, ferrous (Fe^{+2})	HACH IR-18C -Mod. SM 315 B	Color Disc 1, 10 Phenanthrolein	Field. Follow test kit instructions. Analyze immediately at well head. Filter if turbid (>10 NTU) as recommended by the manufacture.	0-10	N/A	0.2
Iron, total dissolved (Filtered)	Fixed-base lab -SW-846 6010B	N/A	250 mL in plastic container. Field filter to 0.45 µ. HCl to pH <2. Cool to 4°C. Analyze within 6 months.	N/A	N/A	N/A
Manganese (Mn^{+2})	HACH DR-850 -HACH 8034 -CFR 44(116) 34193	Colorimeter / Cold Periodate Oxidation	Field. Follow test kit instructions. Avoid agitation and analyze at well head. Filter if turbid as recommended by the manufacture.	0-20.0	± 0.18 mg/L with a 10.00 mg/L Mn solution.	0.12
Manganese (Mn^{+2})	HACH MN-5 -Mod. SM 319 B -CFR 44(116) 34193	Color Disc / Cold Periodate Oxidation	Field. Follow test kit instructions. Avoid agitation and analyze at well head. Filter if turbid as recommended by the manufacture.	0-3	N/A	0.1
Manganese, total dissolved (Filtered)	Fixed-base lab -SW-846 6010B	N/A	250 mL in plastic container. Field filter to 0.45 µ. HCl to pH <2. Cool to 4°C. Analyze within 6 months.	N/A	N/A	N/A
Methane, dissolved	Fixed-base lab -VOA water sample, Vaportech -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	40 mL in VOA vial. 2 to 3 vials by (Vaportech).	N/A	N/A	N/A
Methane, dissolved	Fixed-base lab -Microseeps gas stripping cell -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial (Microseeps only).	N/A	N/A	N/A
Nitrate (NO_3^-)	Fixed-base lab -EPA 300	N/A	250 mL plastic container. Cool to 4°C. Analyze within 48 hours.	N/A	N/A	N/A
Nitrate (NO_3^-)	HACH DR-850 -HACH 8192 -Mod. EPA 353.2	Colorimeter / Cadmium Reduction	Field. Follow test kit instructions. Avoid agitation and analyze at well head. Pretreatment required if nitrite is present.	0-0.50	± 0.03 mg/L with a 0.25 mg/L of nitrate nitrogen (NO_3^- N) solution.	0.01
Nitrite (NO_2^-)	Fixed-base lab -EPA 300	N/A	250 mL plastic container. Cool to 4°C. Analyze within 48 hours. Filter if turbid as recommended by the manufacture.	N/A	N/A	N/A

ATTACHMENT E

GEOCHEMICAL SAMPLING PARAMETERS - METHODS, EQUIPMENT, VOLUME, CONTAINER, PRESERVATION, HOLDING TIME, AND DETECTION RANGES

Parameter	Method / Reference	Equipment / Method Chemistry	Sample Volume, Container, Preservation, & Holding Time	Range (mg/L)	Precision (mg/L)	Estimated Detection Limit (mg/L)
Nitrite (NO_2^-)	HACH DR-850 -HACH 8507 -Mod. EPA 354.1 -Mod. SM 419 -CFR 44(85) 25595	Colorimeter / Diazotization	Field. Follow test kit instructions. Avoid agitation and analyze at well head. Filter if turbid as recommended by the manufacture.	0-0.350	± 0.001 mg/L with a 0.250 mg/L nitrite nitrogen solution.	0.005
Nitrogen, dissolved	Fixed-base lab -Microseeps gas stripping cell - Vaportech VOA water sample	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required for Microseeps. Ship in glass septum vial (Microseeps) or VOA vial (Vaportech).	N/A	N/A	N/A
Nitrogen, Total Kjeldahl	Fixed-base lab -EPA 351.2	N/A	500 mL plastic/glass container. Cool to 4°C. H_2SO_4 to pH $\leq$ 2. Analyze within 28 days.	N/A	N/A	N/A
Oxidation Reduction Potential	Field Meter - ASTM D-1498	Direct Reading Meter	Field. Do not aerate. Gently agitate probe using flow over ot flow-through method. Analyze immediately at well head.	N/A	N/A	N/A
Oxygen, dissolved	CHEMetrics K-7501, K-7512 -ASTM D 5543-94 -ASTM D 887-92	CHEMets® Vacuum Vials / Rhodazine D and Indigo Carmine	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head.	0-1 (K-7501) 1-12 (K-7512)	N/A	0.025 1
Oxygen, dissolved	Fixed-base lab -VOA water sample, Vaportech -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	40 mL in VOA vial. 2 to 3 vials by (Vaportech).	N/A	N/A	N/A
Oxygen, dissolved	Fixed-base lab -Microseeps gas stripping cell -RSK SOP-147 & 175	GC-ECD/RGD/FID Detector	Field bubble-strip sampling required. Ship in glass septum vial (Microseeps only).	N/A	N/A	N/A
Oxygen, dissolved	HACH OX-DT -HACH 8215 -SM 4500-O-G	Digital Titration / Azide Modification of Winkler Digital Titration Method	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head.	1-10	N/A	1
Oxygen, dissolved	HACH DR-850 (AccuVac Ampules) LR HRDO Method	-Indigo Carmine Method -Rhadazine D Method	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head.	0-0.8 ppm 0-10 ppm	0.01 ppm 0.1 ppm	N/A
Oxygen, dissolved	Field Meter	Direct Reading Meter	Analyze immediately at well head. Avoid agitation and analyze immediately at well head. Used for well stabilization measurement parameter only.	N/A	N/A	N/A
pH	Field Meter -SW 9040B	Direct Reading Meter	Analyze immediately at well head.	N/A	N/A	N/A
Phosphate (ortho)	Fixed-base lab -EPA 300	Ion Chromatography	250 mL plastic container. Cool to 4°C. Analyze within 48 hours. Filter if turbid as recommended by the manufacture.	N/A	N/A	N/A
Phosphate, potassium	Fixed-base lab -SW-846 6010B	Inductively Coupled Plasma	250 mL plastic container. Cool to 4°C. Analyze within 48 hours. Filter if turbid as recommended by the manufacture.	N/A	N/A	N/A
Salinity	Field Meter	Direct Reading Meter	Analyze immediately.	N/A	N/A	N/A
Sulfate (SO_4^{-2})	Fixed-base lab	N/A	250 mL plastic container. Cool to 4°C. Analyze within 48 hours. Filter if turbid as recommended by the manufacture.	N/A	N/A	N/A
Sulfate (SO_4^{-2})	HACH DR-850 -HACH 8051 -EPA 375.4	Colorimeter / Turbimetric SulfaVer 4	Field. Follow test kit instructions. Filter if turbid as recommended by the manufacture.	0-70	± 0.5 mg/L with a 50 mg/L sulfate solution.	4.9
Sulfide (Hydrogen Sulfide, H_2S)	HACH HS-C -HACH Proprietary -Mod. SM 426 C	Color Chart / Effervescence of H_2S through sulfide reactive paper.	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head.	0-5	N/A	0.1
Sulfide (S^{-2})	CHEMetrics K-9510 -SM 4500-S^2	CHEMets® Vacuum Vials / Methylene Blue	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head.	0-1 1-10	N/A	0.1 1

ATTACHMENT E

GEOCHEMICAL SAMPLING PARAMETERS - METHODS, EQUIPMENT, VOLUME, CONTAINER, PRESERVATION, HOLDING TIME, AND DETECTION RANGES

Parameter	Method / Reference	Equipment / Method Chemistry	Sample Volume, Container, Preservation, & Holding Time	Range (mg/L)	Precision (mg/L)	Estimated Detection Limit (mg/L)
Sulfide (S^{-2})	Fixed-base lab -EPA 376.1/376.2	N/A	1 liter in plastic container, no headspace. NaOH to pH >9. Cool to 4°C. Avoid agitation and analyze within 7 days.	N/A	N/A	N/A
Sulfide (S^{-2})	HACH DR-850 -HACH 8131 -SM 4500-S^2	Colorimeter / Methylene Blue	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head. Pretreatment required for turbid samples as recommended by the manufacture.	0-0.70	± 0.02 mg/L with a 0.73 mg/L sulfide solution.	0.01
Sulfide (S^{-2})	HACH HS-WR -SM 4500-S^2	Color Disc / Methylene Blue	Field. Follow test kit instructions. Avoid agitation and analyze immediately at well head. Pretreatment required for turbid samples as recommended by the manufacture.	0-11.25	N/A	0.1-2.5
Temperature	Field Meter / Thermometer - E170.1	Direct Reading Meter / Thermometer	Analyze immediately.	N/A	N/A	N/A
Total Organic Carbon (TOC)-Groundwater	Fixed-base lab -E 415.1	N/A	125 mL HDPE. H_2SO_4 to pH < 2.0. Cool to 4°C. Analyze within 28 days.	N/A	N/A	N/A
Turbidity	Field Meter - E 180.1	Direct Reading Meter	Analyze immediately.	N/A	N/A	N/A

N/A = Not applicable.

ATTACHMENT F

FIELD ANALYTICAL LOG SHEET, GEOCHEMICAL PARAMETERS
PAGE 1 OF 3

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Page __ of __

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

Sampled By: _____ Duplicate: ☐

Field Analyst: _____ Blank: ☐

Field Form Checked as per QA/QC Checklist (initials): _____

SAMPLING DATA:

Date:	Color	pH	S.C.	Temp.	Turbidity	DO	Salinity	ORP (Eh)
Time:	(Visual)	(S.U.)	(mS/cm)	(°C)	(NTU)	(mg/l)	(%)	(+/- mv)
Method:								

SAMPLE COLLECTION/ANALYSIS INFORMATION:

ORP (Eh) (+/- mv)

Electrode Make & Model: _____

Reference Electrode (circle one): Silver-Silver Chloride / Calomel / Hydrogen

Dissolved Oxygen:

Equipment: Chemetrics Test Kit

Concentration: _____ ppm

Range Used:	Range	Method	Concentration ppm
☐	0 to 1 ppm	K-7510	
☐	1 to 12 ppm	K-7512	

Analysis Time: _____

Equipment: HACH Digital Titrator OX-DT

Analysis Time: _____

Range Used:	Range	Sample Vol.	Cartridge	Multiplier
☐	1-5 mg/L	200 ml	0.200 N	0.01
☐	2-10 mg/L	100 ml	0.200 N	0.02

Titration Count	Multiplier		Concentration
_____	x 0.01	=	mg/L
_____	x 0.02	=	mg/L

Notes:

Carbon Dioxide:

Equipment: Chemetrics Test Kit

Concentration: _____ ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-1910	
☐	100 to 1000 ppm	K-1920	
☐	250 to 2500 ppm	K-1925	

Analysis Time: _____

Equipment: HACH Digital Titrator CA-DT

Range Used:	Range	Sample Vol.	Cartridge	Multiplier
☐	10-50 mg/L	200 ml	0.3636 N	0.1
☐	20-100 mg/L	100 ml	0.3636 N	0.2
☐	100-400 mg/L	200 ml	3.636 N	1.0
☐	200-1000 mg/L	100 ml	3.636 N	2.0

Titration Count			Concentration
_____	x 0.1	=	mg/L
_____	x 0.2	=	mg/L
_____	x 1.0	=	mg/L
_____	x 2.0	=	mg/L

Standard Additions: ☐ Titrant Molarity: _____ Digits Required: 1st.: _____ 2nd.: _____ 3rd.: _____

Notes:

Hydrogen, dissolved

Equipment: Bubble strip sampling field method

Start stripper at _____ (time)

End stripper at _____ (time)

Total stripper time _____

Pump rate _____ milliliters/minute

ATTACHMENT F

FIELD ANALYTICAL LOG SHEET, GEOCHEMICAL PARAMETERS
PAGE 2 OF 3

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Page __ of __

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

Sampled By: _____ Duplicate: ☐

Field Analyst: _____ Blank: ☐

Alkalinity:

Equipment: Chemetrics Test Kit Concentration: _____ ppm

Range Used:	Range	Method	Concentration ppm
☐	10 to 100 ppm	K-9810	
☐	50 to 500 ppm	K-9815	
☐	100 to 1000 ppm	K-9820	

Analysis Time: _____

Filtered: ☐

Equipment: HACH Digital Titrator AL-DT

Range Used:	Range	Sample Vol.	Cartridge	Multiplier	Titration Count	Multiplier	Concentration
☐	10-40 mg/L	100 ml	0.1600 N	0.1	_____ & _____	x 0.1	= mg/L
☐	40-160 mg/L	25 ml	0.1600 N	0.4	_____ & _____	x 0.4	= mg/L
☐	100-400 mg/L	100 ml	1.600 N	1.0	_____ & _____	x 1.0	= mg/L
☐	200-800 mg/L	50 ml	1.600 N	2.0	_____ & _____	x 2.0	= mg/L
☐	500-2000 mg/L	20 ml	1.600 N	5.0	_____ & _____	x 5.0	= mg/L
☐	1000-4000 mg/L	10 ml	1.600 N	10.0	_____ & _____	x 10.0	= mg/L

Parameter:	Hydroxide	Carbonate	Bicarbonate
Relationship:			

Standard Additions: ☐ Titrant Molarity: _____ Digits Required: 1st.: _____ 2nd.: _____ 3rd.: _____

Notes:

Ferrous Iron (Fe^{2+}):

Equipment: DR-850 DR-8 _ _ Range: 0 - 3.00 mg/L Concentration: _____ ppm

Program/Module: 500nm 33

Analysis Time: _____

Equipment: IR-18C Color Wheel Range: 0 - 10 mg/L

Notes: Filtered: ☐

Hydrogen Sulfide (H_2S): Range: 0 - 5 mg/L

Equipment: HS-C Other: _____ Concentration: _____ ppm

Exceeded 5.0 mg/L range on color chart: ☐ Analysis Time: _____

Notes:

Sulfide (S^{2-}):

Equipment: Chemetrics Test Kit Range: 0 - 10 mg/L Concentration: _____ ppm

Range Used:	Range	Method	Concentration ppm
☐	0 to 1 ppm	K-9510	
☐	1 to 10 ppm	K-9510	

Analysis Time: _____

Filtered: ☐

Equipment: DR-850 DR-8 _ _ Range: 0 - 0.70 mg/L

Program/Module: 610nm 93

Notes:

ATTACHMENT F

FIELD ANALYTICAL LOG SHEET, GEOCHEMICAL PARAMETERS
PAGE 3 OF 3

Note: Analyte, method, and/or equipment may be deleted from form if not being performed.

FIELD ANALYTICAL LOG SHEET
GEOCHEMICAL PARAMETERS

Tetra Tech NUS, Inc.

Page __ of __

Project Site Name: _____ Sample ID No.: _____

Project No.: _____ Sample Location: _____

Sampled By: _____ Duplicate: ☐

Field Analyst: _____ Blank: ☐

Sulfate (SO_4^{2-}):

Equipment: DR-850 DR-8 _ _ Range: 0 - 70 mg/L Concentration: _____ ppm

Program/Module: _____ 91 Analysis Time: _____

Standard Solution: ☐ Results: _____ Filtered: ☐

Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Notes:

Nitrate (NO_3^--N):

Equipment: DR-850 DR-8 _ _ Range: 0 - 0.50 mg/L(1) Concentration: _____ ppm

Program/Module: 55 Analysis Time: _____ Filtered: ☐

Standard Solution: ☐ Results: _____ Nitrite Interference Treatment: ☐ Reagent Blank Correction: ☐

Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Alternate forms: NO_2 _____ $NaNO_2$ _____ mg/L

Notes (1): If results are over limit use dilution method at step 3, 5ml sample 10ml DI result X3, range upto 1.5mg/L

Notes:

Nitrite (NO_2^--N):

Concentration: _____ ppm

Equipment: DR-850 DR-8 _ _ Range: 0 - 0.350 mg/L Analysis Time: _____ Filtered: ☐

Program/Module: 62

Standard Solution: ☐ Results: _____ Reagent Blank Correction: ☐

Notes:

Manganese (Mn^{2+}):

Concentration: _____ ppm

Equipment: DR-850 DR-8 _ _ Range: 0 - 20.0 mg/L Analysis Time: _____ Filtered: ☐

Program/Module: 525nm 41

Standard Solution: ☐ Results: _____ Digestion: ☐ Reagent Blank Correction: ☐

Standard Additions: ☐ Digits Required: 0.1ml:_____ 0.2ml:_____ 0.3ml:_____

Equipment: HACH MN-5 Range: 0 - 3 mg/L

Notes:

QA/QC Checklist:

All data fields have been completed as necessary: ☐

Correct measurement units are cited in the SAMPLING DATA block: ☐

Values cited in the SAMPLING DATA block are consistent with the Groundwater Sample Log Sheet: ☐

Mulitplication is correct for each *Multiplier* table: ☐

Final calulated concentration is within the appropriate *Range Used* block: ☐

Alkalinity *Relationship* is determined appropriatly as per manufacturer (HACH) instructions: ☐

QA/QC sample (e.g., Std. Additions, etc.) frequency is appropriate as per the project planning documents: ☐

Nitrite Interference treatment was used for Nitrate test if Nitrite was detected: ☐

Title block on each page of form is initialized by person who performed this QA/QC Checklist: ☐

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1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide information on sample preservation, packaging, and shipping procedures to be used in handling environmental samples submitted for chemical constituent, biological, or geotechnical analysis. Sample chain-of-custody procedures and other aspects of field documentation are addressed in SOP SA-6.3. Sample identification is addressed in SOP CT-04.

2.0 SCOPE

This procedure describes the appropriate containers to be used for samples depending on the analyses to be performed, and the steps necessary to preserve the samples when shipped off site for chemical analysis.

3.0 GLOSSARY

Hazardous Material - A substance or material which has been determined by the Secretary of Transportation to be capable of posing an unreasonable risk to health, safety, and property when transported in commerce, and which has been so designated. Under 49 CFR, the term includes hazardous substances, hazardous wastes, marine pollutants, and elevated temperature materials, as well as materials designated as hazardous under the provisions of §172.101 and §172.102 and materials that meet the defining criteria for hazard classes and divisions in Part 173. With slight modifications, IATA has adopted DOT "hazardous materials" as IATA "Dangerous Goods."

Hazardous Waste - Any substance listed in 40 CFR, Subpart D (~~y~~261.30 et seq.), or otherwise characterized as ignitable, corrosive, reactive, or toxic (as defined by Toxicity Characteristic Leaching Procedure, TCLP, analysis) as specified under 40 CFR, Subpart C (~~y~~261.20 et seq.), that would be subject to manifest requirements specified in 40 CFR 262. Such substances are defined and regulated by EPA.

Marking - A descriptive name, identification number, instructions, cautions, weight, specification or UN marks, or combination thereof required on outer packaging of hazardous materials.

n.o.i - Not otherwise indicated (may be used interchangeably with n.o.s.).

n.o.s. - Not otherwise specified.

Packaging - A receptacle and any other components or materials necessary for compliance with the minimum packaging requirements of 49 CFR 174, including containers (other than freight containers or overpacks), portable tanks, cargo tanks, tank cars, and multi-unit tank-car tanks to perform a containment function in conformance with the minimum packaging requirements of 49 CFR 173.24(a) & (b).

Placard - Color-coded, pictorial sign which depicts the hazard class symbol and name and which is placed on the side of a vehicle transporting certain hazardous materials.

Common Preservatives:

- Hydrochloric Acid - HCl
- Sulfuric Acid - H_2SO_4
- Nitric Acid - HNO_3
- Sodium Hydroxide - NaOH

Other Preservatives

- Zinc Acetate
- Sodium Thiosulfate - $Na_2S_2O_3$

Normality (N) - Concentration of a solution expressed as equivalent per liter, an equivalent being the amount of a substance containing 1 gram-atom of replaceable hydrogen or its equivalent.

Reportable Quantity (RQ) - For the purposes of this SOP, means the quantity specified in column 3 of the Appendix to DOT 49 CFR §172.101 for any material identified in column 1 of the appendix. A spill greater than the amount specified must be reported to the National Response Center.

Sample - A sample is physical evidence collected from a facility or the environment, which is representative of conditions at the location and time of collection.

4.0 RESPONSIBILITIES

Field Operations Leader - Directly responsible for the bottling, preservation, labeling, packaging, shipping, and custody of samples up to and including release to the shipper.

Field Samplers - Responsible for initiating the Chain-of-Custody Record (per SOP SA-6.3), implementing the packaging and shipping requirements, and maintaining custody of samples until they are relinquished to another custodian or to the shipper.

5.0 PROCEDURES

Sample identification, labeling, documentation, and chain-of-custody are addressed by SOP SA-6.3.

5.1 Sample Containers

Different types of chemicals react differently with sample containers made of various materials. For example, trace metals adsorb more strongly to glass than to plastic, whereas many organic chemicals may dissolve various types of plastic containers. Attachments A and B show proper containers (as well as other information) per 40 CFR 136. In general, the sample container shall allow approximately 5-10 percent air space ("ullage") to allow for expansion/vaporization if the sample warms during transport. However, for collection of volatile organic compounds, head space shall be omitted. The analytical laboratory will generally provide certified-clean containers for samples to be analyzed for chemical constituents. Shelby tubes or other sample containers are generally provided by the driller for samples requiring geotechnical analysis. Sufficient lead time shall be allowed for a delivery of sample container orders. Therefore, it is critical to use the correct container to maintain the integrity of the sample prior to analysis.

Once opened, the container must be used at once for storage of a particular sample. Unused but opened containers are to be considered contaminated and must be discarded. Because of the potential for introduction of contamination, they cannot be reclosed and saved for later use. Likewise, any unused containers which appear contaminated upon receipt, or which are found to have loose caps or a missing Teflon liner (if required for the container), shall be discarded.

5.2 Sample Preservation

Many water and soil samples are unstable and therefore require preservation to prevent changes in either the concentration or the physical condition of the constituent(s) requiring analysis. Although complete and irreversible preservation of samples is not possible, preservation does retard the chemical and biological

changes that inevitably take place after the sample is collected. Preservation techniques are usually limited to pH control, chemical addition(s), and refrigeration/ freezing (certain biological samples only).

5.2.1 Overview

The preservation techniques to be used for various analytes are listed in Attachments A and B. Reagents required for sample preservation will either be added to the sample containers by the laboratory prior to their shipment to the field or be added in the field (in a clean environment). Only high purity reagents shall be used for preservation. In general, aqueous samples of low-concentration organics (or soil samples of low- or medium-concentration organics) are cooled to 4°C. Medium-concentration aqueous samples, high-hazard organic samples, and some gas samples are typically not preserved. Low-concentration aqueous samples for metals are acidified with HNO_3, whereas medium-concentration and high-hazard aqueous metal samples are not preserved. Low- or medium-concentration soil samples for metals are cooled to 4°C, whereas high-hazard samples are not cooled.

The following subsections describe the procedures for preparing and adding chemical preservatives. Attachments A and B indicate the specific analytes which require these preservatives.

The FOL is responsible for ensuring that an accurate Chemical Inventory is created and maintained for all hazardous chemicals brought to the work site (see Section 5 of the TtNUS Health and Safety Guidance Manual). Furthermore, the FOL must ensure that a corresponding Material Safety Data Sheet (MSDS) is collected for every substance entered on the site Chemical Inventory, and that all persons using/handling/ disposing of these substances review the appropriate MSDS for substances they will work with. The Chemical Inventory and the MSDSs must be maintained at each work site in a location and manner where they are readily-accessible to all personnel.

5.2.2 Preparation and Addition of Reagents

Addition of the following acids or bases may be specified for sample preservation; these reagents shall be analytical reagent (AR) grade or purer and shall be diluted to the required concentration with deionized water before field sampling commences. To avoid uncontrolled reactions, be sure to Add Acid to water (not vice versa). A dilutions guide is provided below.

Acid/Base	Dilution	Concentration	Estimated Amount Required for Preservation
Hydrochloric Acid (HCl)	1 part concentrated HCl: 1 part double-distilled, deionized water	6N	5-10 mL
Sulfuric Acid (H_2SO_4)	1 part concentrated H_2SO_4: 1 part double-distilled, deionized water	18N	2 - 5 mL
Nitric Acid (HNO_3)	Undiluted concentrated HNO_3	16N	2 - 5 mL
Sodium Hydroxide (NaOH)	400 grams solid NaOH dissolved in 870 mL double-distilled, deionized water; yields 1 liter of solution	10N	2 mL

The amounts required for preservation shown in the above table assumes proper preparation of the preservative and addition of the preservative to one liter of aqueous sample. This assumes that the sample is initially at pH 7, is poorly buffered, and does not contain particulate matter; as these conditions vary, more preservative may be required. Consequently, the final sample pH must be checked using narrow-range pH paper, as described in the generalized procedure detailed below:

- Pour off 5-10 mL of sample into a dedicated, clean container. Use some of this sample to check the initial sample pH using wide range (0-14) pH paper. Never dip the pH paper into the sample; always apply a drop of sample to the pH paper using a clean stirring rod or pipette.

- Add about one-half of the estimated preservative required to the original sample bottle. Cap and invert gently several times to mix. Check pH (as described above) using medium range pH paper (pH 0-6 or pH 7.5-14, as applicable).

- Cap sample bottle and seal securely.

Additional considerations are discussed below:

- To test if ascorbic acid must be used to remove oxidizing agents present in the sample before it can be properly preserved, place a drop of sample on KI-starch paper. A blue color indicates the need for ascorbic acid addition.

  If required, add a few crystals of ascorbic acid to the sample and retest with the KI-starch paper. Repeat until a drop of sample produces no color on the KI-starch paper. Then add an additional 0.6 grams of ascorbic acid per each liter of sample volume.

  Continue with proper base preservation of the sample as described above.

- Samples for sulfide analysis must be treated by the addition of 4 drops (0.2 mL) of 2N zinc acetate solution per 100 ml of sample.

  The 2N zinc acetate solution is made by dissolving 220 grams of zinc acetate in 870 mL of double-distilled, deionized water to make 1 liter of solution.

  The sample pH is then raised to 9 using the NaOH preservative.

- Sodium thiosulfate must be added to remove residual chlorine from a sample. To test the sample for residual chlorine use a field test kit specially made for this purpose.

  If residual chlorine is present, add 0.08 grams of sodium thiosulfate per liter of sample to remove the residual chlorine.

  Continue with proper acidification of the sample as described above.

For biological samples, 10% buffered formalin or isopropanol may also be required for preservation. Questions regarding preservation requirements should be resolved through communication with the laboratory before sampling begins.

5.3 Field Filtration

At times, field-filtration may be required to provide for the analysis of dissolved chemical constituents. Field-filtration must be performed prior to the preservation of samples as described above. General procedures for field filtration are described below:

- The sample shall be filtered through a non-metallic, 0.45-micron membrane filter, immediately after collection. The filtration system shall consist of dedicated filter canister, dedicated tubing, and a peristaltic pump with pressure or vacuum pumping squeeze action (since the sample is filtered by mechanical peristalsis, the sample travels only through the tubing).

- To perform filtration, thread the tubing through the peristaltic pump head. Attach the filter canister to the discharge end of the silicon tubing (note flow direction arrow); attach the aqueous sample container to the intake end of the silicon tubing. Turn the peristaltic pump on and perform filtration. Run approximately 100 ml of sample through the filter and discard prior to sample collection.

- Continue by preserving the filtrate (contained in the filter canister), as applicable and generally described above.

5.4 Sample Packaging and Shipping

Only employees who have successfully completed the TtNUS "Shipping Hazardous Materials" training course are authorized to package and ship hazardous substances. These trained individuals are responsible for performing shipping duties in accordance with this training.

Samples collected for shipment from a site shall be classified as either environmental or hazardous material samples. Samples from drums containing materials other than Investigative Derived Waste (IDW) and samples obtained from waste piles or bulk storage tanks are generally shipped as hazardous materials. A distinction must be made between the two types of samples in order to:

- Determine appropriate procedures for transportation of samples (if there is any doubt, a sample shall be considered hazardous and shipped accordingly.)

- Protect the health and safety of transport and laboratory personnel receiving the samples (special precautions are used by the shipper and at laboratories when hazardous materials are received.)

Detailed procedures for packaging environmental samples are outlined in the remainder of this section.

5.4.1 Environmental Samples

Environmental samples are packaged as follows:

- Place properly identified sample container, with lid securely fastened, in a plastic bag (e.g. Ziploc baggie), and seal the bag.

- Place sample in a cooler constructed of sturdy material which has been lined with a large, plastic bag (e.g. "garbage" bag). Drain plugs on coolers must be taped shut.

- Pack with enough cushioning materials such as bubble wrap (shoulders of bottles must be iced if required) to minimize the possibility of the container breaking.

- If cooling is required (see Attachments A and B), place ice around sample container shoulders, and on top of packing material (minimum of 8 pounds of ice for a medium-size cooler).

- Seal (i.e., tape or tie top in knot) large liner bag.

- The original (top, signed copy) of the COC form shall be placed inside a large Ziploc-type bag and taped inside the lid of the shipping cooler. If multiple coolers are sent but are included on one COC form, the COC form should be sent with the cooler containing the vials for VOC analysis. The COC form should then state how many coolers are included with that shipment.

- Close and seal outside of cooler as described in SOP SA-6.3. Signed custody seals must be used.

Coolers must be marked as containing "Environmental Samples." The appropriate side of the container must be marked "This End Up" and arrows placed appropriately. No DOT marking or labeling is required; there are no DOT restrictions on mode of transportation.

6.0 REFERENCES

American Public Health Association, 1981. Standard Methods for the Examination of Water and Wastewater, 15th Edition. APHA, Washington, D.C.

International Air Transport Association (latest issue). Dangerous Goods Regulations, Montreal, Quebec, Canada.

U.S. Department of Transportation (latest issue). Hazardous Materials Regulations, 49 CFR 171-177.

U.S. EPA, 1984. "Guidelines Establishing Test Procedures for the Analysis of Pollutants under Clean Water Act." Federal Register, Volume 49 (209), October 26, 1984, p. 43234.

U.S. EPA, 1979. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020, U.S. EPA-EMSL, Cincinnati, Ohio.

ATTACHMENT A

GENERAL SAMPLE CONTAINER AND PRESERVATION REQUIREMENTS

Sample Type and Concentration			Container[1]	Sample Size	Preservation[2]	Holding Time[2]
WATER						
Organics (GC&GC/MS)	VOC	Low	Borosilicate glass	2 x 40 mL	Cool to 4°C HCl to ≤ 2	14 days[9]
	Extractables SVOCs and pesticide/PCBs)	(Low	Amber glass	2x2 L or 4x1 L	Cool to 4°C	7 days to extraction; 40 days after extraction
	Extractables SVOCs and pesticide/PCBs)	(Medium	Amber glass	2x2 L or 4x1 L	None	7 days to extraction; 40 days after extraction
Inorganics	Metals	Low	High-density polyethylene	1 L	HNO_3 to pH ≤2	6 months (Hg-28 days)
		Medium	Wide-mouth glass	16 oz.	None	6 months
	Cyanide	Low	High-density polyethylene	1 L	NaOH to pH>12	14 days
	Cyanide	Medium	Wide-mouth glass	16 oz.	None	14 days
Organic/ Inorganic	High Hazard		Wide-mouth glass	8 oz.	None	14 days
SOIL						
Organics (GC&GC/MS)	VOC		EnCore Sampler	(3) 5 g Samplers	Cool to 4°C	48 hours to lab preservation
	Extractables SVOCs and pesticides/PCBs)	(Low	Wide-mouth glass	8 oz.	Cool to 4°C	14 days to extraction; 40 days after extraction
	Extractables SVOCs and pesticides/PCBs)	(Medium	Wide-mouth glass	8 oz.	Cool to 4°C	14 days to extraction; 40 days after extraction
Inorganics	Low/Medium		Wide-mouth glass	8 oz.	Cool to 4°C	6 months (Hg - 28 days) Cyanide (14 days)
Organic/Inorganic	High Hazard		Wide-mouth glass	8 oz.	None	NA
Dioxin/Furan	All		Wide-mouth glass	4 oz.	None	35 days until extraction; 40 days after extraction
TCLP	All		Wide-mouth glass	8 oz.	None	7 days until preparation; analysis as per fraction
AIR						
Volatile Organics	Low/Medium		Charcoal tube -- 7 cm long, 6 mm OD, 4 mm ID	100 L air	Cool to 4°C	5 days recommended

1 All glass containers should have Teflon cap liners or septa.
2 See Attachment E. Preservation and maximum holding time allowances per 40 CFR 136.

ATTACHMENT B

ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES

Parameter Number/Name	Container[1]	Preservation[2][3]	Maximum Holding Time[4]
INORGANIC TESTS:			
Acidity	P, G	Cool, 4°C	14 days
Alkalinity	P, G	Cool, 4°C	14 days
Ammonia - Nitrogen	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Biochemical Oxygen Demand (BOD)	P, G	Cool, 4°C	48 hours
Bromide	P, G	None required	28 days
Chemical Oxygen Demand (COD)	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Chloride	P, G	None required	28 days
Chlorine, Total Residual	P, G	None required	Analyze immediately
Color	P, G	Cool, 4°C	48 hours
Cyanide, Total and Amenable to Chlorination	P, G	Cool, 4°C; NaOH to pH 12; 0.6 g ascorbic acid[5]	14 days[6]
Fluoride	P	None required	28 days
Hardness	P, G	HNO_3 to pH 2; H_2SO_4 to pH 2	6 months
Total Kjeldahl and Organic Nitrogen	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Nitrate - Nitrogen	P, G	None required	48 hours
Nitrate-Nitrite - Nitrogen	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Nitrite - Nitrogen	P, G	Cool, 4°C	48 hours
Oil & Grease	G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Total Organic Carbon (TOC)	P, G	Cool, 4°C; HCl or H_2SO_4 to pH 2	28 days
Orthophosphate	P, G	Filter immediately; Cool, 4°C	48 hours
Oxygen, Dissolved-Probe	G Bottle & top	None required	Analyze immediately
Oxygen, Dissolved-Winkler	G Bottle & top	Fix on site and store in dark	8 hours
Phenols	G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Phosphorus, Total	P, G	Cool, 4°C; H_2SO_4 to pH 2	28 days
Residue, Total	P, G	Cool, 4°C	7 days
Residue, Filterable (TDS)	P, G	Cool, 4°C	7 days
Residue, Nonfilterable (TSS)	P, G	Cool, 4°C	7 days
Residue, Settleable	P, G	Cool, 4°C	48 hours
Residue, Volatile (Ash Content)	P, G	Cool, 4°C	7 days
Silica	P	Cool, 4°C	28 days
Specific Conductance	P, G	Cool, 4°C	28 days
Sulfate	P, G	Cool, 4°C	28 days

ATTACHMENT B
ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES
PAGE TWO

Parameter Number/Name	Container[1]	Preservation[2][3]	Maximum Holding Time[4]
INORGANIC TESTS (Cont'd):			
Sulfide	P, G	Cool, 4°C; add zinc acetate plus sodium hydroxide to pH 9	7 days
Sulfite	P, G	None required	Analyze immediately
Turbidity	P, G	Cool, 4°C	48 hours
METALS:[7]			
Chromium VI (Hexachrome)	P, G	Cool, 4°C	24 hours
Mercury (Hg)	P, G	HNO_3 to pH 2	28 days
Metals, except Chromium VI and Mercury	P, G	HNO_3 to pH 2	6 months
ORGANIC TESTS:[8]			
Purgeable Halocarbons	G, Teflon-lined septum	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]	14 days
Purgeable Aromatic Hydrocarbons	G, Teflon-lined septum	Cool, 4°C; 0.008% $Na_2S_2O_3$[5] HCl to pH 2 [9]	14 days
Acrolein and Acrylonitrile	G, Teflon-lined septum	Cool, 4°C; 0.008% $Na_2S_2O_3$[5] adjust pH to 4-5 [10]	14 days
Phenols[11]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]	7 days until extraction; 40 days after extraction
Benzidines[11], [12]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]	7 days until extraction[13]
Phthalate esters[11]	G, Teflon-lined cap	Cool, 4°C	7 days until extraction; 40 days after extraction
Nitrosamines[11], [14]	G, Teflon-lined cap	Cool, 4°C; store in dark; 0.008% $Na_2S_2O_3$[5]	7 days until extraction; 40 days after extraction
PCBs[11]	G, Teflon-lined cap	Cool, 4°C	7 days until extraction; 40 days after extraction
Nitroaromatics & Isophorone[11]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]; store in dark	7 days until extraction; 40 days after extraction
Polynuclear Aromatic Hydrocarbons (PAHs)[11],[14]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]; store in dark	7 days until extraction; 40 days after extraction
Haloethers[11]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]	7 days until extraction; 40 days after extraction
Dioxin/Furan (TCDD/TCDF)[11]	G, Teflon-lined cap	Cool, 4°C; 0.008% $Na_2S_2O_3$[5]	7 days until extraction; 40 days after extraction

ATTACHMENT B
ADDITIONAL REQUIRED CONTAINERS, PRESERVATION TECHNIQUES, AND HOLDING TIMES
PAGE THREE

(1) Polyethylene (P): generally 500 ml or Glass (G): generally 1L.
(2) Sample preservation should be performed immediately upon sample collection. For composite chemical samples each aliquot should be preserved at the time of collection. When use of an automated sampler makes it impossible to preserve each aliquot, then chemical samples may be preserved by maintaining at 4°C until compositing and sample splitting is completed.
(3) When any sample is to be shipped by common carrier or sent through the United States Mail, it must comply with the Department of Transportation Hazardous Materials Regulations (49 CFR Part 172).
(4) Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis and still be considered valid. Samples may be held for longer periods only if the permittee, or monitoring laboratory, has data on file to show that the specific types of samples under study are stable for the longer periods, and has received a variance from the Regional Administrator.
(5) Should only be used in the presence of residual chlorine.
(6) Maximum holding time is 24 hours when sulfide is present. Optionally, all samples may be tested with lead acetate paper before pH adjustments are made to determine if sulfide is present. If sulfide is present, it can be removed by the addition of cadmium nitrate powder until a negative spot test is obtained. The sample is filtered and then NaOH is added to pH 12.
(7) Samples should be filtered immediately on site before adding preservative for dissolved metals.
(8) Guidance applies to samples to be analyzed by GC, LC, or GC/MS for specific compounds.
(9) Sample receiving no pH adjustment must be analyzed within 7 days of sampling.
(10) The pH adjustment is not required if acrolein will not be measured. Samples for acrolein receiving no pH adjustment must be analyzed within 3 days of sampling.
(11) When the extractable analytes of concern fall within a single chemical category, the specified preservative and maximum holding times should be observed for optimum safeguard of sample integrity. When the analytes of concern fall within two or more chemical categories, the sample may be preserved by cooling to 4°C, reducing residual chlorine with 0.008% sodium thiosulfate, storing in the dark, and adjusting the pH to 6-9; samples preserved in this manner may be held for 7 days before extraction and for 40 days after extraction. Exceptions to this optional preservation and holding time procedure are noted in footnote 5 (re: the requirement for thiosulfate reduction of residual chlorine) and footnotes 12, 13 (re: the analysis of benzidine).
(12) If 1,2-diphenylthydrazine is likely to be present, adjust the pH of the sample to 4.0±0.2 to prevent rearrangement to benzidine.
(13) Extracts may be stored up to 7 days before analysis if storage is conducted under an inert (oxidant-free) atmosphere.
(14) For the analysis of diphenylnitrosamine, add 0.008% $Na_2S_2O_3$ and adjust pH to 7-10 with NaOH within 24 hours of sampling.
(15) The pH adjustment may be performed upon receipt at the laboratory and may be omitted if the samples are extracted within 72 hours of collection. For the analysis of aldrin, add 0.008% $Na_2S_2O_3$.

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1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to identify and designate the field data record forms, logs, and reports generally initiated and maintained for documenting Tetra Tech NUS, Inc. (TtNUS) field activities.

2.0 SCOPE

Documents presented within this SOP (or equivalents) shall be used for all TtNUS field activities, as applicable. Other or additional documents may be required by specific client contracts or project planning documents.

3.0 GLOSSARY

None.

4.0 RESPONSIBILITIES AND PERSONNEL QUALIFICATIONS

Project Manager (PM) - The PM is responsible for obtaining hardbound controlled-distribution logbooks (from the appropriate source), as needed. In addition, the Project Manager is responsible for placing all field documentation used in site activities (i.e., records, field reports, sample data sheets, field notebooks, and the site logbook) in the project's central file upon the completion of field work.

Field Operations Leader (FOL) - The FOL is responsible for ensuring that the site logbook, notebooks, and all appropriate and current forms and field reports included in this SOP (and any additional forms required by the contract) are correctly used, accurately filled out, and completed in the required time frame.

General personnel qualifications for field documentation activities include the following:

- Occupational Safety and Health Administration (OSHA) 40-hour and applicable refresher training.
- Capability of performing field work under the expected physical and environmental (i.e., weather) conditions.
- Familiarity with appropriate procedures for documentation, handling, packaging, and shipping.

5.0 PROCEDURES

5.1 SITE LOGBOOK

5.1.1 General

The site logbook is a hard-bound, paginated, controlled-distribution record book in which all major on-site activities are documented. At a minimum, record or reference the following activities/events (daily) in the site logbook:

- All field personnel present
- Arrival/departure times and names of site visitors
- Times and dates of health and safety training
- Arrival/departure times of equipment
- Times and dates of equipment calibration

- Start and/or completion of borehole, trench, monitoring well installation activities, etc.
- Daily on-site activities
- Sample pickup information
- Health and safety issues (level of protection, personal protective equipment [PPE], etc.)
- Weather conditions

Maintain a site logbook for each project and initiate it at the start of the first on-site activity (e.g., site visit or initial reconnaissance survey). Make entries every day that on-site activities take place involving TtNUS or subcontractor personnel. Upon completion of the fieldwork, provide the site logbook to the PM or designee for inclusion in the project's central file.

Record the following information on the cover of each site logbook:

- Project name
- TtNUS project number
- Sequential book number
- Start date
- End date

Information recorded daily in the site logbook need not be duplicated in other field notebooks (see Section 5.2) but must summarize the contents of these other notebooks and refer to specific page locations in these notebooks for detailed information (where applicable). An example of a typical site logbook entry is shown in Attachment A.

If measurements are made at any location, either record the measurements and equipment used in the site logbook or reference the field notebook in which the measurements are recorded (see Attachment A).

Make all logbook, notebook, and log sheet entries in indelible ink (black pen is preferred). No erasures are permitted. If an incorrect entry is made, cross out the entry with a single strike mark, initial, and date it. At the completion of entries by any individual, the logbook pages used must be signed and dated by the person making the entries. The site logbook must also be signed by the FOL at the end of each day.

5.1.2 Photographs

Sequentially number movies, slides, or photographs taken of a site or any monitoring location to correspond to logbook/notebook entries. Enter the name of the photographer, date, time, site location, site description, and weather conditions in the logbook/notebook as the photographs are taken. A series entry may be used for rapid-sequence photographs. The photographer is not required to record the aperture settings and shutter speeds for photographs taken within the normal automatic exposure range. However, special lenses, films, filters, and other image-enhancement techniques must be noted in the logbook/notebook. If possible, such techniques shall be avoided because they can adversely affect the accuracy of photographs. Chain-of-custody procedures depend on the subject matter, type of camera (digital or film), and the processing it requires. Follow chain-of-custody procedures for film used for aerial photography, confidential information, or criminal investigation. After processed, consecutively number the slides of photographic prints and label them according to the logbook/notebook descriptions. Docket the site photographs and associated negatives and/or digitally saved images to compact disks into the project's central file.

5.2 FIELD NOTEBOOKS

Key field team personnel may maintain a separate dedicated field notebook to document the pertinent field activities conducted directly under their supervision. For example, on large projects with multiple investigative sites and varying operating conditions, the Health and Safety Officer may elect to maintain a

separate field notebook. Where several drill rigs are in operation simultaneously, each site geologist assigned to oversee a rig must maintain a field notebook.

5.3 FIELD FORMS

All TtNUS field forms (see list in Section 6.0 of this SOP) can be found on the company's intranet site (http://intranet.ttnus.com) under Field Log Sheets. Forms may be altered or revised for project-specific needs, subject to client approval. Care must be taken to ensure that all essential information can be documented. Guidelines for completing these forms can be found in the related sampling SOPs.

5.3.1 Sample Collection, Labeling, Shipment, Request for Analysis, and Field Test Results

5.3.1.1 Sample Log Sheet

Sample log sheets are used to record specified types of data while sampling. The data recorded on these sheets are useful in describing the sample as well as pointing out any problems, difficulties, or irregularities encountered during sampling. Complete a sample log sheet for each sample obtained, including field quality control (QC) samples.

5.3.1.2 Sample Label

A typical sample label is illustrated in Attachment B. Complete the required information on the adhesive labels and apply them to every sample container. Obtain sample labels from the appropriate program/project source, request that they be electronically generated in house, or request them the laboratory subcontractor.

5.3.1.3 Chain-of-Custody Record

The chain-of-custody record is a multi-part form that is initiated as samples are acquired and accompanies a sample (or group of samples) as they are transferred from person to person. This form must be used as follows for any samples collected for chemical or geotechnical analysis whether the analyses are performed on site or off site:

- Retain one carbonless copy of the completed chain-of custody form in the field.
- Send one copy is sent to the PM (or designee)
- Send the original to the laboratory with the associated samples. Place the original (top, signed copy) of the chain-of custody form inside a large Ziploc®-type bag taped inside the lid of the shipping cooler. If multiple coolers are sent but are included on one chain-of custody form, send the form with the cooler containing vials for volatile organic compound (VOC) analysis or the cooler with the air bill attached. Indicate on the air bill how many coolers are included with that shipment.

An example of a chain-of-custody form is provided as Attachment C. After the samples are received at the laboratory, the sample cooler and contents are checked and any problems are noted on the enclosed chain-of custody form (any discrepancies between the sample labels and chain-of custody form and any other problems that are noted are resolved through communication between the laboratory point-of-contact and the TtNUS PM). The chain-of custody form is signed and copied. The laboratory will retain the copy, and the original becomes part of the samples' corresponding analytical data package.

5.3.1.4 Chain-of-Custody Seal

Attachment D is an example of a custody seal. The custody seal is an adhesive-backed label that is part of a chain-of-custody process and is used to prevent tampering with samples after they have been collected in the field and sealed in coolers for transport to the laboratory. Sign and date custody seals

and affix them across the lid and body of each cooler (front and back) containing environmental samples (see SOP SA-6.1). Obtain custody seals from the laboratory (if available) or purchase them from a supplier.

5.3.1.5 Geochemical Parameters Log Sheets

Complete Field Analytical Log Sheets to record geochemical and/or natural attenuation field test results.

5.3.2 Hydrogeological and Geotechnical Forms

5.3.2.1 Groundwater Level Measurement Sheet

Complete a Groundwater Level Measurement Sheet for each round of water level measurements made at a site.

5.3.2.2 Data Sheet for Pumping Test

During the performance of a pumping test (or an in-situ hydraulic conductivity test), a large amount of data must be recorded, often within a short time period. Use a Pumping Test Data Sheet to facilitate this task by standardizing the data collection format for the pumping well and observation wells, and allowing the time interval for collection to be established in advance.

5.3.2.3 Packer Test Report Form

Complete a Packer Test Report Form for each well at which a packer test is conducted.

5.3.2.4 Boring Log

Complete a Summary Log of Boring, or Boring Log for each soil boring performed to document the materials encountered, operation and driving of casing, and locations/depths of samples collected. In addition, if volatile organics are monitored on cores, samples, cuttings from the borehole, or breathing zone, (using a photoionization detector [PID] or flame ionization detector [FID]), enter these readings on the boring log at the appropriate depth. When they become available, enter the laboratory sample number, concentrations of key contaminants, or other pertinent information in the "Remarks" column. This feature allows direct comparison of contaminant concentrations with soil characteristics.

5.3.2.5 Monitoring Well Construction Details Form

Complete a Monitoring Well Construction Details Form for every monitoring well, piezometer, or temporary well point installed. This form contains specific information on length and type of well riser pipe and screen, backfill, filter pack, annular seal and grout characteristics, and surface seal characteristics. This information is important in evaluating the performance of the monitoring well, particularly in areas where water levels show temporal variation or where there are multiple (immiscible) phases of contaminants. Depending on the type of monitoring well (in overburden or bedrock, stick-up or flush mount), different forms are used.

5.3.2.6 Test Pit Log

When a test pit or trench is constructed for investigative or sampling purposes, a Test Pit Log must be filled out by the responsible field geologist or sampling technician.

5.3.2.7 Miscellaneous Monitoring Well Forms

Miscellaneous monitoring well forms that may be required on a project-specific basis include the Monitoring Well Materials Certificate of Conformance and Monitoring Well Development Record. Use a Monitoring Well Materials Certificate of Conformance to document all materials utilized during each monitoring well installation. Use a Monitoring Well Development Record to document all well development activities.

5.3.2.8 Miscellaneous Field Forms – Quality Assurance and Checklists

Miscellaneous field forms/checklists forms that may be required on a project-specific basis include the following:

- Container Sample and Inspection Sheet – use this form when a container (drum, tank, etc.) is sampled and/or inspected.
- QA Sample Log Sheet – use this form when a QA sample such as an equipment rinsate blank, source blank, etc. is collected.
- Field Task Modification Request (FTMR) – use this form to document deviations from the project planning documents. The FOL is responsible for initiating the FTMRs. Maintain copies of all FTMRs with the on-site planning documents, and place originals in the final evidence file.
- Field Project Daily Activities Checklist and Field Project Pre-Mobilization Checklist – used these during both the planning and field effort to ensure that all necessary tasks are planned for and completed. These two forms are not requirements but are useful tools for most field work.

5.3.3 Equipment Calibration and Maintenance Form

The calibration or standardization of monitoring, measuring, or test equipment is necessary to ensure the proper operation and response of the equipment, to document the accuracy, precision, or sensitivity of the measurements, and determine if correction should be applied to the readings. Some items of equipment require frequent calibration, others infrequent. Some are calibrated by the manufacturer, others by the user.

Each instrument requiring calibration has its own Equipment Calibration Log, which documents that the manufacturer's instructions were followed for calibration of the equipment, including frequency and type of standard or calibration device. Maintain an Equipment Calibration Log for each electronic measuring device used in the field; make entries for each day the equipment is used or in accordance with manufacturer recommendations.

5.4 FIELD REPORTS

The primary means of recording on-site activities is the site logbook. Other field notebooks may also be maintained. These logbooks and notebooks (and supporting forms) contain detailed information required for data interpretation or documentation but are not easily used for tracking and reporting of progress. Furthermore, the field logbook/notebooks remain on site for extended periods of time and are thus not accessible for timely review by project management. Other reports useful for tracking and reporting the progress of field activities are described below.

5.4.1 Daily Activities Report

To provide timely oversight of on-site contractors, complete and submit Daily Activities Reports (DARs) as described below.

5.4.1.1 Description

The DAR documents the activities and progress for each day's field work. Complete this report on a daily basis whenever there are drilling, test pitting, well construction, or other related activities occurring that involve subcontractor personnel. These sheets summarize the work performed and form the basis of payment to subcontractors. The DAR form can be found on the TtNUS intranet site.

5.4.1.2 Responsibilities

It is the responsibility of the rig geologist to complete the DAR and obtain the driller's signature acknowledging that the times and quantities of material entered are correct.

5.4.1.3 Submittal and Approval

At the end of the shift, the rig geologist must submit the DAR to the FOL for review and filing. The Daily Activities Report is not a formal report and thus requires no further approval. The DARs are retained by the FOL for use in preparing the site logbook and in preparing weekly status reports for submission to the PM.

5.4.2 Weekly Status Reports

To facilitate timely review by project management, photocopies of logbook/notebook entries may be made for internal use.

In addition to those described herein, other summary reports may also be contractually required.

All TtNUS field forms can be found on the company's intranet site at http://intranet.ttnus.com under Field Log Sheets.

6.0 LISTING OF FIELD FORMS ON THE TtNUS INTRANET SITE

- Boring Log
- Container Sample and Inspection Sheet
- Daily Activities Checklist
- Daily Activities Record
- Equipment Calibration Log
- Field Task Modification Request
- Field Analytical Log sheet - Geochemical Parameters
- Groundwater Level Measurement Sheet
- Groundwater Sample Log Sheet
- Hydraulic Conductivity Test Data Sheet
- Low Flow Purge Data Sheet
- Bedrock Monitoring Well Construction (Stick Up)
- Bedrock Monitoring Well Construction Flush Mount
- Bedrock Monitoring Well Construction Open Hole
- Confining Layer Monitoring Well Construction
- Monitoring Well Development Record

- Monitoring Well Materials Certificate of Conformance
- Overburden Monitoring Well Construction Flush Mount
- Overburden Monitoring Well Construction Stick Up
- Packer Test Report Form
- Pumping Test Data Sheet
- QA Sample Log Sheet
- Soil/Sediment Sample Log Sheet
- Surface Water Sample Log Sheet
- Test Pit Log
- Field Project Pre-Mobilization Checklist

ATTACHMENT A
TYPICAL SITE LOGBOOK ENTRY

START TIME: _____ DATE: _____

SITE LEADER: _____
PERSONNEL:

TtNUS	DRILLER	SITE VISITORS
_____	_____	_____
_____	_____	_____
_____	_____	_____

WEATHER: Clear, 68°F, 2-5 mph wind from SE

ACTIVITIES:

1. Steam jenney and fire hoses were set up.
2. Drilling activities at well ____ resumes. Rig geologist was _____. See Geologist's Notebook, No. 1, page 29-30, for details of drilling activity. Sample No. 123-21-S4 collected; see sample logbook, page 42. Drilling activities completed at 11:50 and a 4-inch stainless steel well installed. See Geologist's Notebook, No. 1, page 31, and well construction details for well _____.
3. Drilling rig No. 2 steam-cleaned at decontamination pit. Then set up at location of well _____.
4. Well _____ drilled. Rig geologist was _____. See Geologist's Notebook, No. 2, page ____ for details of drilling activities. Sample numbers 123-22-S1, 123-22-S2, and 123-22-S3 collected; see sample logbook, pages 43, 44, and 45.
5. Well _____ was developed. Seven 55-gallon drums were filled in the flushing stage. The well was then pumped using the pitcher pump for 1 hour. At the end of the hour, water pumped from well was "sand free."
6. EPA remedial project manger arrives on site at 14:25 hours.
7. Large dump truck arrives at 14:45 and is steam-cleaned. Backhoe and dump truck set up over test pit _____.
8. Test pit _____ dug with cuttings placed in dump truck. Rig geologist was _____. See Geologist's Notebook, No. 1, page 32, for details of test pit activities. Test pit subsequently filled. No samples taken for chemical analysis. Due to shallow groundwater table, filling in of test pit ___ resulted in a very soft and wet area. A mound was developed and the area roped off.
9. Express carrier picked up samples (see Sample Logbook, pages 42 through 45) at 17:50 hours. Site activities terminated at 18:22 hours. All personnel off site, gate locked.

_____

Field Operations Leader

ATTACHMENT B
SAMPLE LABEL

Tetra Tech NUS, Inc. 661 Andersen Drive Pittsburgh, 15220 (412)921-7090	Project: Site: Location:		
Sample No:			Matrix:
Date:	Time:	Preserve:	
Analysis:			
Sampled by:	Laboratory:		

ATTACHMENT C
CHAIN-OF-CUSTODY RECORD FORM

TETRA TECH NUS, INC.

CHAIN OF CUSTODY | NUMBER 3413 | PAGE ___ OF ___

PROJECT NO: | FACILITY: | PROJECT MANAGER | PHONE NUMBER | LABORATORY NAME AND CONTACT:

SAMPLERS (SIGNATURE) | FIELD OPERATIONS LEADER | PHONE NUMBER | ADDRESS

CARRIER/WAYBILL NUMBER | CITY, STATE

STANDARD TAT ☐
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR	TIME	SAMPLE ID	LOCATION ID	TOP DEPTH (FT)	BOTTOM DEPTH (FT)	MATRIX (GW, SO, SW, SD, QC, ETC.)	COLLECTION METHOD GRAP (G) COMP (C)	No. OF CONTAINERS	CONTAINER TYPE PLASTIC (P) or GLASS (G) / PRESERVATIVE USED / TYPE OF ANALYSIS	COMMENTS

	DATE	TIME
1. RELINQUISHED BY	DATE	TIME
2. RELINQUISHED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME

	DATE	TIME
1. RECEIVED BY	DATE	TIME
2. RECEIVED BY	DATE	TIME
3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

FORM NO. TtNUS-001 4/02R

ATTACHMENT D
CHAIN-OF-CUSTODY SEAL

CUSTODY SEAL	**CUSTODY SEAL**
Date _____	**Date** _____
Signature _____	**Signature** _____

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1.0 PURPOSE

Decontamination is the process of removing and/or neutralizing site contaminants that have contacted and/or accumulated on equipment. The purpose of this Standard Operating Procedure (SOP) is to protect site personnel, the general public, and the environment while preserving or maintaining sample integrity. It is further intended through this procedure to describe the steps necessary for proper decontamination of drilling equipment, earth-moving equipment , chemical sampling equipment and field operation and analytical equipment.

2.0 SCOPE AND APPLICABILITY

This procedure applies to all equipment used to provide access to/acquire environmental samples that may have become contaminated through direct contact with contaminated media including air, water, and soil. This equipment includes drilling and heavy equipment and chemical sampling and field analytical equipment. Where technologically and economically feasible, single-use sealed disposable equipment will be employed to minimize the potential for cross-contamination. This SOP also provides general reference information on the control of contaminated materials.

Decontamination methods and equipment requirements may differ from one project to another. General equipment items are specified in Section 6.0, but project-specific equipment must be obtained to address the project-specific decontamination procedures presented in Section 7.0 and applicable subsections.

3.0 GLOSSARY

Alconox/Liquinox - A brand of phosphate-free laboratory-grade detergent.

Decontamination Solution - A solution selected/identified in the Health and Safety Plan or Project-Specific Quality Assurance Plan. The solution is selected and employed as directed by the project chemist/health and safety professional.

Deionized Water (DI) - Tap water that has been treated by passing through a standard deionizing resin column. This water may also pass through additional filtering media to attain various levels of analyte-free status. The DI water should meet College of American Pathologists (CAP) and National Committee for Clinical Laboratory Standards (NCCLS) specifications for reagent-grade Type I water.

Potable Water - Tap water from any municipal water treatment system. Use of an untreated potable water supply is not an acceptable substitute for tap water.

Pressure Washing - Process employing a high-pressure pump and nozzle configuration to create a high-pressure spray of potable water. High-pressure spray is employed to remove solids from equipment.

Solvent – A liquid in which solid chemicals or other liquids are dissolved. The solvent of choice is pesticide-grade isopropanol. Use of other solvents (methanol, acetone, or hexane) may be required for particular projects or for a particular purpose (e.g., removal of concentrated waste) and must be justified in the project planning documents. For example, it may be necessary to use hexane when analyzing for trace levels of pesticides, PCBs, or fuels. In addition, because many of these solvents are not miscible in water, the equipment should be air dried prior to use. Solvents should not be used on PVC equipment or well construction materials.

Steam Pressure Washing - A cleaning method employing a high-pressure spray of heated potable water to remove various organic/inorganic chemicals from equipment.

4.0 RESPONSIBILITIES AND PERSONNEL QUALIFICATIONS

Project Manager - Responsible for ensuring that all field activities are conducted in accordance with approved project plan(s) requirements.

Decontamination Personnel - Individuals assigned the task of decontamination. It is the responsibility of these individuals to understand the use and application of the decontamination process and solutions as well as the monitoring of that process to ensure that it is working properly. This is accomplished through visual evaluation, monitoring instrument scanning of decontaminated items, and/or through the collection of rinsate blanks to verify contaminant removal.

Field Operations Leader (FOL) - Responsible for the implementation of project-specific planning documents. This includes on-site verification that all field activities are performed in compliance with approved SOPs or as otherwise dictated by the approved project plan(s). The FOL is also responsible for the completion and accuracy of all field documentation.

Site Safety Officer (SSO) - Exercises shared responsibility with the FOL concerning decontamination effectiveness. All equipment arriving on site (as part of the equipment inspection), leaving the site, and moving between locations is required to go through a decontamination evaluation. This is accomplished through visual examination and/or instrument screening to determine the effectiveness of the decontamination process. Improper or incomplete decontamination is sufficient to restrict equipment from entering the site, exiting the site, or moving to a new location on the site until the objectives are successfully completed.

General personnel qualifications for decontamination activities include the following:

- Occupational Safety and Health Administration (OSHA) 40-hour and applicable refresher training.
- Capability of performing field work under the expected physical and environmental (i.e., weather) conditions.
- Familiarity with appropriate decontamination procedures.

5.0 HEALTH AND SAFETY

In addition to the health and safety issues and reminders specified in subsections of this SOP, the following considerations and requirements must be observed as SOPs for field equipment decontamination activities:

- If any solvents or hazardous chemicals (e.g., isopropyl alcohol) are to be used in equipment decontamination activities, the FOL must first obtain the manufacturer's/supplier's Material Safety Data Sheet (MSDS) and assure that it is reviewed by all users (prior to its use), added to the site Hazardous Chemical Inventory, and maintained on site as part of the project Hazard Communication Program.
- Review and observe specific health and safety requirements (e.g., personal protective equipment [PPE]) specified in the project-specific health and safety plan for this activity.

6.0 EQUIPMENT LIST

- Wood for decontamination pad construction, when applicable (see Section 7.1).

- Tools for constructing decontamination pad frame, when applicable (see Section 7.1).
- Visqueen sheeting or comparable material to cover decontamination pad frame, when applicable (see Section 7.1).
- Wash/drying racks for auger flights and drill/drive rods, when applicable (see Section 7.2).
- PPE as specified in the project health and safety plan.
- Soap and water for washing and rinsing.
- Deionized water for final rinsing.
- Solvents (e.g., pesticide-grade isopropanol) for rinsing (see applicable portions of Section 7.2).
- Tubs, buckets, etc. for containerizing rinse water (see applicable portions of Section 7.2).
- Sample bottles for collecting rinsate blanks (see Section 7.2).
- Calibrated photoionization detector (PID) or flame ionization detector (FID) to monitor decontaminated equipment for organic vapors generated through the existence of residual contamination or the presence of decontamination solvent remaining after the piece was rinsed.
- Aluminum foil or clear clean plastic bag for covering cleaned equipment (see applicable portions of Section 7.2).
- Paper towels or cloths for wiping.
- Brushes, scrapers, or other hand tools useful for removing solid materials from equipment.
- Clear plastic wrap for covering or wrapping large decontaminated equipment items (see Section 7.2.2).
- Drum-moving equipment for moving filled waste drums (optional) (see Section 7.3).
- Drum labels for waste drums (see Attachment A).

7.0 PROCEDURES

The process of decontamination is accomplished through the removal of contaminants, neutralization of contaminants, or isolation of contaminants. To accomplish this activity, preparation is required including site preparation, equipment selection, and evaluation of the decontamination requirements and processes. Site contaminant types, concentrations, and media types are primary drivers in the selection of the types of decontamination and where it will be conducted. For purposes of this SOP, discussion is limited to decontamination procedures for general environmental investigations.

Decontamination processes will be performed at the location(s) specified in project-specific planning documents. Typical decontamination locations include the following:

- Temporary decontamination pads/facilities
- Sample locations
- Centralized decontamination pad/facilities

- Combination of some or all of the above

The following discussion includes general considerations for the decontamination process. Specific construction and implementation procedures will be as specified in the project-specific planning documents and/or may be as dictated by site-specific conditions as long as the intent of the requirements in the planning documents is met. This intent is to contain any residual fluids and solids generated through the decontamination process.

7.1 Decontamination Pad Design/Construction Considerations

7.1.1 Temporary Decontamination Pads

Temporary decontamination pads may be constructed at satellite locations within the site area in support of temporary work areas. These structures are generally constructed to support the decontamination of heavy equipment such as drill rigs and earth-moving equipment but can be employed for smaller articles.

The purpose of the decontamination pad is to contain wash waters and potentially contaminated soil generated during decontamination procedures. Therefore, construction of these pads should take into account the following considerations:

- Site location – The decontamination site selected should be far enough from the work site to maximize decontamination effectiveness while minimizing travel distance. The location of the decontamination site shall be selected to provide, in the judgment of the FOL or FOL designee, compliance with as many of the following characteristics as practicable:

  - Well removed from pedestrian/vehicle thoroughfares.

  - Avoidance of areas where control/custody cannot be maintained.

  - Avoidance of areas where potential releases of contaminated media or decontamination fluids may be compounded through access to storm water transport systems, streams, or other potentially sensitive areas.

  - Avoidance of potentially contaminated areas.

  - Avoidance of areas too close to the ongoing operation, where cross-contamination may occur.

  The selected decontamination site should include the following, where possible:

  - Areas where potable water and electricity are provided.

> ***Safety Reminder***
>
> When utilizing electrical power sources, either hard-wired or portable-generated sources, ensure that:
>
> - All power is routed through a Ground Fault Circuit Interrupter (GFCI).
>
> - All power cords are in good condition (no physical damage), rated for the intended energy load, and designated for outdoor use.
>
> In situations where accomplishing these elements is not possible, it will be necessary to implement a site electrical grounding program.

- Areas where support activities such as removing decontamination waters soil and sediment are possible without entering an active exclusion zone.

- Areas that offer sufficient size to carry out the specific decontamination sequence.

- Decontamination pad (decon pad) – The decon pad shall be constructed to meet the following characteristics:

  - Size – The size of the pad should be sufficient to accept the equipment to be decontaminated as well as permitting free movement around the equipment by the personnel conducting the decontamination. The size should permit these movements utilizing pressure/steam washer wands and hoses and minimizing splash due to work in close quarters.

  - Slope – An adequate slope will be constructed to permit the collection of water and potentially contaminated soil within a trough or sump constructed at one end. The collection point for wash waters should be of adequate distance that the decontamination workers do not have to walk through the wash waters while completing their tasks. Because the pad will be sloped, place a light coating of sand over the plastic to minimize potential slips and falls. See the text about liners below.

  - Sidewalls – The sidewalls shall be at least 6 inches in height (or as high as possible if 6 inches is not achievable) to provide adequate containment for wash waters and soil. If splash represents a potential problem, splash guards should be constructed to control overspray. Sidewalls may be constructed of wood, inflatables, sand bags, etc. to permit containment. Splash guards are typically wood frames with Visqueen coverings to control overspray.

  - Liner – Depending on the types of equipment and decontamination method to be used, the liner should be of sufficient thickness to provide a puncture-resistant barrier between the decontamination operation and the unprotected environment. Care should be taken to examine the surface area prior to placing the liner to remove sharp articles (sticks, stones, debris) that could puncture the liner. Liners are intended to form an impermeable barrier. The thickness may vary from a minimum recommended thickness of 10 mil to 30 mil. The desired thickness may be achieved through layering materials of lighter construction. It should be noted that various materials (rubber, polyethylene sheeting) become slippery when wet. To minimize this potential hazard associated with a sloped liner, a light coating of sand shall be applied to provide traction as necessary.

  - Wash/drying racks – Auger flights, drill/drive rods, and similar equipment require racks positioned off of the ground to permit these articles to be washed, drained, and dried while secured from falling during this process.

For decontamination of direct-push technology (DPT) equipment, the pad may be as simple as a mortar tub containing buckets of soapy water for washing and an empty bucket to capture rinse waters. Decontamination may be conducted at the rear of the rig to permit rapid tool exchange.

- Maintenance – Maintain the decontamination area by:

  - Periodically clearing the work area of standing water, soil, and debris, and coiling hoses to aid in eliminating slip, trip, and fall hazards. In addition, these articles will reduce potential backsplash and cross-contamination.

- Regularly changing the decontamination fluids to ensure proper cleaning and prevent cross-contamination.

- PPE – Periodically evaluate the condition of, and maintain the decontamination equipment, including regular cleaning of face shields and safety glasses. This is critical to ensuring the safety of decontamination personnel and the integrity of the decontamination process, and it will ensure that equipment is functioning properly.

7.1.2 Decontamination Activities at Drill Rigs/DPT Units

During subsurface sampling activities including drilling and DPT activities, decontamination of drive rods, Macro Core Samplers, split spoons, etc. is typically conducted at an area adjacent to the operation. Decontamination is generally accomplished using a soap/water wash and rinse utilizing buckets and brushes. This area requires sufficient preparation to accomplish the decontamination objectives.

Buckets shall be placed within mortar tubs or similar secondary containment tubs to prevent splash and spills from reaching unprotected environmental media. Drying racks shall be employed as directed for temporary pads to permit parts to dry and be evaluated prior to use/reuse. Methodology regarding this activity is provided in Section 7.2.

7.1.3 Decontamination Activities at Remote Sample Locations

When sampling at remote locations, sampling equipment such as trowels and pumps/tubing should be evacuated of potentially contaminated media to the extent possible. This equipment should be wrapped in plastic for transport to the temporary/centralized decontamination location for final cleaning and disposition. Flushing and cleaning of single-use equipment such as disposable trowels, tubing, and surgeon's gloves may allow disposal of this equipment after visible soil and water remnants have been removed.

7.2 Equipment Decontamination Procedures

The following represents procedures to be employed for the decontamination of equipment that may have contacted and/or accumulated contamination through site investigation activities.

7.2.1 Monitoring Well Sampling Equipment

7.2.1.1 Groundwater sampling equipment – This includes pumps inserted into monitoring wells such as bladder pumps, Whale pumps, and Redi-Flo pumps and reusable bailers, etc.

1. Evacuate to the extent possible, any purge water within the pump/bailer.

2. Scrub using soap and water and/or steam clean the outside of the pump/bailer and, if applicable, the pump tubing.

3. Insert the pump and tubing/bailer into a clean container of soapy water. Pump/run a sufficient amount of soapy water through the pump/bailer to flush out any residual well water. After the pump is flushed, circulate soapy water through the pump to ensure that the internal components are thoroughly flushed.

4. Remove the pump and tubing/bailer from the container

5. Rinse external pump components using tap water.

6. Insert the pump and tubing/bailer into a clean container of tap water. Pump/run a sufficient amount of tap water through the pump/bailer to evacuate all of the soapy water (until clear).

> ***CAUTION***
> Do not rinse PE, PVC, and associated tubing with solvents –
> Use the procedures defined in the project-specific planning documents. If they are not defined, contact the FOL for guidance. The solvent rinse described in Step 7 may be omitted if groundwater does not contain oil, grease, PAHs, PCBs, or other hard to remove organic materials.

7. If groundwater contains or is suspected to contain oil, grease, PAHs, PCBs, or other hard to remove organic materials, rinse the equipment to be cleaned with pesticide-grade isopropanol.

8. Pass deionized water through the hose to flush out the tap water and solvent residue as applicable.

9. Drain residual deionized water to the extent possible.

10. Allow components of the equipment to air dry.

11. For bladder pumps, disassemble the pump and wash the internal components with soap and water, then rinse with tap water, isopropanol, and deionized water and allow to dry. After the parts are dry, conduct a visual inspection and a monitoring instrument scan to ensure that potential contaminants and all decontamination solvent have been removed. Collect a rinsate blank in accordance with the project-specific planning documents to ensure that the decontamination process is functioning as intended. The typical frequency of collection for rinsate blanks is 1 per 20 field samples. In addition, wipe samples or field tests such as UV light may be used.

12. Wrap pump/bailer in aluminum foil or a clear clean plastic bag for storage.

> ***SAFETY REMINDER***
> Remember when handling powered equipment to disconnect the power source and render the equipment to a zero energy state (both potential and kinetic) before opening valves, disconnecting lines, etc.

7.2.1.2 Electronic Water Level Indicators/Sounders/Tapes

During water level measurements, rinsing the extracted tape and probe with deionized water and wiping the surface of the extracted tape between locations is acceptable. However, periodic full decontamination should be conducted as follows:

1. Wash with soap and water
2. Rinse with tap water
3. Rinse with deionized water

> ***NOTE***
> In situations where oil, grease, free product, other hard to remove materials are encountered, probes and exposed tapes should be washed in hot soapy water. If probes or tapes cannot be satisfactorily decontaminated (they are still stained, discolored, etc.), they should be removed from service.

7.2.1.3 Miscellaneous Equipment

Miscellaneous equipment including analytical equipment (water quality testing equipment) shall be cleaned per manufacturers' instructions. This generally includes wiping the sensor housing and rinsing with tap and deionized water.

Coolers/shipping containers employed to ship samples are received from the laboratory in a variety of conditions including marginal to extremely poor. Coolers shall be evaluated prior to use for the following:

- Structural integrity – Coolers missing handles or having breaks in the outer housing should be removed and not used. Notify the laboratory that the risk of shipping samples in the cooler(s) provided is too great and request a replacement unit.

- Cleanliness – As per protocol, only volatile organic samples are accompanied by a trip blank. If a cooler's cleanliness is in question (visibly dirty/stained) or if there are noticeable odors, the cooler should be decontaminated prior to use as follows:

  1. Wash with soap and water
  2. Rinse with tap water
  3. Dry

If these measures fail to clean the cooler to an acceptable level, remove the unit from use as a shipping container and ask the cooler provider (e.g., the analytical laboratory) to provide a replacement unit.

7.2.2 Downhole Drilling Equipment

This includes any portion of the drill rig that is over the borehole, including auger flights, drill stems, rods, and associated tooling that would extend over the borehole. The following procedure is to be employed prior to initiating the drilling/sampling activity, then between locations:

> ***CAUTION***
> Exercise care when using scrapers to remove soil and debris from downhole drilling equipment. Inadvertent slips of scrapers have resulted in cuts, scrapes, and injured knuckles, so use scrapers carefully when removing soil from these items.

1. Remove loose soil using shovels, scrapers, etc.

2. Through a combination of scrubbing using soap and water and/or steam cleaning or pressure washing, remove visible dirt/soil from the equipment being decontaminated.

> ***CAUTION***
> In Step 3, do not rinse PE, PVC, and associated tubing with solvents. The appropriate procedures should be defined within the project-specific planning documents. If they are not defined, contact the FOL for guidance. The solvent rinse described in Step 4 may be omitted if groundwater does not contain oil, grease, PAHs, PCBs, or other hard to remove organic materials.

3. Rinse the equipment with tap water, where applicable (steam cleaning and pressure washing incorporate rinsing as part of the process).

4. If the equipment has directly or indirectly contacted contaminated sample media and is known or suspected of being contaminated with oil, grease, PAHs, PCBs, or other hard to remove organic materials, rinse equipment with pesticide-grade isopropanol

5. To the extent possible, allow components to air dry.

6. If the decontaminated equipment is to be used immediately after decontamination, screen it with a calibrated photoionization detector (PID)/flame ionization detector (FID) to ensure that all contaminants and possible decontamination solvents (if they were used) have been adequately removed.

7. Wrap or cover equipment in clear plastic until it is time to be used.

SAFETY REMINDER

Even when equipment is disconnected from power sources, dangers such as the following may persist:

Falls - An auger flight standing on its end may fall and injure someone. Secure all loose articles to prevent heavy articles from falling onto people or equipment.

Burns - Steam cleaner water is heated to more than 212 ˚F and exhibits thermal energy that can cause burns. Prevent contact of skin with hot water or surfaces.

High water pressure - Pressure washer discharge can have 2,000 to 4,000 psi of water pressure. Water under this amount of pressure can rupture skin and other human tissues. Water at 4,000 psi exiting a 0˚ tip can be dangerous because of its relatively high cutting power. The exit velocity and cutting power of the water are reduced when exiting a 40˚ fan tip, but damage to soft tissues is still possible.

In general, follow the rules below to avoid injury, equipment damage, or incomplete decontamination:

1. Read the operating manual and follow the manufacturers' recommended safety practices before operating pressure washers and steam cleaners.

2. Never point the pressure washer or steam cleaner at another person or use to clean your boots or other parts of your body. Water lacerations and burns may appear to be minor at first but can be life threatening. Do not attempt to hold small parts in your hand while washing them with high-temperature or high-pressure water.

3. Always wear PPE as specified in the HASP such as:

   - Hard hat, safety glasses, splash shield, impermeable apron or splash suit, and hearing protection. Remember that excessive noise is a hazard when operating gas-powered engines and electrically driven pressure washers. PPE will be identified in your project specific planning documents.

4. Inspect each device before use. An inspection checklist will be provided in the project-specific planning documents. If it is a rented device, safety measures are typically provided by the vendor. In all cases, if you are not familiar with the operation of a pressure washer/steam cleaner, do not operate it until you obtain and thoroughly review operating instructions and recommended safety practices.

5. Do not modify equipment unless the manufacturer has approved the modifications.

7.2.3 Soil/Sediment Sampling Equipment

This section applies to soil sampling equipment including but not limited to hand augers, stainless steel trowels/spoons, bowls, dredges, scoops, split spoons, Macro Core samplers, etc.

1. Remove all loose soil from the equipment through manual means.

2. Through a combination of scrubbing using soap and water and/or steam cleaning or pressure washing, remove visible dirt/soil from the equipment.

3. Rinse the equipment with tap water.

> ***CAUTION***
> Do not rinse PE, PVC, and associated tubing with solvents. The appropriate procedures should be defined within the project-specific planning documents. If they are not defined, contact the FOL for guidance. The solvent rinse described in Step 4 may be omitted if groundwater does not contain oil, grease, PAHs, PCBs, or other hard to remove organic materials.

4. If the equipment is contaminated or suspected to be contaminated with oil, grease, PAHs, PCBs, or other hard to remove organic materials, rinse the equipment with pesticide-grade isopropanol.

5. Rinse the equipment with deionized water.

6. To the extent possible, allow components to air dry.

7. If the equipment is to be used immediately after decontamination, screen it with a calibrated PID/FID to ensure that all solvents (if they were used) and trace contaminants have been adequately removed.

8. After the equipment has dried, wrap it in aluminum foil for storage until use.

Dredges employed in sediment sampling are typically decontaminated as follows:

- Remove the sediment sample from the sampling device

- If sufficient associated surface water is available at the sampling site, place the dredge in the water and flush to remove visible sediment.

- Extract the dredge and wash it in soap and water per the project-specific planning documents.

> ***CAUTION***
> When handling dredges, the primary safety concern is trapping fingers or extremities in the larger dredge samplers within the jaws or pinch points of the mechanical jaws. Keep hands, fingers, and extremities away from these pinch and compression points. Either handle the device by the rope or preferably lock the jaws in place to control the potential for closing during maintenance and/or cleaning.

7.3 Contact Waste/Materials

During the course of field investigations, disposable/single-use equipment becomes contaminated. These items include tubing, trowels, PPE (gloves, overboots, splash suits, etc.), and broken sample containers.

With the exception of the broken glass, single-use articles should be cleaned (washed and rinsed) of visible materials and disposed as normal refuse. The exception to this rule is that extremely soiled materials that cannot be cleaned shall be containerized for disposal in accordance with applicable federal, state, and local regulations.

7.3.1 Investigation-Derived Wastes - Decontamination Wash Waters and Sediments

NOTE
Requirements for waste storage may differ from one facility to the next. Facility-specific directions for waste storage areas will be provided in project-specific documents, or separate direction will be provided by the Project Manager.

1. Assume that all investigation-derived waste (IDW) generated from decontamination activities contains the hazardous chemicals associated with the site unless there are analytical or other data to the contrary. Waste solution volumes could vary from a few gallons to several hundred gallons in cases where large equipment required cleaning.

2. Where possible, use filtering systems to extend the use of water within a closed system wash unit to recycle water and to reduce possible waste amounts.

NOTE
Containerized waste rinse solutions are best stored in 55-gallon drums (or equivalent containers) that can be sealed until ultimate disposal at an approved facility.

3. Label waste storage containers appropriately labeled (see Attachment A).

4. Ensure that the IDW storage area is configured to meet the following specifications to permit access to the containers and to conduct spill/leak monitoring, sampling, and extraction when the disposal route is determined:

   - Enclose areas accessible by the general public using construction fencing and signs.

   - Stored materials in 55-gallon drums on pallets with four (or fewer) drums per pallet.

   - Maintain the retaining bolt and label on the outside of storage containers where readily visible.

   - Provide at least 4 feet of room between each row of pallets to allow access to containers for sampling, drum removal, and spill response.

   - As directed in project-specific planning documents, maintain an IDW Inventory List and provide the list to the site Point of Contact at the termination of each shift.

   - Maintain spill response equipment at the IDW storage area in case it is required for immediate access.

- Where possible, use equipment for moving containers. Where not possible, obtain help to manipulate containers.

CAUTION

Each container of water can weigh up to 490 pounds. Each 55-gallon drum of wet soil can weigh more than 750 pounds. Fill drums and temporary containers to 80 percent capacity to minimize spill and handling difficulties. Use drum carts to move filled drums.

See safe lifting techniques provided in Section 4.4 of the Tetra Tech NUS, Inc. Health and Safety Guidance Manual.

When placing drums, keep your fingers out of pinch and smash points such as between the drums. In some cases such as well development and/or purge water, you can place the drums to be filled on the pallet and transport materials in smaller easier to handle containers.

7.4 Decontamination Evaluation

Upon decontamination of equipment, determine the effectiveness of the decontamination process in the following manner:

- Visual evaluation – A visual evaluation will be conducted to ensure the removal of particulate matter. This shall be done to ensure that the washing/rinsing process is working as intended.

- Instrument Screening – A properly calibrated PID/FID should be used to evaluate the presence of site contaminants and solvents used in the cleaning process. The air intake of the instrument shall be passed over the article to be evaluated. Avoid placing the instrument probe into residual waters. A PID/FID reading greater than the daily established background level requires a repeat of the decontamination process, followed by rescreening with the PID/FID. This sequence must be repeated until no instrument readings greater than the daily established background level are observed. It should be noted that the instrument scan is only viable if the contaminants are detectable within the instrument's capabilities.

NOTE

When required by project-specific planning documents, collection of rinsate blanks (see next step) shall be completed without exception unless approval to not collect these samples is obtained from the Project Manager.

- Collection of Rinsate Blanks – It is recommended that rinsate samples be collected to:

  - Evaluate the decontamination procedure representing different equipment applications (pumps versus drilling equipment) and different decontamination applications.

  - Single-use disposable equipment – The number of samples should represent different types of equipment as well as different lot numbers of single-use articles.

  - The collection and the frequency of collection of rinsate samples are as follows unless specified differently in the project-specific planning documents:

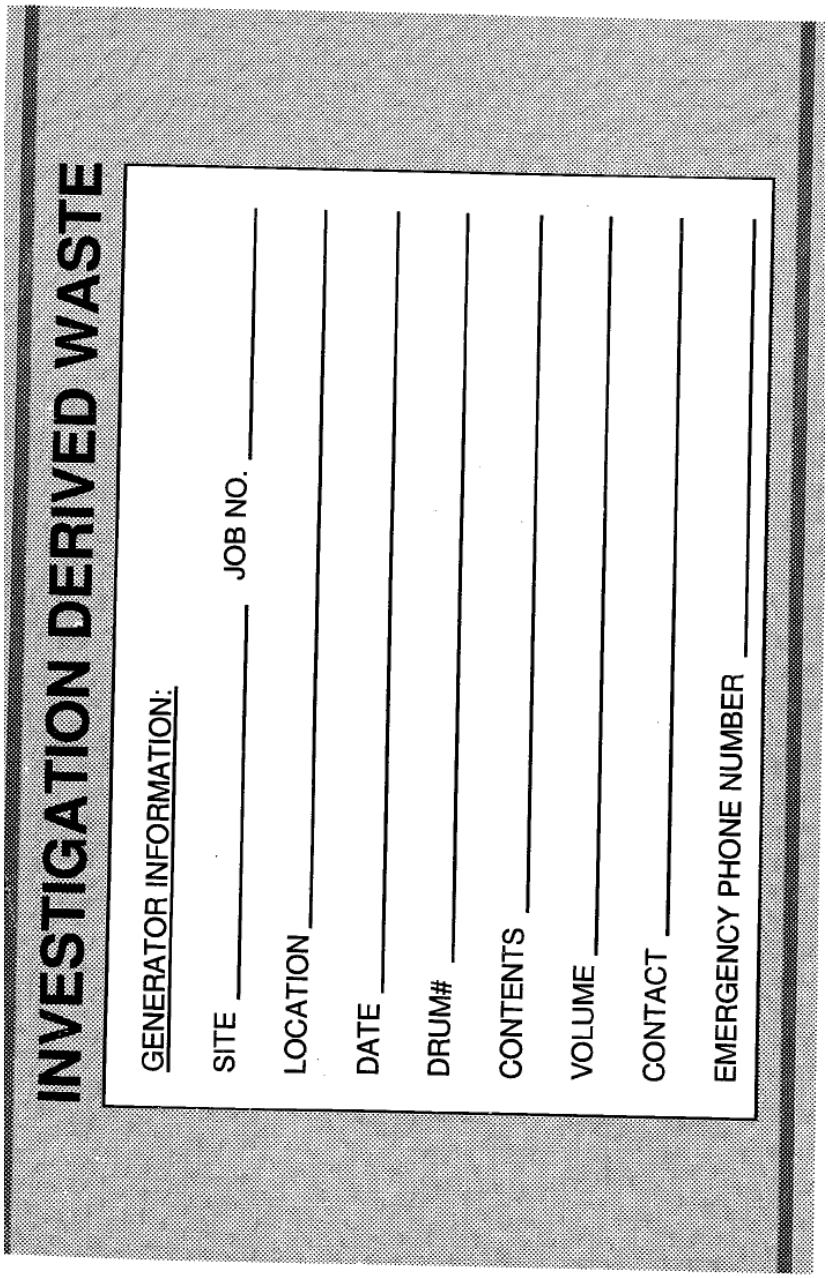
    - Per decontamination method
    - Per disposable article/batch number of disposable articles

NOTE

It is recommended that an initial rinsate sample be collected early in the project to ensure that the decontamination process is functioning properly and to avoid using a contaminated batch of single-use articles. It is recommended that a follow-up sample be collected later during the execution of the project to ensure that those conditions do not change.

Rinsate samples collection may be driven by types of and/or levels of contaminant. Difficult to remove contaminants, oils/greases, some PAHs/PCBs, etc. may also support the collection of additional rinsates due to the obvious challenges to the decontamination process. This is a field consideration to be determined by the FOL.

Attachment A
iDW Label



APPENDIX C

LABORATORY STANDARD OPERATING PROCEDURES, QC LIMITS, AND DoD ELAP CERTIFICATION

LABORATORY ACCREDITATION BUREAU

Certificate Number L2223

Certificate of Accreditation

Accredited to DoD ELAP and ISO/IEC 17025:2005

Katahdin Analytical Services, Inc.

600 Technology Way
Scarborough, ME 04074

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 4, 2012

R. Douglas Leonard, Jr., Managing Director
Laboratory Accreditation Bureau
Presented the 4th 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).

LABORATORY ACCREDITATION BUREAU

Certificate # L2223

Scope of Accreditation For Katahdin Analytical Services

600 Technology Way
Scarborough, ME 04074
Leslie Dimond
1- 207-874-2400

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 Katahdin Analytical Services to perform the following tests:

Accreditation granted through: **November 4, 2012**

Testing - Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	608 / 8081A,B/ SOM01.2	4 4`-DDD
GC/ECD	608 / 8081A,B/ SOM01.2	4 4`-DDE
GC/ECD	608 / 8081A,B / SOM01.2	4 4`-DDT
GC/ECD	608 / 8081A,B / SOM01.2	Aldrin
GC/ECD	608 / 8081A,B / SOM01.2	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	8081A,B / SOM01.2	Alpha-Chlordane
GC/ECD	608 / 8081A,B / SOM01.2	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	608 /8081A,B	Chlordane (tech.)
GC/ECD	608 / 8081A,B / SOM01.2	delta-BHC
GC/ECD	608 / 8081A,B / SOM01.2	Dieldrin
GC/ECD	608 / 8081A,B / SOM01.2	Endosulfan I
GC/ECD	608 / 8081A,B / SOM01.2	Endosulfan II
GC/ECD	608 / 8081A,B / SOM01.2	Endosulfan sulfate
GC/ECD	608 / 8081A,B / SOM01.2	Endrin
GC/ECD	608 / 8081A,B / SOM01.2	Endrin aldehyde
GC/ECD	8081A,B / SOM01.2	Endrin Ketone
GC/ECD	8081A,B / SOM01.2	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	608 / 8081A,B / SOM01.2	Heptachlor
GC/ECD	608 / 8081A,B / SOM01.2	Heptachlor epoxide

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	8081A,B / SOM01.2	Methoxychlor
GC/ECD	608 / 8081A,B / SOM01.2	Toxaphene (Chlorinated camphene)
GC/ECD	608 / 8082/8082A / SOM01.2	Aroclor-1221 (PCB-1221)
GC/ECD	608 / 8082/8082A / SOM01.2	Aroclor-1232 (PCB-1232)
GC/ECD	608 / 8082/8082A / SOM01.2	Aroclor-1242 (PCB-1242)
GC/ECD	608 / 8082/8082A / SOM01.2	Aroclor-1248 (PCB-1248)
GC/ECD	608 / 8082/8082A / SOM01.2	Aroclor-1254 (PCB-1254)
GC/ECD	608 / 8082/8082A / SOM01.2	Aroclor-1260 (PCB-1260)
GC/ECD	8082/8082A	Aroclor-1262 (PCB-1262)
GC/ECD	8082/8082A	Aroclor-1268 (PCB-1268)
GC/ECD	8082/8082A	2 2' 3 3' 4 4' 5 5' 6-Nonachlorobiphenyl (BZ 206)
GC/ECD	8082/8082A	2 2' 3 3' 4 4' 5 6-Octachlorobiphenyl (BZ 195)
GC/ECD	8082/8082A	2 2' 3 3' 4 4' 5-Heptachlorobiphenyl (BZ 170)
GC/ECD	8082/8082A	2 2' 3 3' 4 4'-Hexachlorobiphenyl (BZ 128)
GC/ECD	8082/8082A	2 2' 3 4 4' 5 5'-Heptachlorobiphenyl (BZ 180)
GC/ECD	8082/8082A	2 2' 3 4 4' 5' 6-Heptachlorobiphenyl (BZ 183)
GC/ECD	8082/8082A	2 2' 3 4 4' 5'-Hexachlorobiphenyl (BZ 138)
GC/ECD	8082/8082A	2 2' 3 4 4' 6 6'-Heptachlorobiphenyl (BZ 184)
GC/ECD	8082/8082A	2 2' 3 4' 5 5' 6-Heptachlorobiphenyl (BZ 187)
GC/ECD	8082/8082A	2 2' 3 4 5'-Pentachlorobiphenyl (BZ 87)
GC/ECD	8082/8082A	2 2' 3 5'-Tetrachlorobiphenyl (BZ 44)
GC/ECD	8082/8082A	2 2' 4 4' 5 5'-Hexachlorobiphenyl (BZ 153)
GC/ECD	8082/8082A	2 2' 4 5 5'-Pentachlorobiphenyl (BZ 101)
GC/ECD	8082/8082A	2 2' 4' 5-Tetrachlorobiphenyl (BZ 49)
GC/ECD	8082/8082A	2 2' 5 5'-Tetrachlorobiphenyl (BZ 52)
GC/ECD	8082/8082A	2 2' 5-Trichlorobiphenyl (BZ 18)
GC/ECD	8082/8082A	2 3 3' 4 4' 5-Hexachlorobiphenyl (BZ 156)
GC/ECD	8082/8082A	2 3 3' 4 4' 5'-Hexachlorobiphenyl (BZ 157)
GC/ECD	8082/8082A	2 3 3' 4 4'-Pentachlorobiphenyl (BZ 105)
GC/ECD	8082/8082A	2 3 3’ 4 4’ 5 5’-Heptachlorobiphenyl (BZ 189)
GC/ECD	8082/8082A	2 3' 4 4' 5 5'-Hexachlorobiphenyl (BZ 167)
GC/ECD	8082/8082A	2 3' 4 4' 5-Pentachlorobiphenyl (BZ 118)
GC/ECD	8082/8082A	2 3' 4 4'5-Pentachlorobiphenyl (BZ 123)
GC/ECD	8082/8082A	2 3' 4 4'-Tetrachlorobiphenyl (BZ 66)
GC/ECD	8082/8082A	2 3’ 4 4’ 5-Pentachlorobiphenyl (BZ 114)
GC/ECD	8082/8082A	2 4 4'-Trichlorobiphenyl (BZ 28)
GC/ECD	8082/8082A	2 4'-Dichlorobiphenyl (BZ 8)
GC/ECD	8082/8082A	3 3' 4 4' 5 5'-Hexachlorobiphenyl (BZ 169)
GC/ECD	8082/8082A	3 3' 4 4' 5-Pentachlorobiphenyl (BZ 126)
GC/ECD	8082/8082A	3 3' 4 4'-Tetrachlorobiphenyl (BZ 77)
GC/ECD	8082/8082A	3 4 4’ 5-Tetrachlorobiphenyl (BZ 81)
GC/ECD	8082/8082A	Decachlorobiphenyl (BZ 209)
GC/ECD	8151A	2 4 5-T
GC/ECD	8151A	2 4-D
GC/ECD	8151A	2 4-DB

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	8151A	Dalapon
GC/ECD	8151A	Dicamba
GC/ECD	8151A	Dichloroprop
GC/ECD	8151A	DInoseb
GC/ECD	8151A	MCPA
GC/ECD	8151A	MCPP
GC/ECD	8151A	Pentachlorophenol
GC/ECD	8151A	Silvex (2 4 5-TP)
GC/FID	8015B/C	Diesel range organics (DRO)
GC/FID	8015B/C	Gasoline range organics (GRO)
GC/FID	8011 / 504	1 2-Dibromoethane (EDB)
GC/FID	8011 / 504	1 2-Dibromo-3-chloropropane
GC/FID	RSK-175	Methane Ethane Ethene
GC/MS	8260B,C / 524.2	1 1 1 2-Tetrachloroethane
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	1 1 1-Trichloroethane
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	1 1 2 2-Tetrachloroethane
GC/MS	SOM01.2	1 1 2-Trichloro-1 2 2-trifluoroethane
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	1 1 2-Trichloroethane
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	1 1-Dichloroethane
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	1 1-Dichloroethene
GC/MS	8260B,C / 524.2	1 1-Dichloropropene
GC/MS	8260B,C / SOM01.2 / 524.2	1 2 3-Trichlorobenzene
GC/MS	8260B,C / 524.2	1 2 3-Trichloropropane
GC/MS	8260B,C / SOM01.2 / 524.2	1 2 4-Trichlorobenzene
GC/MS	8260B,C / 524.2	1 2 4-Trimethylbenzene
GC/MS	8260B,C / SOM01.2 / 524.2	1 2-Dibromo-3-chloropropane
GC/MS	8260B,C / SOM01.2 / 524.2	1 2-Dibromoethane (EDB)
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	1 2-Dichlorobenzene
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	1 2-Dichloroethane
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	1 2-Dichloropropane
GC/MS	8260B,C / 524.2	1 3 5-Trimethylbenzene
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	1 3-Dichlorobenzene
GC/MS	8260B,C / 524.2	1 3-Dichloropropane
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	1 4-Dichlorobenzene
GC/MS	8260B,C / SOM01.2	1 4-Dioxane
GC/MS	8260B,C / 524.2	2 2-Dichloropropane

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8260B,C / SOM01.2 / 524.2	2-Butanone
GC/MS	624 / 8260B,C	2-Chloroethyl vinyl ether
GC/MS	8260B,C / 524.2	2-Chlorotoluene
GC/MS	8260B,C / SOM01.2 / 524.2	2-Hexanone
GC/MS	8260B,C / 524.2	4-Chlorotoluene
GC/MS	8260B,C / SOM01.2 / 524.2	4-Methyl-2-pentanone
GC/MS	8260B,C / SOM01.2 / 524.2	Acetone
GC/MS	8260B,C	Acetonitrile
GC/MS	624 / 8260B,C	Acrolein
GC/MS	624 / 8260B,C / 524.2	Acrylonitrile
GC/MS	8260B,C / 524.2	Allyl chloride
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Benzene
GC/MS	8260B,C / 524.2	Bromobenzene
GC/MS	8260B,C / SOM01.2 / 524.2	Bromochloromethane
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Bromodichloromethane
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Bromoform
GC/MS	8260B,C / SOM01.2 / 524.2	Carbon disulfide
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Carbon tetrachloride
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Chlorobenzene
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Chloroethane
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Chloroform
GC/MS	8260B,C	Chloroprene
GC/MS	8260B,C / SOM01.2 / 524.2	cis-1 2-Dichloroethene
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	cis-1 3-Dichloropropene
GC/MS	SOM01.2	Cyclohexane
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Dibromochloromethane
GC/MS	8260B,C / 524.2	Dibromomethane
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Dichlorodifluoromethane
GC/MS	8260B,C / 524.2	Diethyl ether
GC/MS	8260B,C	Di-isopropylether
GC/MS	8260B,C / 524.2	Ethyl methacrylate
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Ethylbenzene
GC/MS	8260B,C	Ethyl-t-butylether
GC/MS	8260B,C / 524.2	Hexachlorobutadiene
GC/MS	8260B,C	Iodomethane
GC/MS	8260B,C	Isobutyl alcohol

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8260B,C / SOM01.2 / 524.2	Isopropyl benzene
GC/MS	8260B,C / SOM01.2 / 524.2	m p-xylenes
GC/MS	8260B,C / 524.2	Methacrylonitrile
GC/MS	SOM01.2	Methyl acetate
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Methyl bromide (Bromomethane)
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Methyl chloride (Chloromethane)
GC/MS	8260B,C / 524.2	Methyl methacrylate
GC/MS	8260B,C / SOM01.2 / 524.2	Methyl tert-butyl ether
GC/MS	SOM01.2	Methylcyclohexane
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Methylene chloride
GC/MS	8260B,C / 524.2	Naphthalene
GC/MS	8260B,C / 524.2	n-Butylbenzene
Gc/ms	8260B,C / 524.2	n-Propylbenzene
GC/MS	8260B,C / SOM01.2 / 524.2	o-Xylene
GC/MS	8260B,C / 524.2	p-Isopropyltoluene
GC/MS	8260B,C / 524.2	Propionitrile
GC/MS	8260B,C / 524.2	sec-butylbenzene
GC/MS	8260B,C / SOM01.2 / 524.2	Styrene
GC/MS	8260B,C	t-Amylmethylether
GC/MS	8260B,C / 524.2	tert-Butyl alcohol
GC/MS	8260B,C	tert-Butylbenzene
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Tetrachloroethene (Perchloroethylene)
GC/MS	8260B,C / 524.2	Tetrahydrofuran
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Toluene
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	trans-1 2-Dichloroethylene
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	trans-1 3-Dichloropropylene
GC/MS	8260B,C / 524.2	trans-1 4-Dichloro-2-butuene
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Trichloroethene (Trichloroethylene)
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Trichlorofluoromethane
GC/MS	8260B,C	Vinyl acetate
GC/MS	624 / 8260B,C / SOM01.2 / 524.2	Vinyl chloride
GC/MS	624 8260B,C	Xylene
GC/MS	8270C,D / SOM01.2	1 2 4 5-Tetrachlorobenzene
GC/MS	625 / 8270C,D / SOM01.2	1 2 4-Trichlorobenzene
GC/MS	625 / 8270C,D / SOM01.2	1 2-Dichlorobenzene
GC/MS	8270C,D	1 2-Diphenylhydrazine

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8270C,D	1 3 5-Trinitrobenzene
GC/MS	625 / 8270C,D / SOM01.2	1 3-Dichlorobenzene
GC/MS	8270C,D	1 3-Dinitrobenzene
GC/MS	625 / 8270C,D / SOM01.2	1 4-Dichlorobenzene
GC/MS	8270C,D	1 4-Dioxane
GC/MS	8270C,D	1 4-Naphthoquinone
GC/MS	8270C,D	1 4-Phenylenediamine
GC/MS	8270C,D	1-Naphthylamine
GC/MS	8270C,D / SOM01.2	2 3 4 6-Tetrachlorophenol
GC/MS	8270C,D / SOM01.2	2 4 5-Trochlorophenol
GC/MS	625 / 8270C,D / SOM01.2	2 4 6-Trichlorophenol
GC/MS	625 / 8270C,D / SOM01.2	2 4-Dichlorophenol
GC/MS	625 / 8270C,D / SOM01.2	2 4-Dimethylphenol
GC/MS	625 / 8270C,D / SOM01.2	2 4-Dinitrophenol
GC/MS	625 / 8270C,D / SOM01.2	2 4-Dinitrotoluene (2 4-DNT)
GC/MS	8270C,D	2 6-Dichlorophenol
GC/MS	625 / 8270C,D / SOM01.2	2 6-Dinitrotoluene (2 6-DNT)
GC/MS	8270C,D	2-Acetylaminofluorene
GC/MS	625 / 8270C,D / SOM01.2	2-Chloronaphthalene
GC/MS	625 / 8270C,D / SOM01.2	2-Chlorophenol
GC/MS	625 / 8270C,D / SOM01.2	2-Methyl-4 6-dinitrophenol
GC/MS	8270C,D / SOM01.2	2-Methylnaphthalene
GC/MS	8270C,D / SOM01.2	2-Methylphenol
GC/MS	8270C,D	2-Naphthylamine
GC/MS	8270C,D	2-Nitroaniline
GC/MS	625 / 8270C,D / SOM01.2	2-Nitrophenol
GC/MS	8270C,D	2-Picoline
GC/MS	625 / 8270C,D / SOM01.2	3 3’-Dichlorobenzidine
GC/MS	8270C,D	3 3’-Dimethylbenzidine
GC/MS	8270C,D	3-Methylcholanthrene
GC/MS	8270C,D / SOM01.2	3-Nitroaniline
GC/MS	8270C,D	4-Aminobiphenyl
GC/MS	625 / 8270C,D / SOM01.2	4-Bromophenyl phenyl ether
GC/MS	625 / 8270C,D / SOM01.2	4-Chloro-3-methylphenol
GC/MS	8270C,D / SOM01.2	4-Chloroaniline
GC/MS	625 / 8270C,D / SOM01.2	4-Chlorophenyl phenylether
GC/MS	8270C,D	4-Dimethyl aminoazobenzene
GC/MS	8270C,D / SOM01.2	4-Methylphenol
GC/MS	8270C,D / SOM01.2	4-Nitroaniline
GC/MS	625 / 8270C,D / SOM01.2	4-Nitrophenol
GC/MS	8270C,D	5-Nitro-o-toluidine
GC/MS	8270C,D	7,12-Dimethylphenethylamine
GC/MS	8270C,D	a a-Dimethylphenethylamine
GC/MS	625 / 8270C,D / SOM01.2	Acenaphthene
GC/MS	625 / 8270C,D / SOM01.2	Acenaphthylene

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8270C,D / SOM01.2	Acetophenone
GC/MS	8270C,D	Aniline
GC/MS	625 / 8270C,D / SOM01.2	Anthracene
GC/MS	8270C,D	Aramite
GC/MS	8270C,D / SOM01.2	Atrazine
GC/MS	SOM01.2	Benzaldehyde
GC/MS	625 / 8270C,D	Benzidine
GC/MS	625 / 8270C,D / SOM01.2	Benzo(a)anthracene
GC/MS	625 / 8270C,D / SOM01.2	Benzo(a)pyrene
GC/MS	625 / 8270C,D / SOM01.2	Benzo(b)fluoranthene
GC/MS	625 / 8270C,D / SOM01.2	Benzo(g h i)perylene
GC/MS	625 / 8270C,D / SOM01.2	Benzo(k)fluoranthene
GC/MS	8270C,D	Benzoic Acid
GC/MS	8270C,D	Benzyl alcohol
GC/MS	8270C,D / SOM01.2	Biphenyl
GC/MS	625 / 8270C,D / SOM01.2	bis(2-Chloroethoxy)methane
GC/MS	625 / 8270C,D / SOM01.2	bis(2-Chloroethyl) ether
GC/MS	625 / 8270C,D / SOM01.2	bis(2-Chloroisopropyl) ether (2 2`-Oxybis(1-chloropropane))
GC/MS	625 / 8270C,D / SOM01.2	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	625 / 8270C,D / SOM01.2	Butyl benzyl phthalate
GC/MS	SOM01.2	Caprolactam
GC/MS	8270C,D / SOM01.2	Carbazole
GC/MS	8270C,D	Chlorobenzilate
GC/MS	625 / 8270C,D / SOM01.2	Chrysene
GC/MS	8270C,D	Diallate
GC/MS	625 / 8270C,D / SOM01.2	Dibenz(a h)anthracene
GC/MS	8270C,D / SOM01.2	Dibenzofuran
GC/MS	625 / 8270C,D / SOM01.2	Diethyl phthalate
GC/MS	8270C,D	Dimethoate
GC/MS	625 / 8270C,D / SOM01.2	Dimethyl phthalate
GC/MS	625 / 8270C,D / SOM01.2	Di-n-butyl phthalate
GC/MS	625 / 8270C,D / SOM01.2	Di-n-octyl phthalate
GC/MS	8270C,D	Ethyl methanesulfonate
GC/MS	8270C,D	Famfur
GC/MS	625 / 8270C,D / SOM01.2	Fluoranthene
GC/MS	625 / 8270C,D / SOM01.2	Fluorene
GC/MS	625 / 8270C,D / SOM01.2	Hexachlorobenzene
GC/MS	625 / 8270C,D / SOM01.2	Hexachlorobutadiene
GC/MS	625 / 8270C,D / SOM01.2	Hexachlorocyclopentadiene
GC/MS	625 / 8270C,D / SOM01.2	Hexachloroethane
GC/MS	8270C,D	Hexachloropropene
GC/MS	625 / 8270C,D / SOM01.2	Indeno(1 2 3-cd)pyrene
GC/MS	8270C,D	Isodrin
GC/MS	625 / 8270C,D / SOM01.2	Isophorone

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	8270C,D	Isosafrole
GC/MS	8270C,D	Methapyriline
GC/MS	8270C,D	Methy methanesulfonate
GC/MS	8270C,D	Methyl parathion
GC/MS	625 / 8270C,D / SOM01.2	Naphthalene
GC/MS	625 / 8270C,D / SOM01.2	Nitrobenzene
GC/MS	8270C,D	Nitroquinoline-1-oxide
GC/MS	8270C,D	n-Nitrosodiethylamine
GC/MS	625 / 8270C,D / SOM01.2	n-Nitrosodimethylamine
GC/MS	8270C,D	n-Nitroso-di-n-butylamine
GC/MS	625 / 8270C,D / SOM01.2	n-Nitrosodi-n-propylamine
GC/MS	625 / 8270C,D / SOM01.2	n-Nitrosodiphenylamine
GC/MS	8270C,D	n-Nitrosomethylethylamine
GC/MS	8270C,D	n-Nitrosomorpholine
GC/MS	8270C,D	n-Nitrosopiperidine
GC/MS	8270C,D	n-Nitrosopyrrolidine
GC/MS	8270C,D	o o o-Triethyl phosphorothioate
GC/MS	8270C,D	o-Toluidine
GC/MS	8270C,D	Pentachlorobenzene
GC/MS	8270C,D	Pentachloronitrobenzene
GC/MS	625 / 8270C,D / SOM01.2	Pentachlorophenol
GC/MS	8270C,D	Phenacetin
GC/MS	625 / 8270C,D / SOM01.2	Phenanthrene
GC/MS	625 / 8270C,D / SOM01.2	Phenol
GC/MS	8270C,D	Phorate
GC/MS	8270C,D	Pronamide
GC/MS	625 / 8270C,D / SOM01.2	Pyrene
GC/MS	8270C,D	Pyrididne
GC/MS	8270C,D	Safrole
GC/MS	8270C,D	Thionazin
HPLC	8330/8330A/8330B	1 3 5-Trinitrobenzene
HPLC	8330/8330A/8330B	1 3-Dinitrobenzene
HPLC	8330/8330A/8330B	2 4 6-Trinitrotoluene
HPLC	8330/8330A/8330B	2 4-Dinitrotoluene
HPLC	8330/8330A/8330B	2 6-Dinitrotoluene
HPLC	8330/8330A/8330B	2-Amino-4 6 -dinitrotoluene
HPLC	8330/8330A/8330B	2-Nitrotoluene
HPLC	8330/8330A/8330B	3-Nitrotoluene
HPLC	8330/8330A/8330B	4-Amino-2,3-dinitrotoluene
HPLC	8330/8330A/8330B	4-Nitrotoluene
HPLC	8330/8330A/8330B	Hexahydro-1 3 5-trinitro-1 3 5-triazine (RDX)
HPLC	8330/8330A/8330B	Nitrobenzene
HPLC	8330/8330A/8330B	Nitroglycerin
HPLC	8330/8330A/8330B	Octahydro-1 3 5 7-tetrazocine (HMX)
HPLC	8330/8330A/8330B	Tetryl

Non-Potable Water		
Technology	**Method**	**Analyte**
CVAA	245.1 / 7470A / ILM05.3	Mercury
CVAF	1631E	Low Level Mercury
ICP	200.7 / 6010B,C / ILM05.3	Aluminum
ICP	200.7 / 6010B,C / ILM05.3	Antimony
ICP	200.7 / 6010B,C / ILM05.3	Arsenic
ICP	200.7 / 6010B,C / ILM05.3	Barium
ICP	200.7 / 6010B,C / ILM05.3	Beryllium
ICP	200.7 / 6010B,C	Boron
ICP	200.7 / 6010B,C / ILM05.3	Cadmium
ICP	200.7 / 6010B,C / ILM05.3	Calcium
ICP	200.7 / 6010B,C / ILM05.3	Chromium
ICP	200.7 / 6010B,C / ILM05.3	Cobalt
ICP	200.7 / 6010B,C / ILM05.3	Copper
ICP	200.7 / 6010B,C / ILM05.3	Iron
ICP	200.7 / 6010B,C / ILM05.3	Lead
ICP	200.7 / 6010B,C / ILM05.3	Magnesium
ICP	200.7 / 6010B,C / ILM05.3	Manganese
ICP	200.7 / 6010B,C	Molybdenum
ICP	200.7 / 6010B,C / ILM05.3	Nickel
ICP	200.7 / 6010B,C / ILM05.3	Potassium
ICP	200.7 / 6010B,C / ILM05.3	Selenium
ICP	200.7	Silicon
ICP	200.7 / 6010B,C / ILM05.3	Silver
ICP	200.7 / 6010B,C / ILM05.3	Sodium
ICP	6010B,C	Strontium
ICP	200.7 / 6010B,C / ILM05.3	Thallium
ICP	200.7 / 6010B,C	Tin
ICP	200.7 / 6010B,C	Titanium
ICP	200.7 / 6010B,C / ILM05.3	Vanadium
ICP	200.7 / 6010B,C / ILM05.3	Zinc
ICP/MS	200.8 / 6020/6020A / ILM05.3	Aluminum
ICP/MS	200.8 / 6020/6020A / ILM05.3	Antimony
ICP/MS	200.8 / 6020/6020A / ILM05.3	Arsenic
ICP/MS	200.8 / 6020/6020A / ILM05.3	Barium
ICP/MS	200.8 / 6020/6020A / ILM05.3	Beryllium
ICP/MS	200.8 / 6020/6020A	Boron
ICP/MS	200.8 / 6020/6020A / ILM05.3	Cadmium
ICP/MS	200.8 / 6020/6020A	Calcium
ICP/MS	200.8 / 6020/6020A / ILM05.3	Chromium
ICP/MS	200.8 / 6020/6020A / ILM05.3	Cobalt
ICP/MS	200.8 / 6020/6020A / ILM05.3	Copper
ICP/MS	200.8 / 6020/6020A	Iron
ICP/MS	200.8 / 6020/6020A / ILM05.3	Lead
ICP/MS	200.8 / 6020/6020A / ILM05.3	Magnesium
ICP/MS	200.8 / 6020/6020A	Manganese

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Non-Potable Water		
Technology	**Method**	**Analyte**
ICP/MS	200.8 / 6020/6020A	Molybdenum
ICP/MS	200.8 / 6020/6020A / ILM05.3	Nickel
ICP/MS	200.8 / 6020/6020A	Potassium
ICP/MS	200.8 / 6020/6020A / ILM05.3	Selenium
ICP/MS	200.8 / 6020/6020A / ILM05.3	Silicon
ICP/MS	200.8 / 6020/6020A / ILM05.3	Silver
ICP/MS	200.8 / 6020/6020A	Sodium
ICP/MS	6020/6020A	Strontium
ICP/MS	200.8 / 6020/6020A / ILM05.3	Thallium
ICP/MS	200.8 / 6020/6020A	Tin
ICP/MS	200.8 / 6020/6020A	Titanium
ICP/MS	200.8	Uranium
ICP/MS	200.8 / 6020/6020A / ILM05.3	Vanadium
ICP/MS	200.8 / 6020/6020A / ILM05.3	Zinc
IC	300.0 / 9056/9056A	Bromide
IC	300.0 / 9056/9056A	Chloride
IC	300.0 / 9056/9056A	Nitrate as N
IC	300.0 / 9056/9056A	Nitrite as N
IC	300.0 / 9056/9056A	Nitrate + Nitrite
IC	300.0 / 9056/9056A	Orthophosphate as P
IC	300.0 / 9056/9056A	Sulfate
Titration	310.2 / 2320B	Alkalinity
Caculation	2340C	Hardness
Gravimetric	1664A	Oil and Grease
Gravimetric	2540 B, C, D	Solids
ISE	120.1 / 2510 B	Conductivity
ISE	2520B	Practical Salinity
ISE	4500F- C	Fluoride
ISE	4500H+ B	pH
ISE	5210B	TBOD / CBOD
Physical	1010 A	Ignitability
Physical	9040C	pH
Titration	2340B	Hardness
Titration	4500SO_3 B	Sulfite
Titration	9034 / 4500S^{2-} E	Sulfide
Titration	Chap. 7.3.4	Reactive Sulfide
TOC	9060A / 5310B	Total organic carbon
Turbidimetric	180.1 / 2130B	Turbidity
Turbidimetric	9038 / ASTM 516-02	Sulfate
UV/VIS	335.4 / 9012B / 4500-CN G	Amenable cyanide
UV/VIS	350.1 / 4500NH3 H	Ammonia as N
UV/VIS	3500Fe D	Ferrous Iron
UV/VIS	351.2	Kjeldahl nitrogen - total
UV/VIS	353.2 / 4500NO3 F	Nitrate + Nitrite

Non-Potable Water		
Technology	**Method**	**Analyte**
UV/VIS	353.2 / 4500NO3 F	Nitrate as N
UV/VIS	353.2 / 4500NO3 F	Nitrite as N
UV/VIS	365.1 / 4500P E	Orthophosphate as P
UV/VIS	365.4	Phosphorus total
UV/VIS	376.3	AVS-SEM
UV/VIS	410.4	COD
UV/VIS	420.1 / 9065	Total Phenolics
UV/VIS	4500Cl G	Total Residual Chlorine
UV/VIS	5540C	MBAS
UV/VIS	7196A / 3500-Cr D	Chromium VI
UV/VIS	9012B / ILM05.3/ 335.4	Total Cyanide
UV/VIS	9251 / 4500Cl E	Chloride
UV/VIS	Chap. 7.3.4	Reactive Cyanide
Preparation	**Method**	**Type**
Cleanup Methods	3640A	Gel Permeation Clean-up
Cleanup Methods	3630C	Silica Gel
Cleanup Methods	3660B	Sulfur Clean-Up
Cleanup Methods	3665A	Sulfuric Acid Clean-Up
Organic Preparation	3510C	Separatory Funnel Extraction
Organic Preparation	3520C	Continuous Liquid-Liquid Extraction
Inorganic Preparation	3010A	Hotblock
Volatile Organic Preparation	5030B,C	Purge and Trap

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/ECD	8081A,B/ SOM01.2	4 4`-DDD
GC/ECD	8081A,B / SOM01.2	4 4`-DDE
GC/ECD	8081A,B / SOM01.2	4 4`-DDT
GC/ECD	8081A,B / SOM01.2	Aldrin
GC/ECD	8081A,B / SOM01.2	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	8081A,B / SOM01.2	Alpha-Chlordane
GC/ECD	8081A,B / SOM01.2	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	608 /8081A,B	Chlordane (tech.)
GC/ECD	8081A,B / SOM01.2	delta-BHC
GC/ECD	8081A,B / SOM01.2	Dieldrin
GC/ECD	8081A,B / SOM01.2	Endosulfan I
GC/ECD	8081A,B / SOM01.2	Endosulfan II
GC/ECD	8081A,B / SOM01.2	Endosulfan sulfate
GC/ECD	8081A,B / SOM01.2	Endrin
GC/ECD	8081A,B / SOM01.2	Endrin aldehyde
GC/ECD	8081A,B / SOM01.2	Endrin Ketone

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/ECD	8081A,B / SOM01.2	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	8081A,B / SOM01.2	Heptachlor
GC/ECD	8081A,B / SOM01.2	Heptachlor epoxide
GC/ECD	8081A,B / SOM01.2	Methoxychlor
GC/ECD	8081A,B / SOM01.2	Toxaphene (Chlorinated camphene)
GC/ECD	8082/8082A/ SOM01.2	Aroclor-1016 (PCB-1016)
GC/ECD	8082/8082A/ SOM01.2	Aroclor-1221 (PCB-1221)
GC/ECD	8082/8082A/ SOM01.2	Aroclor-1232 (PCB-1232)
GC/ECD	8082/8082A/ SOM01.2	Aroclor-1242 (PCB-1242)
GC/ECD	8082/8082A/ SOM01.2	Aroclor-1248 (PCB-1248)
GC/ECD	8082/8082A/ SOM01.2	Aroclor-1254 (PCB-1254)
GC/ECD	8082/8082A/ SOM01.2	Aroclor-1260 (PCB-1260)
GC/ECD	8082/8082A	Aroclor-1262 (PCB-1262)
GC/ECD	8082/8082A	Aroclor-1268 (PCB-1268)
GC/ECD	8082/8082A	2 2' 3 3' 4 4' 5 5' 6-Nonachlorobiphenyl (BZ 206)
GC/ECD	8082/8082A	2 2' 3 3' 4 4' 5 6-Octachlorobiphenyl (BZ 195)
GC/ECD	8082/8082A	2 2' 3 3' 4 4' 5-Heptachlorobiphenyl (BZ 170)
GC/ECD	8082/8082A	2 2' 3 3' 4 4'-Hexachlorobiphenyl (BZ 128)
GC/ECD	8082/8082A	2 2' 3 4 4' 5 5'-Heptachlorobiphenyl (BZ 180)
GC/ECD	8082/8082A	2 2' 3 4 4' 5' 6-Heptachlorobiphenyl (BZ 183)
GC/ECD	8082/8082A	2 2' 3 4 4' 5'-Hexachlorobiphenyl (BZ 138)
GC/ECD	8082/8082A	2 2' 3 4 4' 6 6'-Heptachlorobiphenyl (BZ 184)
GC/ECD	8082/8082A	2 2' 3 4' 5 5' 6-Heptachlorobiphenyl (BZ 187)
GC/ECD	8082/8082A	2 2' 3 4 5'-Pentachlorobiphenyl (BZ 87)
GC/ECD	8082/8082A	2 2' 3 5'-Tetrachlorobiphenyl (BZ 44)
GC/ECD	8082/8082A	2 2' 4 4' 5 5'-Hexachlorobiphenyl (BZ 153)
GC/ECD	8082/8082A	2 2' 4 5 5'-Pentachlorobiphenyl (BZ 101)
GC/ECD	8082/8082A	2 2' 4' 5-Tetrachlorobiphenyl (BZ 49)
GC/ECD	8082/8082A	2 2' 5 5'-Tetrachlorobiphenyl (BZ 52)
GC/ECD	8082/8082A	2 2' 5-Trichlorobiphenyl (BZ 18)
GC/ECD	8082/8082A	2 3 3' 4 4' 5-Hexachlorobiphenyl (BZ 156)
GC/ECD	8082/8082A	2 3 3' 4 4' 5'-Hexachlorobiphenyl (BZ 157)
GC/ECD	8082/8082A	2 3 3' 4 4'-Pentachlorobiphenyl (BZ 105)
GC/ECD	8082/8082A	2 3 3’ 4 4’ 5 5’-Heptachlorobiphenyl (BZ 189)
GC/ECD	8082/8082A	2 3' 4 4' 5 5'-Hexachlorobiphenyl (BZ 167)
GC/ECD	8082/8082A	2 3' 4 4' 5-Pentachlorobiphenyl (BZ 118)
GC/ECD	8082/8082A	2 3' 4 4'5-Pentachlorobiphenyl (BZ 123)
GC/ECD	8082/8082A	2 3' 4 4'-Tetrachlorobiphenyl (BZ 66)
GC/ECD	8082/8082A	2 3’ 4 4’ 5-Pentachlorobiphenyl (BZ 114)
GC/ECD	8082/8082A	2 4 4'-Trichlorobiphenyl (BZ 28)
GC/ECD	8082/8082A	2 4'-Dichlorobiphenyl (BZ 8)
GC/ECD	8082/8082A	3 3' 4 4' 5 5'-Hexachlorobiphenyl (BZ 169)
GC/ECD	8082/8082A	3 3' 4 4' 5-Pentachlorobiphenyl (BZ 126)
GC/ECD	8082/8082A	3 3' 4 4'-Tetrachlorobiphenyl (BZ 77)

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/ECD	8082/8082A	3 4 4' 5-Tetrachlorobiphenyl (BZ 81)
GC/ECD	8082/8082A	Decachlorobiphenyl (BZ 209)
GC/ECD	8151A	2 4 5-T
GC/ECD	8151A	2 4-D
GC/ECD	8151A	2 4-DB
GC/ECD	8151A	Dalapon
GC/ECD	8151A	Dicamba
GC/ECD	8151A	Dichloroprop
GC/ECD	8151A	DInoseb
GC/ECD	8151A	MCPA
GC/ECD	8151A	MCPP
GC/ECD	8151A	Pentachlorophenol
GC/ECD	8151A	Silvex (2 4 5-TP)
GC/FID	8015B,C	Diesel range organics (DRO)
GC/FID	8015B,C	Gasoline range organics (GRO)
GC/FID	8011	EDB
GC/FID	8011	1 2-Dibromo-3-chloropropane
GC/MS	8260B,C	1 1 1 2-Tetrachloroethane
GC/MS	8260B,C / SOM01.2	1 1 1-Trichloroethane
GC/MS	8260B,C / SOM01.2	1 1 2 2-Tetrachloroethane
GC/MS	SOM01.2	1 1 2-Trichloro-1 2 2-trifluoroethane
GC/MS	8260B,C / SOM01.2	1 1 2-Trichloroethane
GC/MS	8260B,C / SOM01.2	1 1-Dichloroethane
GC/MS	8260B,C / SOM01.2	1 1-Dichloroethylene
GC/MS	8260B,C	1 1-Dichloropropene
GC/MS	8260B,C / SOM01.2	1 2 3-Trichlorobenzene
GC/MS	8260B,C	1 2 3-Trichloropropane
GC/MS	8260B,C / SOM01.2	1 2 4-Trichlorobenzene
GC/MS	8260B,C	1 2 4-Trimethylbenzene
GC/MS	8260B,C / SOM01.2	1 2-Dibromo-3-chloropropane
GC/MS	8260B,C / SOM01.2	1 2-Dichlorobenzene
GC/MS	8260B,C / SOM01.2	1 2-Dichloroethane
GC/MS	8260B,C / SOM01.2	1 2-Dichloropropane
GC/MS	8260B,C	1 3 5-Trimethylbenzene
GC/MS	8260B,C / SOM01.2	1 3-Dichlorobenzene
GC/MS	8260B,C	1 3-Dichloropropane
GC/MS	8260B,C / SOM01.2	1 4-Dichlorobenzene
GC/MS	8260B,C / SOM01.2	1 4-Dioxane
GC/MS	8260B,C	2 2-Dichloropropane
GC/MS	8260B,C / SOM01.2	2-Butanone
GC/MS	8260B,C	2-Chloroethyl vinyl ether
GC/MS	8260B,C	2-Chlorotoluene
GC/MS	8260B,C / SOM01.2	2-Hexanone
GC/MS	8260B,C	4-Chlorotoluene
GC/MS	8260B,C / SOM01.2	4-Methyl-2-pentanone

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	8260B,C / SOM01.2	Acetone
GC/MS	8260B,C	Acetonitrile
GC/MS	8260B,C	Acrolein
GC/MS	8260B,C	Acrylonitrile
GC/MS	8260B,C	Allyl chloride
GC/MS	8260B,C / SOM01.2	Benzene
GC/MS	8260B,C	Bromobenzene
GC/MS	8260B,C / SOM01.2	Bromochloromethane
GC/MS	8260B,C / SOM01.2	Bromodichloromethane
GC/MS	8260B,C / SOM01.2	Bromoform
GC/MS	8260B,C / SOM01.2	Carbon disulfide
GC/MS	8260B,C / SOM01.2	Carbon tetrachloride
GC/MS	8260B,C / SOM01.2	Chlorobenzene
GC/MS	8260B,C / SOM01.2	Chloroethane
GC/MS	8260B,C / SOM01.2	Chloroform
GC/MS	8260B,C	Chloroprene
GC/MS	8260B,C / SOM01.2	cis-1 2-Dichloroethene
GC/MS	8260B,C / SOM01.2	cis-1 3-Dichloropropene
GC/MS	SOM01.2	Cyclohexane
GC/MS	8260B,C / SOM01.2	Dibromochloromethane
GC/MS	8260B,C	Dibromomethane
GC/MS	624 / 8260B,C / SOM01.2	Dichlorodifluoromethane
GC/MS	8260B,C	Diethyl ether
GC/MS	8260B,C	Di-isopropylether
GC/MS	8260B,C / SOM01.2	EDB
GC/MS	8260B,C	Ethyl methacrylate
GC/MS	8260B,C / SOM01.2	Ethylbenzene
GC/MS	8260B,C	Ethyl-t-butylether
GC/MS	8260B,C	Hexachlorobutadiene
GC/MS	8260B,C	Iodomethane
GC/MS	8260B,C	Isobutyl alcohol
GC/MS	8260B,C / SOM01.2	Isopropyl benzene
GC/MS	SOM01.2	m p-xylenes
GC/MS	8260B,C	Methacrylonitrile
GC/MS	SOM01.2	Methyl acetate
GC/MS	8260B,C / SOM01.2	Methyl bromide (Bromomethane)
GC/MS	8260B,C / SOM01.2	Methyl chloride (Chloromethane)
GC/MS	8260B,C	Methyl methacrylate
GC/MS	8260B,C / SOM01.2	Methyl tert-butyl ether
GC/MS	SOM01.2	Methylcyclohexane
GC/MS	8260B,C / SOM01.2	Methylene chloride
GC/MS	8260B,C	Naphthalene
GC/MS	8260B,C	n-Butylbenzene
GC/MS	8260B,C	n-proplybenzene
GC/MS	8260B,C	o-Xylene

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	8260B,C	p-Isopropyltoluene
GC/MS	8260B,C	Propionitrile
GC/MS	8260B,C	sec-butylbenzene
GC/MS	8260B,C / SOM01.2	Styrene
GC/MS	8260B,C	t-Amylmethylether
GC/MS	8260B,C	tert-Butyl alcohol
GC/MS	8260B,C	tert-Butylbenzene
GC/MS	8260B,C / SOM01.2	Tetrachloroethylene (Perchloroethylene)
GC/MS	8260B,C	Tetrahydrofuran
GC/MS	8260B,C / SOM01.2	Toluene
GC/MS	8260B,C / SOM01.2	trans-1 2-Dichloroethylene
GC/MS	8260B,C / SOM01.2	trans-1 3-Dichloropropylene
GC/MS	8260B,C	Trans-1 4-Dichloro-2-butuene
GC/MS	8260B,C / SOM01.2	Trichloroethene (Trichloroethylene)
GC/MS	8260B,C / SOM01.2	Trichlorofluoromethane
GC/MS	8260B,C	Vinyl acetate
GC/MS	8260B,C / SOM01.2	Vinyl chloride
GC/MS	8260B,C	Xylene
GC/MS	8270C,D	1-Naphthylamine
GC/MS	8270C,D	2-Acetylaminofluorene
GC/MS	8270C,D / SOM01.2	2-Chloronaphthalene
GC/MS	8270C,D / SOM01.2	2-Chlorophenol
GC/MS	8270C,D / SOM01.2	2-Methylnaphthalene
GC/MS	8270C,D / SOM01.2	2-Methylphenol
GC/MS	8270C,D	2-Naphthylamine
GC/MS	8270C,D	2-Nitroaniline
GC/MS	8270C,D / SOM01.2	2-Nitrophenol
GC/MS	8270C,D	2-Picoline
GC/MS	8270C,D	3-Methylcholanthrene
GC/MS	8270C,D / SOM01.2	3-Nitroaniline
GC/MS	8270C,D	4-Aminobiphenyl
GC/MS	8270C,D / SOM01.2	4-Bromophenyl phenyl ether
GC/MS	8270C,D / SOM01.2	4-Chloro-3-methylphenol
GC/MS	8270C,D / SOM01.2	4-Chloroaniline
GC/MS	8270C,D / SOM01.2	4-Chlorophenyl phenylether
GC/MS	8270C,D	4-Dimethyl aminoazobenzene
GC/MS	8270C,D / SOM01.2	4-Methylphenol
GC/MS	8270C,D / SOM01.2	4-Nitroaniline
GC/MS	8270C,D / SOM01.2	4-Nitrophenol
GC/MS	8270C,D	5-Nitro-o-toluidine
GC/MS	8270C,D	a a-Dimethylphenethylamine
GC/MS	8270C,D / SOM01.2	Acenaphthene
GC/MS	8270C,D / SOM01.2	Acenaphthylene
GC/MS	8270C,D / SOM01.2	Acetophenone
GC/MS	8270C,D	Aniline

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	8270C,D / SOM01.2	Anthracene
GC/MS	8270C,D	Aramite
GC/MS	8270C,D / SOM01.2	Atrazine
GC/MS	SOM01.2	Benzaldehyde
GC/MS	8270C,D	Benzidine
GC/MS	8270C,D / SOM01.2	Benzo(a)anthracene
GC/MS	8270C,D / SOM01.2	Benzo(a)pyrene
GC/MS	8270C,D / SOM01.2	Benzo(b)fluoranthene
GC/MS	8270C,D / SOM01.2	Benzo(g h i)perylene
GC/MS	8270C,D / SOM01.2	Benzo(k)fluoranthene
GC/MS	8270C,D	Benzoic Acid
GC/MS	8270C,D	Benzyl alcohol
GC/MS	8270C,D / SOM01.2	Biphenyl
GC/MS	8270C,D / SOM01.2	bis(2-Chloroethoxy)methane
GC/MS	8270C,D / SOM01.2	bis(2-Chloroethyl) ether
GC/MS	8270C,D / SOM01.2	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	8270C,D / SOM01.2	Butyl benzyl phthalate
GC/MS	SOM01.2	Caprolactam
GC/MS	8270C,D / SOM01.2	Carbazole
GC/MS	8270C,D	Chlorobenzilate
GC/MS	8270C,D / SOM01.2	Chrysene
GC/MS	8270C,D	Diallate
GC/MS	8270C,D / SOM01.2	Dibenz(a h)anthracene
GC/MS	8270C,D / SOM01.2	Dibenzofuran
GC/MS	8270C,D / SOM01.2	Diethyl phthalate
GC/MS	8270C,D	Dimethoate
GC/MS	8270C,D / SOM01.2	Dimethyl phthalate
GC/MS	8270C,D / SOM01.2	Di-n-butyl phthalate
GC/MS	8270C,D / SOM01.2	Di-n-octyl phthalate
GC/MS	8270C,D	Ethyl methanesulfonate
GC/MS	8270C,D	Famfur
GC/MS	8270C,D / SOM01.2	Fluoranthene
GC/MS	8270C,D / SOM01.2	Fluorene
GC/MS	8270C,D / SOM01.2	Hexachlorobenzene
GC/MS	8270C,D / SOM01.2	Hexachlorobutadiene
GC/MS	8270C,D / SOM01.2	Hexachlorocyclopentadiene
GC/MS	8270C,D / SOM01.2	Hexachloroethane
GC/MS	8270C,D	Hexachloropropene
GC/MS	8270C,D	Isodrin
GC/MS	8270C,D / SOM01.2	Isophorone
GC/MS	8270C,D	Isosafrole
GC/MS	8270C,D	Methapyriline
GC/MS	8270C,D	Methyl methanesulfonate
GC/MS	8270C,D	Methyl parathion
GC/MS	8270C,D / SOM01.2	Naphthalene

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	8270C,D / SOM01.2	Nitrobenzene
GC/MS	8270C,D	Nitroquinoline-1-oxide
GC/MS	8270C,D	n-Nitrosodiethylamine
GC/MS	8270C,D / SOM01.2	n-Nitrosodimethylamine
GC/MS	8270C,D	n-Nitroso-di-n-butylamine
GC/MS	8270C,D / SOM01.2	n-Nitrosodi-n-propylamine
GC/MS	8270C,D / SOM01.2	n-Nitrosodiphenylamine
GC/MS	8270C,D	n-Nitrosomethylethylamine
GC/MS	8270C,D	n-Nitrosomorpholine
GC/MS	8270C,D	n-Nitrosopiperidine
GC/MS	8270C,D	n-Nitrosopyrrolidine
GC/MS	8270C,D	o o o-Triethyl phosphorothioate
GC/MS	8270C,D	o-Toluidine
GC/MS	8270C,D	Pentachlorobenzene
GC/MS	8270C,D	Pentachloronitrobenzene
GC/MS	8270C,D/ SOM01.2	Pentachlorophenol
GC/MS	8270C,D	Phenacetin
GC/MS	8270C,D / SOM01.2	Phenanthrene
GC/MS	8270C,D / SOM01.2	Phenol
GC/MS	8270C,D	Phorate
GC/MS	8270C,D	Pronamide
GC/MS	8270C,D / SOM01.2	Pyrene
GC/MS	8270C,D	Pyrididne
GC/MS	8270C,D	Safrole
GC/MS	8270C,D	Thionazin
GC/MS	8270C,D / SOM01.2	Indeno(1 2 3-cd)pyrene
GC/MS	8270C,D / SOM01.2	1 2 4-Trichlorobenzene
GC/MS	8270C,D	1 3 5-Trinitrobenzene
GC/MS	8270C,D / SOM01.2	1 2 4 5-Tetrachlorobenzene
GC/MS	8270C,D / SOM01.2	2 4 5-Trochlorophenol
GC/MS	8270C,D / SOM01.2	2 4 6-Trichlorophenol
GC/MS	8270C,D / SOM01.2	2 3 4 6-Tetrachlorophenol
GC/MS	8270C,D / SOM01.2	1 2-Dichlorobenzene
GC/MS	8270C,D	1 2-Diphenylhydrazine
GC/MS	8270C,D / SOM01.2	1 3-Dichlorobenzene
GC/MS	8270C,D	1 3-Dinitrobenzene
GC/MS	8270C,D / SOM01.2	1 4-Dichlorobenzene
GC/MS	8270C,D	1 4-Dioxane
GC/MS	8270C,D	1 4-Naphthoquinone
GC/MS	8270C,D	1 4-Phenylenediamine
GC/MS	8270C,D / SOM01.2	bis(2-Chloroisopropyl) ether (2 2`-Oxybis(1-chloropropane))
GC/MS	8270C,D / SOM01.2	2 4-Dichlorophenol
GC/MS	8270C,D / SOM01.2	2 4-Dimethylphenol
GC/MS	8270C,D / SOM01.2	2 4-Dinitrophenol

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	8270C,D / SOM01.2	2 4-Dinitrotoluene (2 4-DNT)
GC/MS	8270C,D	2 6-Dichlorophenol
GC/MS	8270C,D / SOM01.2	2 6-Dinitrotoluene (2 6-DNT)
GC/MS	8270C,D / SOM01.2	3 3`-Dichlorobenzidine
GC/MS	8270C,D	3 3'-Dimethylbenzidine
GC/MS	8270C,D / SOM01.2	2-Methyl-4 6-dinitrophenol
GC/MS	8270C,D	7,12-Dimethylphenethylamine
HPLC	8330/8330A/8330B (Analysis Only)	1 3 5-Trinitrobenzene
HPLC	8330/8330A/8330B (Analysis Only)	1 3-Dinitrobenzene
HPLC	8330/8330A/8330B (Analysis Only)	2 4 6-Trinitrotoluene
HPLC	8330/8330A/8330B (Analysis Only)	2 4-Dinitrotoluene
HPLC	8330/8330A/8330B (Analysis Only)	2 6-Dinitrotoluene
HPLC	8330/8330A/8330B (Analysis Only)	2-Amino-4 6 -dinitrotoluene
HPLC	8330/8330A/8330B (Analysis Only)	2-Nitrotoluene
HPLC	8330/8330A/8330B (Analysis Only)	3-Nitrotoluene
HPLC	8330/8330A/8330B (Analysis Only)	4-Amino-2,3-dinitrotoluene
HPLC	8330/8330A/8330B (Analysis Only)	4-Nitrotoluene
HPLC	8330/8330A/8330B (Analysis Only)	Hexahydr-1 3 5-trinitro-1 3 5-triazine (RDX)
HPLC	8330/8330A/8330B (Analysis Only)	Nitrobenzene
HPLC	8330/8330A/8330B (Analysis Only)	Nitroglycerin
HPLC	8330/8330A/8330B (Analysis Only)	Octahydro-1 3 5 7-tetrazocine (HMX)
HPLC	8330/8330A/8330B (Analysis Only)	Tetryl
CVAA	7471B/ ILM05.3	Mercury
CVAF	1631E	Low Level Mercury
ICP	6010B,C /ILM05.3	Aluminum
ICP	6010B,C /ILM05.3	Antimony
ICP	6010B,C /ILM05.3	Arsenic
ICP	6010B,C /ILM05.3	Barium
ICP	6010B,C /ILM05.3	Beryllium
ICP	6010B,C	Boron
ICP	6010B,C /ILM05.3	Cadmium

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
ICP	6010B,C /ILM05.3	Calcium
ICP	6010B,C /ILM05.3	Chromium
ICP	6010B,C /ILM05.3	Cobalt
ICP	6010B,C /ILM05.3	Copper
ICP	6010B,C /ILM05.3	Iron
ICP	6010B,C /ILM05.3	Lead
ICP	6010B,C /ILM05.3	Magnesium
ICP	6010B,C /ILM05.3	Manganese
ICP	6010B,C	Molybdenum
ICP	6010B,C /ILM05.3	Nickel
ICP	6010B,C /ILM05.3	Potassium
ICP	6010B,C /ILM05.3	Selenium
ICP	200.7	Silicon
ICP	6010B,C /ILM05.3	Silver
ICP	6010B,C /ILM05.3	Sodium
ICP	6010B,C	Strontium
ICP	6010B,C /ILM05.3	Thallium
ICP	6010B,C	Tin
ICP	6010B,C	Titanium
ICP	6010B,C /ILM05.3	Vanadium
ICP	6010B,C /ILM05.3	Zinc
ICP/MS	6020/6020A / ILM05.3	Aluminum
ICP/MS	6020/6020A / ILM05.3	Antimony
ICP/MS	6020/6020A / ILM05.3	Arsenic
ICP/MS	6020/6020A / ILM05.3	Barium
ICP/MS	6020/6020A / ILM05.3	Beryllium
ICP/MS	6020/6020A	Boron
ICP/MS	6020/6020A / ILM05.3	Cadmium
ICP/MS	6020/6020A	Calcium
ICP/MS	6020/6020A / ILM05.3	Chromium
ICP/MS	6020/6020A / ILM05.3	Cobalt
ICP/MS	6020/6020A / ILM05.3	Copper
ICP/MS	6020/6020A	Iron
ICP/MS	6020/6020A / ILM05.3	Lead
ICP/MS	6020/6020A / ILM05.3	Magnesium
ICP/MS	6020/6020A	Manganese
ICP/MS	6020/6020A	Molybdenum
ICP/MS	6020/6020A / ILM05.3	Nickel
ICP/MS	6020/6020A	Potassium
ICP/MS	6020/6020A / ILM05.3	Selenium
ICP/MS	6020/6020A / ILM05.3	Silver
ICP/MS	6020/6020A	Sodium
ICP/MS	6020/6020A	Strontium
ICP/MS	6020/6020A / ILM05.3	Thallium
ICP/MS	6020/6020A	Tin

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Solid and Chemical Waste		
Technology	**Method**	**Analyte**
ICP/MS	6020/6020A	Titanium
ICP/MS	6020/6020A / ILM05.3	Vanadium
ICP/MS	6020/6020A / ILM05.3	Zinc
IC	9056/9056A	Chloride
IC	9056/9056A	Fluoride
IC	9056/9056A	Nitrate as N
IC	9056/9056A	Nitrite as N
IC	9056/9056A	Sulfate
Gravimetric	9070A / 9071B	Oil and Grease
Physical	1010A	Ignitability
Physical	9045D	pH
Titration	Chap 7.3.4	Reactive Sulfide
TOC	Lloyd Kahn	Total organic carbon
TOC	9060A / 5310B	Total organic carbon
Turbidimetric	9038 / ASTM 516-02	Sulfate
UV/VIS	350.1 / 4500NH3 H	Ammonia as N
UV/VIS	9251 / 4500Cl E	Chloride
UV/VIS	Chap. 7.3.4	Reactive Cyanide
UV/VIS	376.3	AVS-SEM
UV/VIS	3500Fe D	Ferrous Iron
Cleanup Methods	3630C	Silica Gel
UV/VIS	7196	Chromium VI
UV/VIS	7196A	Chromium VI
UV/VIS	9012B / ILM05.3	Total cyanide
Preparation	**Method**	**Type**
Preparation	1311	Toxicity Characteristic Leaching Procedure
Preparation	1312	Synthetic Precipitation Leaching Procedure
Cleanup Methods	3660B	Sulfur
Cleanup Methods	3620C	Florsil
Cleanup Methods	3630C	Silica Gel
Cleanup Methods	3640A	GPC
Organic Preparation	3540C	Soxhlet Extraction
Organic Preparation	3545A	Pressurized Fluid Extraction
Organic Preparation	3550C	Sonication
Inorganics Preparation	3050B	Hotblock
Inorganics Preparation	3060A	Alkaline Digestion
Volatile Organics Preparation	5035/5035A	Closed System Purge and Trap

Notes:

1) This laboratory offers commercial testing service.

Approved By: _____ Date: November 4, 2009

R. Douglas Leonard
Chief Technical Officer

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Georgia Department of Natural Resources

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Drinking Water Compliance and Enforcement Unit
Suite 1362 East, 2 Martin Luther King, Jr. Drive S.E.
Atlanta, Georgia 30334-4100

July 10, 2009

Ms. Daphne Warren
Laboratory Owner
Katahdin Analytical Services, Inc
P.O. Box 540
600 Technology Way
Scarborough, Maine 04070

RE: Certification by Reciprocity
Katahdin Analytical Services, Inc
Scarborough, Maine 04070
Georgia ID # 951

Dear Ms. Warren:

The Georgia Department of Natural Resources, Environmental Protection Division is in receipt of all required data necessary to fulfill your laboratories request for Chemical Certification by Reciprocity in Georgia. Therefore, in accordance with the Georgia Safe Drinking Water Act of 1977 (Sections12-5-170 through 12-5-193, O.C.G.A.) and the Rules for Safe Drinking Water (Chapter 391-3-5, January 10, 2005) this certification is valid until June 30, 2010. This certificate is contingent upon continued Certification by the State of Florida/Maine and is **non-transferable**. Out-of-State laboratories will be responsible for contacting and requesting all accreditation/certification data from the accrediting/certifying authority prior to this date, and also if a change in status or personnel has occurred. Certification by reciprocity will not be reissued until the Division has received the following data directly from the **Accrediting/Certifying Body**:

1. Name and identification number of Laboratory
2. Copies of the most current on-site and corrective data.
3. Copies of the scope of accreditation listing analytes.
4. Effective Date
5. Expiration Date

For additional information please contact Loretta Lambert at 404-651-5164 or Penn Craig at 404-657-2494

Sincerely,

William N. Morris
for Brad Addison
Program Manager II
Drinking Water Compliance

Loretta M. Lambert
Laboratory Certification Coordinator
Compliance and Enforcement Unit

GA Lab-ID: 981 (07/31/09)	
Please note, listed below are analyte(s) & method(s) requested but not approved due to the following reason(s); (i) not approved by certifying body, **(ii)** not approved by EPA for the SDWA, **or (iii)** P-Ts results not acceptable.	
Analyte	Method
1,1-Dichloroethane	524.2
2-Hexanone	524.2
Acetone	524.2
Calcium	3111B
Carbon Disulfide	524.2
Cyanide	4500CN-G
P-Dichlorobenzene	524.1
Tetrahydrofuran	524.2
Trans-1,3-Dichloropropene	524.2
Turbidity	2130B

**** Methods 311B, 3111b & 3111D must be based on procedure found in SM 18th or 19th editions not the 20th edition.**

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Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
IOC	ALUMINUM	1002	Florida	200.7
IOC	ANTIMONY	1074	Florida	200.8
IOC	ARSENIC	1005	Florida	200.8
IOC	ASBESTOS	1094		
IOC	BARIUM	1010	Florida	200.7, 200.8
IOC	BERYLLIUM	1075	Florida	200.7, 200.8
IOC	BISMUTH	1078		
IOC	BORON	1079		
IOC	BROMATE	1011		
IOC	BROMIDE	1004		
IOC	CADMIUM	1015	Florida	200.7
IOC	CALCIUM	1016		
IOC	CARBON	1018		
IOC	CHLORATE	1007		
IOC	CHLORIDE	1017		
IOC	CHLORITE	1009		
IOC	CHROMIUM	1020	Florida	200.7, 200.8
IOC	CHROMIUM, HEXAVALENT	1080		
IOC	COBALT	1081		
IOC	COPPER	1022	Florida	200.7, 200.8
IOC	CYANIDE	1024	Florida	335.4
IOC	CYANIDE, FREE	1023		
IOC	FLUORIDE	1025	Florida	4500F-C
IOC	IRON	1028	Florida	200.7
IOC	IRON, DISSOLVED	1082		
IOC	IRON, SUSPENDED	1029		
IOC	LEAD	1030	Florida	200.8
IOC	LITHIUM	1083		
IOC	MAGNESIUM	1031	Florida	200.7
IOC	MANGANESE	1032	Florida	200.7
IOC	MANGANESE, SUSPENDED	1033		
IOC	MERCURY	1035	Florida	245.1
IOC	MOLYBDENUM	1084		
IOC	NEW IOC ORTHOPHOSPHATE	IC44		
IOC	NICKEL	1036	Florida	200.7, 200.8

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Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
IOC	NITRATE (AS N)	1040	Florida	300.0, 353.2
IOC	NITRATE+NITRITE (AS N)	1038	Florida	353.2
IOC	NITRITE (AS N)	1041	Florida	300.0, 353.2
IOC	NITROGEN, TOTAL KJELDAHL (AS N)	1037		
IOC	NITROGEN-AMMONIA (AS N)	1003		
IOC	PHOSPHATE (AS PO4)	1043		
IOC	PHOSPHATE, REACTIVE	1073		
IOC	PHOSPHORUS	1093		
IOC	PHOSPHORUS, SOLUBLE	1072		
IOC	POTASSIUM	1042		
IOC	SELENIUM	1045	Florida	200.8
IOC	SILICA	1049	Florida	200.7
IOC	SILVER	1050	Florida	200.7
IOC	SODIUM	1052	Florida	200.7
IOC	SULFATE	1055	Florida	300.0
IOC	THALLIUM	1085	Florida	200.8
IOC	TIN	1086		
IOC	TITANIUM	1087		
IOC	VANADIUM	1088		
IOC	ZINC	1095	Florida	200.7
MOR	ACTINOMYCETES	3011		
MOR	ADENOVIRUSES	3430		
MOR	AEROMONAS	3026		
MOR	AEROMONAS HYDROPHILIA	3200		
MOR	ALGAE TOXINS	3310		
MOR	CALICIVIRUSES	3420		
MOR	CAMPYLOBACTER JEJUNI	3019		
MOR	CITROBACTER	3025		
MOR	CLOSTRIDIUM	3018		
MOR	COLIFORM, E. COLI	3014		
MOR	COLIFORM, FECAL	3013		
MOR	COLIFORM, TOTAL (PRE-TCR)	3000		
MOR	COLIFORM, TOTAL (TCR)	3100		
MOR	COXSACHIEVIRUSES	3410		

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Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
MOR	CRYPTOSPORIDIUM	2078		
MOR	CRYPTOSPORIDIUM	3015		
MOR	CYANOBACTERIA (BLUE GREEN ALGAE)	3300		
MOR	ECHOVIRUSES	3400		
MOR	ENTEROBACTER	3023		
MOR	ENTEROCOCCI	3002		
MOR	ERWINIA	3027		
MOR	FECAL STREPTOCOCCUS	3003		
MOR	FUNGUS	3009		
MOR	GIARDIA LAMBLIA	3008		
MOR	HELICOBACTER PYLORI	3210		
MOR	HETEROTROPHIC BACTERIA (HPC)	3001		
MOR	IRON BACTERIA	3006		
MOR	KLEBSIELLA	3024		
MOR	LEGIONELLA	3012		
MOR	LEPTOSPIRES	3021		
MOR	MICROSPORIDIA	3500		
MOR	NON-COLIFORM GROWTH IDENTIFICATION	3005		
MOR	PSEUDOMONAS	3017		
MOR	SALMONELLA	3007		
MOR	SHIGELLA	3016		
MOR	STAPHYLOCOCCUS	3004		
MOR	VIBRIO CHOLERAE	3020		
MOR	VIRUS	3010		
MOR	YERSINIA ENTEROCOLITICA	3022		
OC	1,1,1,2-TETRACHLOROETHANE	2986	**Florida**	**524.2**
OC	1,1,1-TRICHLORO-2-PROPANONE	2956		
OC	1,1,1-TRICHLOROETHANE	2981	**Florida**	**524.2**
OC	1,1,1-TRICHLOROPROPANONE	2464		
OC	1,1,2,2-TETRACHLOROETHANE	2988	**Florida**	**524.2**
OC	1,1,2-TRICHLOROETHANE	2985	**Florida**	**524.2**
OC	1,1-DICHLORO-2-PROPANONE	2957		
OC	1,1-DICHLOROETHANE	2978		

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Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
OC	1,1-DICHLOROETHYLENE	2977	Florida	524.2
OC	1,1-DICHLOROPROPANONE	2463		
OC	1,1-DICHLOROPROPENE	2410	Florida	524.2
OC	1,2,3 - TRIMETHYLBENZENE	2419		
OC	1,2,3-TRICHLOROBENZENE	2420	Florida	524.2
OC	1,2,3-TRICHLOROPROPANE	2414	Florida	524.2
OC	1,2,4-TRICHLOROBENZENE	2378	Florida	524.2
OC	1,2,4-TRIMETHYLBENZENE	2418	Florida	524.2
OC	1,2-DIBROMOETHYLENE(EDB, Ethylene Dibromide, 1,2-Dibromoethane)	2232	Florida	504.1
OC	1,2-DICHLOROETHANE	2980	Florida	524.2
OC	1,2-DICHLOROPROPANE	2983	Florida	524.2
OC	1,2-DIPHENYLHYDRAZINE	2268		
OC	1,3,5-TRICHLOROBENZENE	2377		
OC	1,3,5-TRIMETHYLBENZENE	2424	Florida	524.2
OC	1,3-DICHLOROPROPANE	2412	Florida	524.2
OC	1,3-DICHLOROPROPENE	2413		
OC	1,3-DICHLOROPROPYLENE	2655		
OC	1,4-DIOXANE	2049		
OC	1-CHLOROBUTANE	2086		
OC	1-CHLOROHEXANE	2087		
OC	1-METHYL-NAPHTHALENE	2315		
OC	1-NAPTHOL (1-HYDORXYNAPTHTHALENE)	2259		
OC	2,2-DICHLOROPROPANE	2416	Florida	524.2
OC	2,3,7,8 TCDD (DIOXIN)	2063		
OC	2,4 DIMETHYLPHENOL	2336		
OC	2,4,5-T	2111		
OC	2,4,5-TP (SILVEX)	2110		
OC	2,4,5-TRICHLOROPHENOL	2242		
OC	2,4,6-TRICHLOROPHENOL	2332		
OC	2,4,DB	2106		
OC	2,4-D	2105		
OC	2,4-DICHLOROPHENOL	2334		
OC	2,4-DINITROPHENOL	2328		

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Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
OC	2,4-DINITROTOLUENE	2270		
OC	2,6-DINITROTOLUENE	2266		
OC	2-CHLOROETHYLVINYL ETHER	2234		
OC	2-CHLORONAPHTHALENE	2258		
OC	2-CHLOROPHENOL	2344		
OC	2-HEXANONE	2269		
OC	2-METHYL NAPHTHALENE	2241		
OC	2-METHYL-4,6-DINITROPHENOL	2227		
OC	2-METHYLPHENOL	2233		
OC	2-NITROANILINE	2200		
OC	2-NITROPHENOL	2340		
OC	2-NITROPROPANE	2469		
OC	3,3-DICHLOROBENZIDINE	2320		
OC	3,4-DICHLOROBENZOIC ACID	2109		
OC	3-HYDROXYCARBOFURAN	2066		
OC	3-NITROANILINE	2201		
OC	4,6-DINITRO-O-CRESOL	2346		
OC	4-BROMOPHENYL PHENYL ETHER	2276		
OC	4-CHLORO-PHENYL-PHENYL ETHER	2318		
OC	4-CHLOROANILINE	2239		
OC	4-METHYLPHENOL	2235		
OC	4-NITROANILINE	2203		
OC	4-NITROPHENOL	2342		
OC	ACENAPHTHENE	2261		
OC	ACENAPHTHYLENE	2260		
OC	ACETALDHYDE	2470		
OC	ACETIC ACID (ETHANOIC ACID)	2449		
OC	ACETONE	2243		
OC	ACIFLUORFEN	2108		
OC	ACROLEIN	2238		
OC	ACRYLAMIDE	2265		
OC	ACRYLONITRILE	2240		
OC	ACTECHLOR	2027		
OC	ALACHLOR (LASSO)	2051		

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Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
OC	ALACHLOR ESA	2004		
OC	ALDICARB	2047		
OC	ALDICARB SULFONE	2044		
OC	ALDICARB SULFOXIDE	2043		
OC	ALDRIN	2356		
OC	ALLYL CHLORIDE	2402		
OC	AMIBEN	2620		
OC	AMPA, AMINOMETHYLPHOSPHONIC ACID	2097		
OC	AMYL ACETATE	2081		
OC	ANILINE	2230		
OC	ANTHRACENE	2280		
OC	AOC/BDOC	2485		
OC	AROCLOR 1016 (PCB)	2388		
OC	AROCLOR 1221 (PCB)	2390		
OC	AROCLOR 1232 (PCB)	2392		
OC	AROCLOR 1242 (PCB)	2394		
OC	AROCLOR 1248 (PCB)	2396		
OC	AROCLOR 1254 (PCB)	2398		
OC	AROCLOR 1260 (PCB)	2400		
OC	ATRAZINE	2050		
OC	AZINPHOS-METHYL (GUITHON)	2059		
OC	AZOBENZENE	2204		
OC	BENEZENE 2	9999		
OC	BENFLURALIN (BENETIN)	2207		
OC	BENTAZON (BASAGRAN)	2625		
OC	BENZALDEHYDE	2479		
OC	BENZENE	2990	**Florida**	**524.2**
OC	BENZIDINE	2292		
OC	BENZO (A) ANTHRACENE	2300		
OC	BENZO (A) PYRENE	2306		
OC	BENZO (B) FLUORANTHENE	2302		
OC	BENZO (G,H,I) PERYLENE	2312		
OC	BENZO (K) FLUORANTHENE	2304		
OC	BENZOIC ACID	2237		

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Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
OC	BENZYL ALCOHOL	2231		
OC	BHC-ALPHA	2348		
OC	BHC-BETA	2350		
OC	BHC-DELTA	2354		
OC	BHC-GAMMA (LINDANE)	2010		
OC	BIS(2-CHLOROETHOXY) METHANE	2250		
OC	BIS(2-CHLOROETHYL) ETHER	2222		
OC	BIS(2-CHLOROISOPROPYL) ETHER	2244		
OC	BIS(2-ETHYLHEXYL) PHTHALATE	2298		
OC	BIS(CHLOROMETHYL) ETHER	2324		
OC	BOLSTAR	2635		
OC	BROMACIL	2098		
OC	BROMOBENZENE	2993	**Florida**	**524.2**
OC	BROMOCHLOROACETIC ACID	2339		
OC	BROMOCHLOROACETIC ACID	2455		
OC	BROMOCHLOROACETONITRILE	2462		
OC	BROMOCHLOROACETONITRILE	2951		
OC	BROMOCHLOROMETHANE	2430	**Florida**	**524.2**
OC	BROMODICHLOROMETHANE	2943	**Florida**	**524.2**
OC	BROMOFORM	2942	**Florida**	**524.2**
OC	BROMOMETHANE (Methyl bromide)	2214	**Florida**	**524.2**
OC	BROMOXYNIL	2209		
OC	BUTACHLOR (MACHETE)	2076		
OC	BUTANAL	2472		
OC	BUTANE	2082		
OC	BUTYL ACETATE	2083		
OC	BUTYLATE (SUTAN)	2053		
OC	BUTYLBENZYL PHTHALATE	2294		
OC	CARBARYL	2021		
OC	CARBOFURAN	2046		
OC	CARBON DISULFIDE	1902		
OC	CARBON TETRACHLORIDE	2982	**Florida**	**524.2**
OC	CHLORAL HYDRATE	2460		
OC	CHLORAL HYDRATE	2952		
OC	CHLORAMBEN	2205		

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Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
OC	CHLORDANE	2959		
OC	CHLOROACETONITRILE	2466		
OC	CHLORODIBROMOMETHANE	2944	**Florida**	**524.2**
OC	CHLOROETHANE	2216	**Florida**	**524.2**
OC	CHLOROFORM	2941	**Florida**	**524.2**
OC	CHLOROMETHANE(Methyl chloride)	2210	**Florida**	**524.2**
OC	CHLOROPICRIN	2465		
OC	CHLOROPICRIN	2953		
OC	CHLORPYRIFOS (LORSBAN)	2057		
OC	CHLORPYRIPHOS	2215		
OC	CHLORSULFURON	2217		
OC	CHLORTHALONL	2213		
OC	CHRYSENE	2296		
OC	CIS-1,2-DICHLOROETHYLENE	2380	**Florida**	**524.2**
OC	CIS-1,3-DICHLOROPROPENE	2228	**Florida**	**524.2**
OC	COUNTER (TERBOFUS)	2545		
OC	CYANAZINE	2054		
OC	CYANOGEN CHLORIDE	2080		
OC	DACTHAL (DCPA)	2099		
OC	DALAPON	2031		
OC	DCPA DI ACID DEGRADATE	2101		
OC	DCPA MONO ACID DEGRADATE	2100		
OC	DDD, ORTHO-PARA	2367		
OC	DDD, PARA-PARA	2071		
OC	DDE, ORTHO-PARA	2365		
OC	DDE, PARA-PARA	2069		
OC	DDT, ORTHO-PARA	2369		
OC	DDT, PARA-PARA	2075		
OC	DECANAL	2481		
OC	DECHLOROBIPHENYL	2384		
OC	DES-ETHYL-ATRAZINE	2006		
OC	DES-ISOPROPYL-ATRAZINE	2007		
OC	DI(2-ETHYLHEXYL) - ADIPATE	2035		
OC	DI(2-ETHYLHEXYL) - PHTHALATE	2039		
OC	DI-N-BUTYL PHTHALATE	2290		

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Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
OC	DI-N-OCTYL PHTHALATE	2223		
OC	DIAZINON (SPECTRACIDE)	2056		
OC	DIBENZO (A,H) ANTHRACENE	2310		
OC	DIBENZOFURAN	2202		
OC	DIBROMOACETIC ACID	2329		
OC	DIBROMOACETIC ACID	2454		
OC	DIBROMOACETONITRILE	2079		
OC	DIBROMOCHLOROPROPANE (DBCP)	2931	**Florida**	**504.1**
OC	DIBROMOMETHANE	2408	**Florida**	**524.2**
OC	DICAMBA	2440		
OC	DICHLORAN; (BOTRAN)	2933		
OC	DICHLORETHYLENE	2650		
OC	DICHLOROACETIC ACID	2331		
OC	DICHLOROACETIC ACID	2451		
OC	DICHLOROACETONITRILE	2461		
OC	DICHLOROACETONITRILE	2954		
OC	DICHLOROBENZENES	2401		
OC	DICHLORODIFLUOROMETHANE	2212	**Florida**	**524.2**
OC	DICHLOROIODOMETHANE	2975		
OC	DICHLOROMETHANE	2964	**Florida**	**524.2**
OC	DICHLORPROP	2206		
OC	DICHROTOPHOS (DEMETON - CO)	2220		
OC	DIELDRIN	2070		
OC	DIETHYL PHTHALATE	2284		
OC	DIIODOMETHANE	2236		
OC	DIMETHOATE	2221		
OC	DIMETHYL PHTHALATE	2282		
OC	DINOSEB	2041		
OC	DIQUAT	2032		
OC	DISSOLVED ORGANIC CARBON (DOC)	2919		
OC	DISULFOTON	2102		
OC	DIURON	2103		
OC	DYFONATE	2570		
OC	ENDOSULFAN I (ALPHA)	2068		

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Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
OC	ENDOSULFAN II (BETA)	2072		
OC	ENDOSULFAN SULFATE	2074		
OC	ENDOTHALL	2033		
OC	ENDRIN	2005		
OC	ENDRIN ALDEHYDE	2372		
OC	EPICHLOROHYDRIN	2257		
OC	EPTAM (EPTC)	2052		
OC	ETHALFLURALIN	2252		
OC	ETHION (ETU)	2062		
OC	ETHYL ACETATE	2088		
OC	ETHYL ALCOHOL	2089		
OC	ETHYL ETHER	2090		
OC	ETHYL METHACRYLATE	2293		
OC	ETHYLBENZENE	2992	**Florida**	**524.2**
OC	ETHYLENE DIBROMIDE (EDB)	2946	**Florida**	**504.1**
OC	ETHYLENE GLYCOL	2960		
OC	FLUOMETURON	2297		
OC	FLUORANTHENE	2286		
OC	FLUORENE	2264		
OC	FORMALDEHYDE	2961		
OC	GASOLINE	2A01		
OC	GLYOXAL	2474		
OC	GLYPHOSATE	2034		
OC	HEPTACHLOR	2065		
OC	HEPTACHLOR EPOXIDE	2067		
OC	HEPTANAL	2477		
OC	HEXACHLOROBENZENE	2274		
OC	HEXACHLOROBUTADIENE	2246	**Florida**	**524.2**
OC	HEXACHLOROCYCLOPENTADIENE	2042		
OC	HEXACHLOROETHANE	2225		
OC	HEXAMETHYLPHOSPHORAMINE (HMPA)	2940		
OC	HEXANAL	2476		
OC	HYDROCARBONS, EXTRACTABLE IN DIESEL OIL	1062		
OC	HYDROCARBONS, EXTRACTABLE	1065		

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Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
	IN WASTE OIL			
OC	HYPOCHLORITE ION	2048		
OC	INDENO (1,2,3-CD) PYRENE	2308		
OC	ISO-OCTANE	2091		
OC	ISOBUTYL ACETATE	2092		
OC	ISOBUTYL ALCOHOL	2093		
OC	ISOFENPHOS (OLFANOL)	2060		
OC	ISOPHORONE	2262		
OC	ISOPROPYL ACETATE	2094		
OC	ISOPROPYL ALCOHOL	2095		
OC	ISOPROPYL ETHER	2245		
OC	ISOPROPYLBENZENE	2994	**Florida**	**524.2**
OC	KELTHANE (DICOFAL)	2370		
OC	KEPONE	2930		
OC	KEROSENE	2374		
OC	LINURON	2283		
OC	M-DICHLOROBENZENE	2967		
OC	MALATHION	2058		
OC	MCPA	2113		
OC	MECOPROP	2112		
OC	METASYSTOX (DEMETONMETHYL)	2253		
OC	METHACRYLONITRILE	2467		
OC	METHANE	2441		
OC	METHIOCARB	2024		
OC	METHOMYL	2022		
OC	METHOXYCHLOR	2015		
OC	METHYL ACETATE	2442		
OC	METHYL ALCOHOL	2443		
OC	METHYL CELLOSOLVE	2444		
OC	METHYL ETHYL KETONE (MEK)	2247		
OC	METHYL GLYOXAL	2475		
OC	METHYL IODINE	2458		
OC	METHYL ISOBUTYL KETONE	2249		
OC	METHYL METHACRYLATE	2295		
OC	METHYL TERT-BUTYL ETHER (MTBE)	2251	**Florida**	**524.2**

Laboratory Name: Katahdin Analytical Services, Inc, GA Lab-ID 951, P.O. Box 540, 600 Technology Way, Scarborough, Maine 04070. Drinking Water Checklist, Effective 07/10/09 thru 06-30-10.

Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
OC	METOLACHLOR	2045		
OC	METRIBUZIN (SENCOR)	2595		
OC	MIREX	2932		
OC	MOCAP	2590		
OC	MOLINATE (ORDRAM)	2626		
OC	MONOBROMOACETIC ACID	2338		
OC	MONOBROMOACETIC ACID	2453		
OC	MONOCHLOROACETIC ACID	2335		
OC	MONOCHLOROACETIC ACID	2450		
OC	MONOCHLOROBENZENE	2989	**Florida**	**524.2**
OC	N-BUTYL ALCOHOL	2084		
OC	N-BUTYLBENZENE	2422	**Florida**	**524.2**
OC	N-HEXANE	2376		
OC	N-NITROSODI-N-PROPYLAMINE	2316		
OC	N-NITROSODIMETHYLAMINE	2314		
OC	N-NITROSODIPHENYLAMINE	2229		
OC	N-PROPYL ALCOHOL	2446		
OC	N-PROPYLBENZENE	2998	**Florida**	**524.2**
OC	NAPHTHALENE	2248	**Florida**	**524.2**
OC	NEW OC ORTHOPHOSPHATE	OC44		
OC	NITROBENZENE	2254		
OC	NONANAL	2480		
OC	O-CHLOROTOLUENE	2965		
OC	O-DICHLOROBENZENE	2968	**Florida**	**524.2**
OC	OCTANAL	2478		
OC	OIL & GREASE	1090		
OC	OIL, #2 FUEL	2A02		
OC	OIL, #4 FUEL	2A04		
OC	OIL, #5 FUEL	2A05		
OC	OIL, JET FUEL #6	2A03		
OC	OIL, MOTOR	2A06		
OC	OIL, SUBMERSIBLE PUMP	2A07		
OC	OXAMYL (VYDATE)	2036		
OC	P-CHLORO-M-CRESOL	2330		
OC	P-CHLOROTOLUENE	2966		

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Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
OC	P-DICHLOROBENZENE	2969	Florida	524.2
OC	P-ISOPROPYLTOLUENE	2030		
OC	PAHS	2038		
OC	PARAQUAT	2028		
OC	PARATHION - ETHYL	2064		
OC	PCB 1262	2399		
OC	PENDIMETHYLIN	2255		
OC	PENTACHLOROETHANE	2327		
OC	PENTACHLOROPHENOL	2326		
OC	PENTANAL	2473		
OC	PENTANE	2325		
OC	PERCHLORATE	1039	Florida	314.0
OC	PERMETHRIN (MIXED, CIS, TRANS)	2114		
OC	PERMETHRIN, TRANS	2275		
OC	PHENANTHRENE	2278		
OC	PHENOLS	2910		
OC	PHORATE	2605		
OC	PHOSDRIN	2073		
OC	PICLORAM	2040		
OC	POLYCHLORINATED BIPHENYLS (PCB)	2383		
OC	PROMETON (P-CYMENE)	2029		
OC	PROPACHLOR	2077		
OC	PROPANAL	2471		
OC	PROPANE	2A09		
OC	PROPANIL	2289		
OC	PROPAZINE	2256		
OC	PROPHOS	2267		
OC	PROPIONITRILE	2468		
OC	PROPOXUR (BAYGON)	2023		
OC	PROPYL ACETATE	2445		
OC	PROWL	2615		
OC	PYRENE	2288		
OC	RDX	2096		
OC	SEC-BUTYL ALCOHOL	2085		

Laboratory Name: Katahdin Analytical Services, Inc, GA Lab-ID 951, P.O. Box 540, 600 Technology Way, Scarborough, Maine 04070. Drinking Water Checklist, Effective 07/10/09 thru 06-30-10.

Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
OC	SEC-BUTYLBENZENE	2428	Florida	524.2
OC	SIDURON	2301		
OC	SIMAZINE	2037		
OC	STYRENE	2996	Florida	524.2
OC	SUVA (SPECFIC ULTRAVIOLET ABSORBANCE)	2923		
OC	TEBUTHIURON	2271		
OC	TEDION	2371		
OC	TERBACIL	2272		
OC	TERRACLOR (PCNB)	2934		
OC	TERT-BUTYLBENZENE	2426	Florida	524.2
OC	TETRACHLOROETHYLENE	2987	Florida	524.2
OC	TETRAHYDROFURAN	2263		
OC	THIDIAZURON	2303		
OC	THIOBENCARB (BOLERO)	2727		
OC	TOLUENE	2991	Florida	524.2
OC	TOTAL HALOACETIC ACIDS (HAA5)	2456		
OC	TOTAL ORGANIC HALIDE (TOX)	2921		
OC	TOTAL TRIHALOMETHANES (TTHM)	2950	Florida	524.2
OC	TOXAPHENE (Chlorinated camphene)	2020		
OC	TRANS-1,2-DICHLOROETHYLENE	2979	Florida	524.2
OC	TRANS-1,2-DICHLOROPROPENE	2226		
OC	TRANS-1,3-DICHLOROPROPENE	2224		
OC	TRANS-1,4-DICHLORO-2-BUTENE	2970		
OC	TRANS-NONACHLOR	2273		
OC	TRICHLOROACETIC ACID	2337		
OC	TRICHLOROACETIC ACID	2452		
OC	TRICHLOROACETONITRILE	2219		
OC	TRICHLOROETHYLENE	2984	Florida	524.2
OC	TRICHLOROFLUOROMETHANE	2218	Florida	524.2
OC	TRICHLOROTRIFLUOROETHANE (FREON 113)	2904		
OC	TRICLOPYR	2107		
OC	TRIFLURALIN	2055		
OC	TRIHALOMETHANE,MAX	2949		

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Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
	POTENTIAL (MTP)			
OC	TRITHION	2061		
OC	VARSOL	2A08		
OC	VINYL 2-CHLOROETHYL ETHER	2520		
OC	VINYL ACETATE	2447		
OC	VINYL CHLORIDE	2976	**Florida**	**524.2**
OC	XYLENE, META	2995		
OC	XYLENE, META AND PARA	2963		
OC	XYLENE, ORTHO	2997		
OC	XYLENE, PARA	2962		
OC	XYLENES	2955	**Florida**	**524.2**
OT	NOTE: (RESERVED BY MSIS)	1999		
OT	NOTE: (RESERVED BY MSIS)	2999		
OT	NOTE: (RESERVED BY MSIS)	4999		
RA	ANTIMONY-122	4240		
RA	ANTIMONY-124	4242		
RA	ANTIMONY-125	4244		
RA	ANTIMONY-127	4246		
RA	ARSENIC-73	4152		
RA	ARSENIC-74	4154		
RA	ARSENIC-76	4156		
RA	ARSENIC-77	4158		
RA	BARIUM-140	4278		
RA	BERYLLIUM-10	4106		
RA	BERYLLIUM-7	4104		
RA	BISMUTH-206	4374		
RA	BISMUTH-207	4376		
RA	BISMUTH-210	4378		
RA	BROMIDE-82	4164		
RA	CADMIUM-109	4224		
RA	CADMIUM-113M	4226		
RA	CADMIUM-115	4230		
RA	CADMIUM-115M	4228		
RA	CALCIUM-45	4118		
RA	CALCIUM-47	4120		

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Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
RA	TUNGSTEN-187	4340		
RA	URANIUM, COMBINED	4006		
RA	URANIUM-234	4007		
RA	URANIUM-235	4008		
RA	URANIUM-238	4009		
RA	VANADIUM-48	4128		
RA	YTTERBIUM-175	4328		
RA	YTTRIUM-90	4176		
RA	YTTRIUM-91	4178		
RA	YTTRIUM-91M	4180		
RA	ZINC-65	4148		
RA	ZIRCONIUM-93	4182		
RA	ZIRCONIUM-95	4184		
RL	CONSUMER CONFIDENCE REPORTS RULE	7000		
RL	DISINFECTION BYPRODUCTS RULE	0400		
RL	FILTER BACKWASH RULE	0500		
RL	INTERIM ENHANCED SWTR	0300		
RL	LEAD & COPPER RULE	5000		
RL	PUBLIC NOTICE RULE	7500		
RL	SURFACE WATER TREATMENT RULE (SWTR)	0200		
WQ	ACIDITY, M.O. (CACO3)	1069		
WQ	ACIDITY, TOTAL (CACO3)	1068		
WQ	AGGRESSIVE INDEX	1994		
WQ	ALKALINITY, BICARBONATE	1928		
WQ	ALKALINITY, CACO3 STABILITY	1067	Florida	2320B
WQ	ALKALINITY, CARBONATE	1929		
WQ	ALKALINITY, PHENOLPHTALEIN	1931		
WQ	ALKALINITY, TOTAL	1927		
WQ	BICARBONATE AS HCO3	1026		

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Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
WQ	BOD, 5DAY	1091		
WQ	CALCIUM	1019		
WQ	CALCIUM	1919		
WQ	CARBON DIOXIDE	1901		
WQ	CARBON, TOTAL ORGANIC (TOC)	2920		
WQ	CHLORAMINE RESIDUAL	1006		
WQ	CHLORINE	0999		
WQ	CHLORINE DIOXIDE RESIDUAL	1008		
WQ	CHLORINE RESIDUAL	1012		
WQ	CHLORINE RESIDUAL, FREE	1013		
WQ	COLOR	1905	**Florida**	**2120B**
WQ	COMBINED CHLORINE	1001		
WQ	CONDUCTIVITY	1064		
WQ	CORROSIVITY	1910		
WQ	FOAMING AGENTS (SURFACTANTS)	2905		
WQ	HARDNESS, CALCIUM	1914		
WQ	HARDNESS, CALCIUM/MAGNESIUM	1918		
WQ	HARDNESS, CARBONATE	1916		
WQ	HARDNESS, NON-CARBONATE	1917		
WQ	HARDNESS, TOTAL (AS CACO3)	1915		
WQ	HARDNESS, TOTAL (GR/GAL)	1048		
WQ	HYDROGEN SULFIDE	1027		
WQ	HYDROXIDE AS CALCIUM CARBONATE	1021		
WQ	LANGELIER INDEX	1997		
WQ	MBAS - FOAMING AGENTS (SURFACTANTS)	1089		
WQ	ODOR	1920		
WQ	ORTHOPHOSPHATE	1044	**Florida**	300.0
WQ	OXYGEN DEMAND, CHEMICAL (COD)	1076		
WQ	OXYGEN DEMAND, TOTAL	1092		

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Type	Analyte	Code	Certified /Accredited by	EPA Approved Methods
WQ	OZONE	1096		
WQ	OZONE RESIDUAL	1014		
WQ	PH	1925	Florida	150.1, 4500H-B
WQ	PH, CACO3 STABILITY SU	1066		
WQ	RESIDUE, FILTERABLE FIXED	1059		
WQ	RESIDUE, FILTERABLE VOLATILE	1058		
WQ	RESIDUE, NONFILTERABLE FIXED	1063		
WQ	RESIDUE, NONFILTERABLE, VOLATILE	1077		
WQ	RESIDUE, SETTLABLE	1071		
WQ	RESIDUE, TOTAL	1070		
WQ	RESIDUE, TOTAL FILTERABLE	1057		
WQ	RESIDUE, TOTAL FIXED	1061		
WQ	RESIDUE, TOTAL VOLATILE	1060		
WQ	SATURATION INDEX	1998		
WQ	SCALE FORMING	1995		
WQ	SODIUM, ADSORPTION RATIO	1047		
WQ	SODIUM, PERCENT	1046		
WQ	SOLIDS, TOTAL DISSOLVED (TDS)	1930		
WQ	STABILITY INDEX	1993		
WQ	TEMPERATURE (C)	1996		
WQ	TOTAL CHLORINE	1000		
WQ	TURBIDITY	0100		
WQ	UV ABSORBANCE @254 NM	2922		

Target List	EPA Method	Aqueous Accuracy % Recovery	Aqueous Precision RPD	Water PQLs	Water MDLs
Methane, Ethane and Ethene				**ug/L**	**ug/L**
Methane	RSK-175	70-130	0-30	10	0.68
Ethene	RSK-175	70-130	0-30	10	0.69
Ethane	RSK-175	70-130	0-30	10	0.58
Volatile Organic Compounds				**ug/L**	**ug/L**
1,1,1-Trichloroethane	8260B	77-129	0-20	1.0	0.20
1,1,2,2-Tetrachloroethane	8260B	79-121	0-20	1.0	0.38
1,1,2-Trichloro-1,2,2-triflurorethane (F	8260B	73-126	0-20	1.0	0.31
1,1,2-Trichloroethane	8260B	84-115	0-20	1.0	0.33
1,1-Dichloroethane	8260B	76-130	0-20	1.0	0.21
1,1-Dichloroethene	8260B	88-127	0-20	1.0	0.35
1,2,3-Trichlorobenzene	8260B	70-122	0-20	1.0	0.27
1,2,4-Trichlorobenzene	8260B	76-126	0-20	1.0	0.37
1,2-Dibromo-3-Chloropropane	8260B	67-124	0-20	1.0	0.50
1,2-Dibromoethane	8260B	84-116	0-20	1.0	0.22
1,2-Dichlorobenzene	8260B	86-112	0-20	1.0	0.15
1,2-Dichloroethane	8260B	81-125	0-20	1.0	0.20
1,2-Dichloropropane	8260B	84-118	0-20	1.0	0.25
1,3-Dichlorobenzene	8260B	86-110	0-20	1.0	0.26
1,4-Dichlorobenzene	8260B	86-111	0-20	1.0	0.24
1,4-Dioxane	8260B	10-149	0-20	100.0	8.8
2-Butanone (MEK)	8260B	71-132	0-20	5	1.31
2-Hexanone	8260B	80-124	0-20	5	1.70
4-methyl-2-pentanone	8260B	83-122	0-20	5.0	1.32
Acetone	8260B	62-172	0-20	5.0	2.21
Benzene	8260B	86-116	0-20	1.0	0.26
Bromochloromethane	8260B	85-117	0-20	1.0	0.21
Bromodichloromethane	8260B	85-122	0-20	1.0	0.33
Bromoform	8260B	86-117	0-20	1.0	0.23
Bromomethane	8260B	57-135	0-20	2.0	0.49
Carbon Disulfide	8260B	71-129	0-20	1.0	0.25
Carbon Tetrachloride	8260B	87-126	0-20	1.0	0.22
Chlorobenzene	8260B	89-113	0-20	1.0	0.22
Chloroethane	8260B	53-157	0-20	2.0	0.55
Chloroform	8260B	78-128	0-20	1.0	0.32
Chloromethane	8260B	59-123	0-20	2.0	0.36
cis-1,2-Dichloroethene	8260B	85-123	0-20	1.0	0.21
cis-1,3-Dichloropropene	8260B	83-119	0-20	1.0	0.19
Cyclohexane	8260B	71-133	0-20	1.0	0.31
Dibromochloromethane	8260B	85-119	0-20	1.0	0.30
Dichlorodifluoromethane	8260B	29-164	0-20	2.0	0.24
Ethylbenzene	8260B	88-113	0-20	1.0	0.21
Isopropylbenzene	8260B	96-136	0-20	1.0	0.23

Target List	EPA Method	Aqueous Accuracy % Recovery	Aqueous Precision RPD	Water PQLs	Water MDLs
m,p-Xylenes	8260B	88-116	0-20	2.0	0.59
Methyl Acetate	8260B	70-132	0-20	1.0	0.53
Methyl tert-butyl ether	8260B	81-125	0-20	1.0	0.36
Methylcyclohexane	8260B	73-125	0-20	1.0	0.30
Methylene Chloride	8260B	72-129	0-20	5.0	1.13
o-Xylene	8260B	90-116	0-20	1.0	0.25
Styrene	8260B	88-117	0-20	1.0	0.23
Tetrachloroethene	8260B	47-155	0-20	1.0	0.40
Toluene	8260B	84-118	0-20	1.0	0.27
trans-1,2-Dichloroethene	8260B	78-125	0-20	1.0	0.25
trans-1,3-Dichloropropene	8260B	85-135	0-20	1.0	0.20
Trichloroethene	8260B	79-121	0-20	1.0	0.28
Trichlorofluoromethane	8260B	70-149	0-20	2.0	0.24
Vinyl Chloride	8260B	64-131	0-20	2.0	0.25
Surrogates:					
DBFM	8260B	68-128	--	--	--
1,2-DCA-d4	8260B	67-135	--	--	--
Toluene-d8	8260B	65-128	--	--	--
BFB	8260B	56-133	--	--	--
Inorganic				**mg/L**	**mg/L**
Sulfate	9056	90-110	0-20	1.0	0.090
DOC	9060 Mod.	80-120	0-20	1.0	0.040

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

SOP Number: CA-202
Revision History
Cover Page
Page 1

TITLE: ANALYSIS OF VOAs BY PURGE AND TRAP GC/MS: SW-846 METHOD 8260

Prepared By: GC/MS Group Date: 2/97

Approved By:

Group Supervisor: J. Haley Date: 011201

Operations Manager: Joel C. Burton Date: 1/15/01

QA Officer: Deborah J. Nadeau Date: 1·23·01

General Manager: Dennis P. Lufkin Date: 1/16/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
03 8260B	Format changes, added pollution prevention, changes to calibration section, new limits, added instrument. Other minor changes throughout.	DN	1·23·01	1·23·01
04 8260B	Revised sections 7.5.3.1, 7.5.5, 7.7.1, 7.8.2 + Table 2 to comply with South Carolina. Added NH oxygenates to calibration.	DN	5·23·01	5·23·01
05 8260B	Updated VOA calibration standard mixes. Added statistical limits for LCS/MS/MSD recoveries and the updated corrective actions	DN	5·21·02	5·21·02
06 8260B	Reorganization of sections 4, 5, 6 and 7, and Tables and Figures. Added definitions and information for the new data processing system.	MRC	05.03.04	05.03.04
07 8260B	Minor changes rewording of sect. 7.6.3 preservation of calcareous soils	LAD	020305	020305

TITLE: ANALYSIS OF VOAs BY PURGE AND TRAP GC/MS: SW-846 METHOD 8260

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
08 8260 B	Added references, setup and operation for the Encon / Centurion autosampler / Purge and trap. Added ref. to instrument "T" and removed instrument "Q". Edited std. conc. to reflect new instrumentation. Minor changes throughout to reflect current practise and correct typos.	LAD	04/06	04/06
09 8260 B	Sect. 11 - added list of waste streams generated and location of satellites. Clarified RT window studies. Added reference to MI Sop. Removed Grand Mean Calibration model. Added wording for project specific acceptance criteria. Added LCS marginal outlier criteria. Added wording clarifying calibration verification std. criteria and corrective action. Reworded Correlation	LAD	LAD 7-25-07 ~~03/07~~ 07/07	~~03/07~~ 07/07
10	coefficient criteria updated sections 7.4.5, 7.4.6, 7.4.7, 7.5.2, 8.1, 10.0 and Table 1 with DoD QSM version 4.1 criteria	LAD	08/09	08/09
11	Added Table 2 with DoD QSM V. 4.1 QC Requirements. Added if the MS/D Batch requirement can not be fulfilled, a LCSD must be analyzed. Removed "2" instrument and added the "C" and "D" instruments.	LAD	04/10	04/10

TITLE: **ANALYSIS OF VOAs BY PURGE AND TRAP GC/MS: SW-846 METHOD 8260**

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SOP CA-202-11**, titled **ANALYSIS OF VOAs BY PURGE AND TRAP GC/MS: SW-846 METHOD 8260**.

Recipient: _____Date:_____

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SOP CA-202-11**, titled **ANALYSIS OF VOAs BY PURGE AND TRAP GC/MS: SW-846 METHOD 8260**.

Recipient: _____Date:_____

TITLE: **ANALYSIS OF VOAs BY PURGE AND TRAP GC/MS: SW-846 METHOD 8260**

1.0 SCOPE AND APPLICATION

The purpose of this SOP is to describe the procedures utilized by Katahdin Analytical Services, Inc. laboratory personnel to prepare and analyze aqueous and solid matrix samples for purgeable organics by GC/MS in accordance with SW-846 Method 8260, current revision.

This SOP will consolidate all aspects of the analyses in one working document, to be revised as necessary, for the purposes of consistency in data quality.

1.1 Definitions

VOC: Volatile Organic Compounds

VOA: Volatile Organic Analysis

ANALYTICAL BATCH: 20 or fewer samples that are analyzed together with the same method sequence and the same lots of reagents and with the handling practices common to each sample within the same time period or in continuous sequential time periods.

METHOD BLANK (laboratory reagent blank): A quality control sample designed to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus. Laboratory reagent grade water is used as a blank matrix. The blank is taken through the appropriate steps of the process.

CALIBRATION CHECK: Verification of the ratio of instrument response to analyte amount, a calibration check is done by analyzing a mid point standard. The calibration check verifies that instrument conditions are sufficiently similar to those at initial calibration.

CALIBRATION STANDARD (WORKING STANDARD): A solution prepared from the stock standard solution that is used to calibrate the instrument response with respect to analyte concentration.

INDEPENDANT CALIBRATION STANDARD: A solution prepared from a stock standard solution independent of the standard that is used to calibrate the instrument. This is prepared as an LCS and analyzed after the calibration before any sample analysis.

LABORATORY CONTROL SAMPLE (LCS): A blank that has been spiked with the analyte(s) from an independent source and is analyzed exactly like a sample. Its purpose is to determine whether the methodology is in control and to measure the degree of accuracy of the determination.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD): Predetermined quantities of stock solutions containing target analytes are added to a sample matrix prior to sample

extraction, in the case of soils, and/or analysis. Samples are split into duplicates, spiked and analyzed. Percent recoveries are calculated for each of the spiked analytes. The relative percent difference between the samples is calculated and used to assess analytical precision.

STANDARD CURVE (CALIBRATION CURVE): A curve that plots concentration of known analyte standard versus the instrument response to the analyte.

STOCK STANDARD SOLUTION: A concentrated solution containing a single analyte or mix of certified standards, or a concentrated solution of a single analyte prepared in the laboratory with an assay reference compound. Stock standard solutions are used to prepare calibration standards.

SURROGATES: Organic compounds which are similar to analytes of interest in chemical composition as well as extraction and chromatography characteristics, but which are not normally found in environmental samples. These compounds are spiked into all blanks, standards, samples and spiked samples prior to analysis. Percent recoveries are calculated for each surrogate. Surrogates provide an indication of the accuracy for the analytical determination in a discrete sample matrix.

TARGET: A software system that combines full processing, reporting and comprehensive review capabilities, regardless of chromatographic vendor and data type.

TARGET DB: An oracle database used to store and organize all Target data files.

QUICKFORMS: A laboratory reporting software for Target and Target DB. The QuickForms report module for Target is preconfigured with generalized forms and US EPA CLP report forms and disk deliverables, which can be customized.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the analysis of volatile organics by the current revision of EPA Method 8260. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, “Personnel Training and Demonstration of Capability”.

It is the responsibility of all Katahdin technical personnel involved in analysis of volatile organics by Method 8260 to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate logbook. Any deviations from the test or irregularities with the samples should also be recorded in the lab logbook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to initiate periodic review of the associated logbooks.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs (material safety data sheets) for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical Health and Safety Manual including the Katahdin Hazardous Waste Management Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Program for further details on pollution prevention techniques.

After analysis, partially-filled VOA vials and sample jars are returned to the appropriate refrigerators to be disposed of in adherence with the Katahdin Hazardous Waste Management Plan and Safety Manual and SOP SD-903, Sample Disposal, current revision. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with this SOP SD-903.

Sample aliquots used for analysis are disposed of in accordance with SOP SD-903 and the Katahdin Hazardous Waste Management Plan and Safety Manual. The soil samples must be decanted and the soil fraction disposed of separately in compliance with Katahdin's disposal policies.
There are three general types of waste generated while performing the 8260 method. The "K" waste is a combination of water, sample aliquot (post analysis), as well as internal and surrogate standards. "K" waste is generated when preparing QC, during sample analysis, and procedural cleanup. There are "K" satellites

attached to each GC/MS instrument as well as an additional satellite located adjacent to the VOA sample preparation bench. "O" waste consists of methanol (as well as trace amounts of volatile analytes) and is generated when standard preparation syringes are rinsed three times with methanol. The "O" waste stream satellite is located inside the fume hood. Organic soil waste stream "I" consists of any solid left over from sample preparation and/or analysis and is located inside the fume hood. All satellites listed above are stored in a secondary container and are located in the Volatile Organics Laboratory room 111.

2.0 SUMMARY OF METHOD

The general methodology involves purging aqueous and soil samples with helium, an inert gas, for a set period of time to efficiently transfer purgeable organics to the gaseous phase. Soil samples with higher contaminant levels are extracted with methanol prior to the helium purge. These volatile organics are then retained on a cooled trap (commercially available trap suitable for the methodology) before heating causes desorption into a gas chromatograph for compound separation. Detection occurs with an electron impact ionization mass spectrometer.

3.0 INTERFERENCES

Interfering contamination may occur when a sample containing low concentrations of VOCs is analyzed immediately after a sample containing high concentrations of VOCs. During initial data review, all analyses are evaluated for potential carryover. Any samples that have suspected carryover are reanalyzed. GC/MS policy is to reanalyze a sample with positive detects greater than the Practical Quantitation Limit (PQL) that has been run immediately after a sample with the same positive detects over the upper limit of the calibration. Typically 2 or 3 rinsing blanks are analyzed at the end of a sequence. Samples are not analyzed on the instrument until a blank with no detects above PQL can be obtained. If the lines are determined to be contaminated, then the entire Tekmar or Archon must be backflushed with warm methanol and water.

4.0 APPARATUS AND MATERIALS

4.1 GC: Hewlett Packard 6890 & 5890

4.2 Mass Spectrometers (MS): HP5973, HP5972 and HP5970

4.3 Helium: Carrier gas for routine applications. All carrier gas lines must be constructed from stainless steel or copper tubing; non-polytetrafluoroethylene (non-PTFE) thread sealant or flow controllers with rubber component are not to be used.

4.4 Columns: RTX-VMS, 40 meter, 0.18 mm ID or equivalent.

4.5 Purge and Traps: Archon 5100, Tekmar 2016 and Centurion auto samplers, and Tekmar 2000, 3000 and Encon concentrators.

4.6 Purge tubes: 5 mL fritted and 25 mL fritted purge vessels and 40 mL VOA vials for soil analysis.

4.7 Hamilton Gastight syringes: 2.00 uL to 25.00 mL.

4.8 Acquisition System: The acquisition system must be interfaced to the MS and allow continuous acquisition of data throughout the duration of the chromatographic program. It must permit, at a minimum, the output of time vs. intensity (peak height or peak area). Hewlett Packard Chemstation or equivalent.

4.9 Data System: The Target software is used for processing data and generating forms.

5.0 REAGENTS

5.1 Purge and trap grade methanol

5.2 Organic-free Laboratory reagent grade water: Siemens, Poland Spring, or equivalent. This water may need to be purged with nitrogen to eliminate organic contaminants such as Methylene chloride and Chloroform, which are commonly found at ambient levels in the laboratory.

5.3 Standards: Stock standards and working standards are received and recorded in accordance with SOP CA-106 “Standard Preparation and Documentation”.

5.3.1 The expiration date for all standards is six months from date of opening the ampule with the following exceptions:

Volatile gases expire within 2 weeks of opening ampule (gases are dichlorodifluoromethane, chloromethane, bromomethane, vinyl chloride, chloroethane, and trichlorofluoromethane).

New standards must be opened if degradation is observed.

5.3.2 Secondary dilution standards

5.3.2.1 Calibration Mix – Prepare a standard in purge and trap methanol containing the compounds listed below. The final concentration of each compound is 200 ug/mL (some individual analyte concentrations may vary, i.e. Ketones). The standard should be prepared in a 1.0 mL conical vial with a mini-inert valve cap. The standard must be prepared every 7 days and stored in the VOA standards freezer between uses.

Acetone
Benzene
Bromobenzene
Bromochloromethane
Bromodichloromethane
Bromoform
Bromomethane
2-Butanone
n-Butylbenzene
sec-Butylbenzene
tert-Butylbenzene
Carbon Disulfide
Carbon Tetrachloride
Chlorobenzene
Chloroethane
2-Chloroethylvinyl Ether
Chloroform
Chloromethane
2-Chlorotoluene
4-Chlorotoluene
Cyclohexane
1,2-Dibromo-3-Chloropropane
Isopropylbenzene
Dibromochloromethane
1,2-Dibromoethane
Dibromomethane
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
Dichlorodifluoromethane
1,1-Dichloroethane
1,2-Dichloroethane
1,1-Dichloroethene
cis-1,2-Dichloroethene
Trans-1,2-Dichloroethene
1,2-Dichloropropane
1,3-Dichloropropane
2,2-Dichloropropane
1,1-Dichloropropene
Cis-1,3-Dichloropropene
Trans-1,3-Dichloropropene
Ethylbezene
Hexachlorobutadiene
2-Hexanone
Idomethane
Methyl Tert-Butyl Ether
P-Isopropyltoluene
Methylene Chloride
4-Methyl-2-Pentanone
Naphthalene
N-Propylbenzene
Styrene
1,1,1,2-Tetrachloroethane
1,1,2,2-Tetrachloroethane
Tetrachloroethene
Tetrahydrofuran
Toluene
1,2,3-Trichlorobenzene
1,2,4-Trichlorobenzene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
Trichloroethene
Trichlorofluoromethane
1,2,3-Trichloropropane
1,2,4-Trimethylbenzene
Vinyl Acetate
Vinyl Chloride
1,3,5-Trimethylbenzene
1-Chlorohexane

5.3.2.2 Extras mix – Prepare a standard as above containing the compounds listed below. The final concentration of each compound is 200 ug/mL. The standard should be prepared in a 1.0 mL conical vial with a mini-inert valve cap. The standard must be prepared every 30 days and stored in the VOA standards freezer between uses.

Acetonitrile
Acrolein
Acrylonitrile
Allyl Chloride
Chloroprene
Diethyl Ether
Cis-1,4-Dichloro-2-Butene
Trans-1,4-Dichloro-2-Butene
1,4-Dioxane
Di-Isopropyl Ether
Ethyl Methacrylate
Ethyl Tertiary-Butyl Ether
Freon-113
Isobutyl Alcohol
Methacrylonitrile
Methylcyclohexane
Methyl Acetate
Methyl Methacrylate
Methyl Tert-Butyl Ether
Pentachloroethane
Propionitrile
Tertiary-Amyl Methyl Ether
Tertiary-Butyl Alcohol
1,3,5-Trichlorobenzene
1,2,3-Trimethylbenzene

5.3.2.3 Independent Calibration Verification Standard, Laboratory Control Spike and MS/MSD Mixture - Prepare a standard as above containing the compounds listed in Table 3. The final concentration of each compound is 200 ug/mL (some individual analyte concentrations may vary, i.e. Ketones). The standard should be prepared in a 1.0 mL conical vial with a mini-inert valve cap. The standard must be prepared every 7 days and stored in the VOA standards freezer between uses.

5.3.2.4 Surrogate Spiking Solution - Prepare a standard as above containing the compounds listed below. The final concentration of each compound is 250 ug/mL or 50 ug/mL depending on which autosampler you will be using. The standard must be prepared every 14 days and stored on the Archon and/or the Centurion autosampler in a pressurized vial or in the VOA standards freezer between uses.

4-Bromofluorobenzene
1,2-Dichloroethane-D_4
Toluene-D_8
Dibromofluoromethane

5.3.2.5 Internal Standard Solution - Prepare a standard as above containing the compounds listed below. The final concentration of each compound is 250 ug/mL or 50 ug/mL depending on which autosampler you will be using. The standard must be prepared every 14 days and stored on the Archon and/or the Centurion autosampler in a pressurized vial or in the VOA standards freezer between uses.

Pentafluorobenzene
1,4-Difluorobenzene
Chlorobenzene-D_5
1,4-Dichlorobenzene-D_4

5.3.2.6 BFB Solution - Prepare a standard as above containing 4-BFB. The final concentration is 25 ug/mL. The standard must be prepared every 30 days and stored in the VOA standards freezer between uses.

5.3.2.7 See Table 4 for a complete list of standards, concentration, and vendors.

NOTE: The concentrations of standards may vary depending on the type of autosampler being used.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

All aqueous samples must be analyzed within 14 days from sample collection if preserved (by addition of HCl to pH <2) or within 7 days from sample collection if unpreserved. All soil/sediments must be analyzed within 14 days from sample collection. For specific projects, soil may be received in pre-weighed vials containing methanol, with an aliquot of the methanol used for analysis. For these projects, the methanol aliquot must be analyzed within 14 days from sample collection. Samples must be stored at 4°C ± 2°C from the time of receipt at the lab until analysis.

7.0 PROCEDURES

7.1 NAMING AND CODING CONVENTIONS FOR ANALYTICAL STANDARDS – Used in accordance with SOP CA-106 "Standard Preparation and Documentation".

7.2 COMPUTER (DATA SYSTEM) CONVENTIONS -

Conventions for all instruments are as follows:

Sub-Directory for data acquisition: C:\HPCHEM\1\DATA

Tune file: BFB.U

Method files: I826AXX.M (all samples and standards)
Where:
XX = the calibration number in chronological order
I = instrument ID (C, D, F, M, S or T).
A = matrix (A for water, S for soil and SB for sodium bisulfate soils)

BFB288AQ.M (waters) or BFB288SL.M (soils) (BFB tuning acquisition)

Data files for BFB: IB_ _ _.D where _ _ _ is a number in chronological order from 000 to 999, and I is the instrument ID (C, D, F, M, S or T).

All other data files: I_ _ _ _.D where _ _ _ _ is a number in chronological order from 0000 to 9999, and I is the instrument ID (C, D, F, M, S or T). This file also contains the Quantitation output file.

7.3 INSTRUMENT TUNING - Prior to the analysis of any calibration standards, blanks, or samples, the GC/MS system must be shown to meet the mass spectral ion abundance criteria for a 50 ng injection of p-Bromofluorobenzene (p-BFB), tabulated below:

Mass	Criteria
50	15.0-40.0% of mass 95
75	30.0-60% of mass 95
95	base peak, 100% relative abundance
96	5.0-9.0% of mass 95
173	less than 2.0% of mass 174
174	greater than 50.0% of mass 95
175	5.0-9.0% of mass 174
176	greater than 95.0%, but less than 101.0% of mass 174
177	5.0-9.0% of mass 176

7.3.1 The following are the GC/MS operating conditions for injection of BFB.

GC/MS type: 5970

Column:	RTX-VMS, 40 meter, 0.18 mm ID
Temperatures: Injection port:	170°
Transfer line:	150°
Source:	170°
Analyzer:	170°
Isothermal temperature:	150°
Run time:	10 minutes
Scan start time:	4 minutes
Scan parameters:	not to exceed 2 sec per scan
Mass range:	35-300
Number of A/D samples:	8
GC peak threshold:	1000 counts
Threshold:	10 counts

GC/MS type: 5972 and 5973

Column:	RTX-624, 40 meter, 0.18 mm I.D or RTX-VMS, 40 meter, 0.18 mm ID.
Temperatures: Injection port:	200°
Transfer line:	150°
Detector:	240°
Isothermal temperature:	150°
Run time:	8 minutes
Scan start time:	3 minutes
Scan parameters:	not to exceed 2 sec per scan
Mass range:	35-300
Number of A/D samples:	8
GC peak threshold:	1000 counts
Threshold:	10 counts

The BFB solution must be analyzed once at the beginning of each 12-hour period, the time stamp of the injection of the BFB is the beginning of the 12-hour clock. All calibrations and samples must be run within the 12-hour clock as the method specifies.

When the BFB run has concluded, the run must be evaluated to determine if sample analysis can proceed. The chromatography and the ion ratios must be examined. The BFB run is processed using the current algorithms in the Target software.

If the results indicate the system does not meet acceptance criteria, the GC/MS must be manually tuned. Once the manual tune procedure is completed, BFB must be re-injected and reevaluated. If the instrument still does not meet criteria, notify your Department Manager. Under no circumstances should calibration proceed if the instrument BFB tune is not in criteria.

7.4 INSTRUMENT CONFIGURATION / CALIBRATION

7.4.1 Tekmar LSC 3000/Archon 5100/ Tekmar 2016, Setup/Operation: Please refer to the Tekmar or Archon Manuals for more detailed operations for these instruments.

To begin, set the Tekmar LSC 2000/3000 to the specification listed in section 2-12 of the Archon manual. Edit method 14 as follows:

Method 14 should include:

Standby:	35°
Prepurge:	0 min
Preheat Temp:	0°
Sample Temp:	0°
Purge:	11 min
Dry purge:	2-4 min
Desorb preheat:	245°
Desorb Temp:	250°
Desorb time:	2-5 min
Dry purge:	2-4 min
Bake Time:	10 min
Bake Temp:	260°
Auto drain:	On
Bake gas by pass:	Off
Valve Temp:	120°
Line Temp:	120°
Runs per sample:	1

The above temperature settings are for a Vocarb 3000 trap, these temperatures may vary with the use of alternative traps. Temperature settings may also vary to optimize system performance.

The Archon autosampler should be set up according to the specifications in the manual. The setting of particular concern, with regards to keeping the Tekmar and Archon in coordination with each other, is the desorb time. There are several other programmable features on the Archon; the settings for this feature will depend on the sample matrix and method of analysis. Please refer to the Archon manual for more specifics on its programming features.

7.4.2 Encon/Centurion, Setup/Operation

Please refer to the Encon or Centurion manuals for more detailed operations for the instruments.

To begin, the Encon operation method should contain:

Purge Conditions:	Purge Gas: Helium Purge Time: 11.0 ±0.1 minute Purge Flow Rate: approx. 24-40 mL/min Purge Temperature: Ambient (water)
Desorb Conditions:	DesorbTemp: 250ºC Desorb Flow rate: 15 mL/min Desorb Time: 2.0 ± 0.1 min Bake Time: 10 min Bake Temperature: 260ºC

The above temperature settings are for a Vocarb 3000 trap, these temperatures may vary with the use of alternative traps. Temperature settings may also vary to optimize system performance.

The Centurion autosampler should be set up according to the specifications in the manual.

7.4.3 Initial Calibration for Method 8260

Once the instrument has achieved BFB tuning criteria, calibration of the instrument can begin.

To determine the linearity of response, the GC/MS must be initially calibrated at six different levels.

For aqueous calibration, target analytes and surrogate are prepared at the following concentrations; 1.0, 5.0, 20, 50, 100 and 200 ug/L. The curve is analyzed at ambient temperature.

For a soil calibration target analytes and surrogates are prepped at the following concentrations: 5.0, 10, 20, 50, 100 and 200 ug/L. The calibration standards are stirred and heated to 40ºC.

The following amounts standards should be added to 100 mL of organic-free laboratory reagent grade water in order to generate a 6-point initial calibration curve:

	STD. ID	CAL. Mix 200 ug/mL	Extras Mix 200 ug/mL	Surr. Mix 250 ug/mL Archon	Surr. Mix 50 ug/mL Centurion
AQ curve only	VSTD001	0.5 uL	0.5 uL	0.4 uL	2.0 uL
	VSTD005	2.5 uL	2.5 uL	2.0 uL	10 uL
SL curve only	VSTD010	5.0 uL	5.0 uL	4.0 uL	20 uL
	VSTD020	10 uL	10 uL	8.0 uL	40 uL
CC	VSTD050	25 uL	25 uL	20 uL	100 uL
	VSTD100	50 uL	50 uL	40 uL	200 uL
	VSTD200	100 uL	100 uL	80 uL	400 uL

The internal standard is spiked by the autosampler. Due to different spike amounts separate standards are used depending on which autosampler is being used.

After analysis of the six points, the standard analyses must be quantitated and evaluated for adherence to QC criteria, as follows. Minimum requirements for method files are use of specific quantitation ions and quantitating a specific set of target compound and surrogates with a specified internal standard. These requirements are found in Tables 3 and 5.

7.4.4 Initial Calibration Criteria

The percent (%) RSD for six calibration check compounds (CCC) must be less than or equal to 30%. CCCs are 1,1-Dichloroethene, Chloroform, 1,2-Dichloropropane, Toluene, Ethylbenzene, and Vinyl Chloride.

A system performance check must be performed as part of initial calibration. The five system performance check compounds (SPCC) and the minimum acceptable average relative response factors (RRF) for these compounds are as follows (taken from 8260B):

SPCC	RRF
Chloromethane	0.10
1,1-Dichloroethane	0.10
Bromoform	0.10
Chlorobenzene	0.30
1,1,2,2-Tetrachloroethane	0.30

The SPCCs are used to check both the standard and instrument stability.

7.4.4.1 Linearity of Target Analytes

If the RSD of any target analyte is 15% or less using the average response factor, then the response factor is presumed to be constant

over the calibration range, and the average response factor may be used for quantitation.

If the RSD of any target analyte exceeds 15% using the average response factor, then a calibration option outlined in section 7.0 of method 8000 will need to be employed. Please note that some options may not be allowable for certain states, federal programs, or clients.

Option 1 (Section 7.5.2 of method 8000 - Rev. 2, 12/96), is a linear regression of instrument response versus the standard concentration. The correlation coefficient (r) for each target analyte and surrogate must be greater than or equal to 0.995. For linear models, Target calculates the correlation coefficient and then squares it (r^2). This is what is reported on all Target forms. The value for r^2 must be greater than or equal to 0.990.

Option 2 (Section 7.5.3 of method 8000 - Rev. 2, 12/96), is a non-linear calibration model not to exceed a third order (seven calibration points required) polynomial. The lab would use a quadratic model or second order polynomial. The use of a quadratic model requires six calibration points. In order for the quadratic model to be acceptable, the coefficient of determination must be greater than or equal to 0.99.

7.4.5 Independent Calibration Verification

Immediately following an initial calibration, an independent calibration standard must be analyzed. This standard contains all target compounds, internal standards and surrogates at a concentration of 50 ug/L and is obtained from a source independent of the initial calibration source. Please refer to section 8.1 and Table 1 for acceptance criteria and corrective action for this standard.
For projects or clients requiring DoD QSM 4.1 all project analytes must fall between 80-120% of the true value. No samples may be run until the ICV criteria are met.

7.4.6 Calibration Verification

Once a valid initial calibration curve has been achieved, a continuing calibration standard containing all the target compounds, internal standards and surrogates at a concentration of 50 ppb must be analyzed every 12-hour clock for Method 8260, timed from the injection of BFB. The relative response factor from the 50 ppb continuing calibration check standard must be compared to the average response factor data from the initial calibration.

The EICP (extracted ion current profile) area for any of the internal standards in the calibration verification must not change by more than a factor of two (-50% to +100%) from the same level standard in the last initial calibration. The retention time for any internal standard cannot shift by more than 30 seconds from the same level standard in the last initial calibration.

For Method 8260, if the percent difference for each CCC is less than or equal to 20%, and all of the SPCCs have a relative response factor greater than or equal to those listed in Section 7.4.3, the continuing calibration is considered valid.

For projects or clients requiring DoD QSM 4.1 all project analytes must have ± 20%D.

Continuing calibration check criteria must be met before sample analysis can proceed.

7.4.7 Retention Time Windows

Retention time windows are set at the midpoint standard of the calibration curve, following every ICAL. When a CV is analyzed (and not an ICAL), the retention time windows of the daily CV must be within 30 seconds of the midpoint calibration standard of the most recent ICAL. The samples analyzed following the daily CV must have retention times within 30 seconds of those for the daily CV. Each successive daily CV must be compared to the most recent ICAL midpoint standard.

For projects or clients requiring DoD QSM 4.1, IS responses and retention time windows for QC and samples are compared to the midpoint of the most recent ICAL.

7.5 QUALITY CONTROL SAMPLE ANALYSIS

When preparing standards in water or spiking samples with internal standards/surrogates or matrix spike solution, be sure to rinse all syringes a minimum of three times with purge and trap grade methanol between uses. Failure to do this will result in cross-contamination of samples and standards.

7.5.1 Laboratory Control Sample (LCS)

The LCS mix is prepared from a secondary source vendor (i.e. different vendor from the calibration standards). The LCS is analyzed immediately after the initial calibration curve or calibration check and prior to the method blank to minimize any analyte carryover possibilities in samples. Acceptance criteria for the LCS are outlined in Section 8.0.

To prepare the water and medium-level soil LCS, 25 uL of the LCS standard mix at 200 ug/mL are spiked into 100 mL of analyte-free laboratory reagent grade water for a final concentration of 50 ug/L. The Archon autosampler adds 1 uL of internal and 1 uL of surrogate standard to a 5 mL aliquot of this preparation for analysis. The Centurion autosampler adds 5 uL of both surrogates and internal standards to a 5 mL aliquot. To prepare the low-level soil LCS, a stir bar is added to 5 mL of the above solution in a VOA vial. The Archon unit adds an additional 10 mL of water to which the internal and surrogate standards have been added; this preparation is then heated, stirred and purged.

To prepare the water and medium-level soil LCS for analysis on the LSC 2000 / 2016 autosampler, 1.25 uL of the LCS standard mix at 200 ug/mL are spiked into 5 mL of analyte-free laboratory reagent grade water for a final concentration of 50 ug/L.

In the event that the batch MS/MSD requirement cannot be fulfilled, a laboratory Control Spike Duplicate must be analyzed.

7.5.2 Method Blank Analysis

After calibration criteria have been met, a method blank must be analyzed before sample analysis can proceed. A method blank analysis must be performed once for each 12-hour calibration immediately after analysis of the calibration standard(s) and prior to sample analysis.

The aqueous method blank is a volume of analyte free laboratory reagent grade water spiked with internal and surrogate standards.

The low-level soil method blank is a volume of analyte free laboratory reagent grade water spiked with internal and surrogate standards. This method blank is analyzed using the low soil specification.

The method blank must contain less than the Practical Quantitation Level (PQL) for all analytes of interest for the samples associated with the blank.

For projects requiring DoD QSM 4.1 no analytes may be detected >1/2 the PQL and > than the $1/10^{th}$ the measured amount in any sample or $1/10^{th}$ the regulatory limit, whichever is larger. Except for common laboratory contaminants which may not be detected > than the PQL.

7.5.3 Surrogate Recovery Limits

Laboratory established limits are derived for each of the surrogates. Please refer to the current revision of Katahdin Analytical Services SOP # QA-808 for further information on statistical limits. All samples including blanks, laboratory

control samples, matrix spikes and client samples, must meet the statistical limits for the analysis to be considered valid. If surrogate recoveries do not meet these limits, reanalysis must occur to confirm matrix interference.

7.5.4 Internal Standard Area Recoveries / Retention Times.

The internal standard responses and retention times in the method blank must be evaluated immediately after or during data acquisition. If the EICP (extracted ion current profile) area for any of the internal standard changes by a factor of two (-50% to +100%), from the last daily calibration standard, the GC/MS must by inspected, and corrective action taken. If the retention time for any internal standard has shifted by more than 30 seconds from the mid-point standard level of the most recent calibration sequence, the GC/MS must be inspected, and corrective action taken. All samples and QC must also meet the EICP area and retention time criteria or must be reanalyzed.

7.5.5 Matrix Spike/Matrix Spike Duplicate (MS/MSD) Analysis

An MS/MSD must be analyzed every twenty samples of a similar matrix. The MS/MSD is prepared in a manner similar to the LCS, except that 40 mL aliquots (aqueous) or 5 g aliquots (soil), of environmental samples are used in place of the analyte-free laboratory reagent grade water. Note that trip blanks and field/equipment blanks should not be used for MS/MSD analyses. The spike solution (section 7.5.1) is added to the sample at a concentration of 50 ppb. Acceptance criteria for the MS/MSD are outlined in Section 8.0.

In the event that sufficient volume of sample is not supplied to the laboratory so that an MS/MSD set cannot be analyzed within a batch of 20 samples, a laboratory control spike duplicate must be analyzed.

7.6 SAMPLE ANALYSIS

When new samples are received, they should be checked for past sample history. If sample history cannot be located or the sites are different than past sites, the project manager should be consulted. He/she may be able to provide more information about the sample. Sample history is used to determine what order in which to run the samples and at what dilution. Refer to Katahdin Analytical Services SOPCA-106, “Basic Laboratory Technique”, current revision for information on subsampling.

Samples are removed from the VOA refrigerator and appropriate chain of custody form is completed. Remove only the vials that have not been opened yet (opened vials will be upside down). Note in sample run log any bubbles, and significant discoloration or sediment in the sample vials.

7.6.1 SAMPLE ANALYSIS FOR 8260B WATER

7.6.1.1 Tekmar LSC 2000 / 2016 units

Rinse a 5.0 mL gas-tight syringe a minimum of three times with analyte-free laboratory reagent grade water (e.g., Poland Spring or equivalent). Pour sample at ambient temperature into the syringe until nearly overflowing. Carefully insert and adjust plunger to sample volume of 5.0 mL. While adjusting plunger to final volume, expel extra volume of sample onto pH paper for sample pH verification. Add 1.0 uL of the internal and surrogate mixtures (250 ug/mL). Immediately inject contents of the syringe into the ALS sparger.

Record the sample pH in the injection logbook. Continue as above for each sample, ensuring that the 5.0 mL gas-tight syringe is rinsed a minimum of three times with laboratory reagent grade water between each sample.

7.6.1.2 Tekmar LSC 3000 / Archon 5100 units

Place the sample vials into the Archon sample tray and program the Archon for the appropriate sample volume and or dilution for the sample. The Archon unit will automatically transfer the sample to the sparge vessel while adding the internal and surrogate standard. The Archon can be programmed to run as many samples as will fit in the twelve-hour window. The auto sampler hot water rinses the sparge vessel, transfer lines, purge needle, and syringe between samples to minimize possible carryover.

Record the sample pH in the injection logbook after sample analysis is complete (usually the day after the analysis is done) and return the sample vial to the sample refrigerator.

7.6.1.3 Centurion/Encon unit

Place the sample vials into the Centurion sample tray and program the Centurion for the proper sequence. The Centurion will automatically transfer the sample to the sparge vessel while adding the internal and surrogate standards. Using the Centurion software, the analyst can program the Centurion to run as many samples that will fit into a 12 hour clock. The autosampler uses hot water to rinse the sparge vessel, transfer lines, purge needle and sample needle to minimize carryover.

Record the sample pH in the injection logbook after sample analysis is complete (usually the day after the analysis is done) and return the sample vial to the sample refrigerator.

Make sure that all entries in the injection log have been made in a complete, neat, and legible manner. Corrections in any logbook must be crossed through with a single line, dated, initialed and have a written explanation or the applicable error code.

If for any reason a sample needs to be rerun, diluted or duplicated, a note in the comments field of the injection logbook must be entered, addressing the reason why in the logbook to facilitate answering any questions that may arise during the review process.

To minimize carryover from samples that contain a target compound at a level exceeding the upper limit of the calibration curve, the following must be done: monitor both the samples immediately after the contaminated sample as well as the next run of the contaminated sample in the same purge inlet for the target(s) in question; both must have levels <PQL.

7.6.2 ANALYSIS OF LOW-LEVEL SOIL SAMPLES

Method 5035 Closed System Purge & Trap procedure for low level soils (5 ug/Kg -200 ug/Kg)

Selecting the appropriate technique may depend on cleanup goals, confidence levels, and anticipated levels of contamination. Field sampling activities typically result in Encore or Encore-like devices being submitted to the lab. These devices must be extruded within 48 hours. It is the laboratory's standard policy to extrude soil samples into 5 mL of Laboratory reagent free laboratory reagent grade water that contains a magnetic stir bar. The sample is subsequently frozen until analysis within 14 days. Note that the sample must be extruded and frozen within 48 hours of sampling, until analysis can begin. This approach is preferred over extrusion into sodium bisulfate because it is believed that the sodium bisulfate reacts with calcium carbonate in highly calcareous soils causing effervescence and driving the volatile analytes out of solution. There is also anecdotal information to suggest that acetone may be generated when bisulfate preservation occurs. The Katahdin sample ID, extrusion date, and time are recorded in the GC/MS extrusion logbook. Please refer to the Katahdin method 5035 SOP, CA-214 for more detail.

In lieu of the use of Encore samplers, the lab may pre-weigh 40 mL VOA vials containing 5 mL of laboratory reagent grade water or a 20% sodium bisulfate solution and a magnetic stir bar and ship these to the field. The vial

is assigned a vial specific number prior to shipment to the field. The vial and weight will be recorded with its vial specific number in the methanol soil logbook. If possible the field sampler should weigh the sealed vial to ensure that 5 +/- 0.5 grams of sample were added in the field. When the lab receives the vials back from the field, the vials will be weighed and the weight recorded. The samples must be frozen within 48 hours of sampling, until analysis can begin.

The subsequent analysis is performed on a specially developed autosampler that heats, stirs, and purges the sample simultaneously without exposing the contents of the vial to the atmosphere. This procedure will help to minimize the loss of VOC's due to transport, handling, and analysis and may help minimize ambient lab contribution. The expected detection limits are consistent with the traditional low soil technique from method 5030. The Archon is programmed to heat each vial to 40°C during the purge time. Initiate purging for 11.0 minutes; the sample must be heated to 40°C ± 1°C before purging can begin. If you have questions concerning setting up the Tekmar or initiating a GC/MS batch run, consult the Organic Department Manager, or senior chemist within the group.

If the client does not require method 5035, method 5030 for analysis of low-level soils may be followed. This means that the Tekmar ALS 2016 unit may be used for the preparative step, as well as the Archon units.

7.6.3 ANALYSIS OF MEDIUM-LEVEL SOIL SAMPLES

Method 5030 Procedure for higher concentration soils (> 200 ug/Kg)

Higher concentration soils may be sampled as either a bulk sample or field preserved with a water miscible solvent such as methanol. If sampled in an Encore unit, the soil is extruded into methanol upon receipt at the lab.

Bulk Sample- A sample is placed in a glass jar or vial and returned to the lab for extraction and analysis. In this approach the lab takes an aliquot of soil and extracts with purge & trap grade methanol, a portion of the methanol is then analyzed for volatile analytes.

Extraction

Calibrate the balance properly (See SOP CA-102) and note it in the appropriate logbook. Place 5.0 grams of thoroughly mixed, undecanted soil sample in a 40.0 mL vial. Add 5.0 mL reagent grade methanol. Shake for 2 minutes. Let stand for 3 minutes. Record extraction in soil prep logbook.

Methanol Field Preservation - A 5 gram sample is added to a VOA vial that has been previously charged with purge and trap grade methanol (the

volume of methanol is dependent upon client request). The vial with methanol has been previously weighed in the lab and assigned a vial specific number prior to shipment to the field. The vial and methanol weight will be recorded with its vial specific number in the VOA vial prep logbook. If possible the field sampler should weigh the sealed vial to ensure that 5 +/- 0.5 grams of sample were added in the field. When the lab receives the vials back from the field, the vials will be weighed and the weight recorded. A portion of the methanol is then analyzed for volatile analytes.

For analysis on Archon or Centurion autosamplers, add 400 uL of the extract into 20 mL of organic-free laboratory reagent grade water (e.g., Poland Spring or equivalent). IS and SS is added by the Archon and/or Centurion autosampler for analysis. This will give an estimated calibration range between 500-10000 ug/Kg.

7.7 FINAL DATA PACKAGE

7.7.1 Initial Data Review (IDR)

The initial data review is performed by the analyst who ran the samples. This review is of sufficient quality and detail to provide a list of samples that need to be reanalyzed or diluted and reanalyzed. The initial data review is performed on the detailed quantitation reports of the analyzed sample. This data review examines criteria that directly impact whether or not the sample needs to be reanalyzed.

- Surrogate recoveries
- stability of internal standard responses
- LCS spike recoveries
- method blank acceptance
- chromatography
- target compound detection/quantitation / review for false positives

The analyst must evaluate all data using the QA Acceptance Criteria table found within this SOP (Table 1). This table gives acceptance criteria and corrective actions for criteria that are not met. In addition to evaluating QC elements, the chromatography and quantitation of target analytes must be reviewed.

7.7.1.1 Chromatography

The chromatography should be examined for the presence or absence of any "ghost" peaks and can also be used as an indication of whether or not matrix interferences might be influencing surrogate recoveries and/or ISTD area recoveries. Whether or not the chromatography is

acceptable is a judgment call on the part of the analyst and should be used in conjunction with other monitored QC (e.g., Surrogate recoveries) to determine the necessity of reanalyses.

Manual integrations are to be performed when chromatographic conditions preclude the computer algorithm from correctly integrating the peak of concern. In no instance shall a manual integration be performed solely to bring a peak within criteria.

Each peak of concern is examined by the primary analyst to ensure that the peak was integrated properly by the computer algorithm. An "M" qualifier will automatically be printed on the quantitation report summary.
This manual integration package must then be submitted to the Organic Department Manager or his/her designee, who will review each manual integration.

For specific procedures on how to manually integrate, refer to Katahdin SOP QA-812, "Manual Integration", current revision.

7.7.1.2 Target Compound Detection/Quantitation

The method files have been set up to error on the side of false positives, that is to identify and quantitate peaks as target compounds that may not necessarily be valid hits.

The requirements for qualitative verification by comparison of mass spectra are as follows:

- all ions present in the standard mass spectra at a relative intensity > 25% must be present in the sample spectrum.
- the relative intensities of primary and secondary ions must agree within ±20% between the standard and sample spectra.
- ions greater than 25% in the sample spectrum but not present in the standard spectrum must be considered and accounted for by the analyst.

If a compound cannot be verified by all three criteria above, but, in the technical judgment of the mass spectral interpretation specialist, the identification is correct, then the laboratory shall report that compound on the Form 1 as a valid hit.

If any target concentration exceeds the upper limit, a dilution must be made and analyzed. The dilution chosen should keep the response of the largest target compound hit in the upper half of the initial calibration range.

The GC/MS laboratory initial data review must be completed within twelve hours of batch completion; in the majority of instances, the initial data review should be accomplished at the beginning of a work shift for the previous set of analyses. After the analyst has completed his or her initial data review, the data should immediately be forwarded to the Organic Department Manager, or his/her designee.

7.7.1.3 Tentatively Identified Compounds (TIC)

TIC's may be requested by certain clients for samples. Refer to SOP CA-207 "GC/MS Library Search and Quantitation".

7.7.2 Reporting

After the chromatograms have been reviewed and any target analytes have been quantitated using Target, the necessary files are brought into QuickForms. Depending on the QC level requested by the client, a Report of Analysis (ROA) and additional reports, such as LCS forms and chronology forms, are generated. The package is assembled to include the necessary forms and raw data. The data package is reviewed by the primary analyst and then forwarded to the secondary reviewer. The secondary reviewer validates the data and checks the package for any errors. When completed, the package is sent to the department manager for final review. A completed review checklist is provided with each package. The final data package from the Organics department is then processed by the Data Management department.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

Refer to Table 1 and to details in this section for a summary of QC requirements, acceptance criteria, and corrective actions. These criteria are intended to be guidelines for analysts. The criteria does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in this section or in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in this section and in Table 1 may rely on analyst experience to make sound scientific judgments. These decisions are based on holding time considerations, client and project specific Data Quality Objectives and on review of chromatograms. The Department Manager, Operations Manager, and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases "qualified" data with narration may be advisable after consultation with the client.

In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work

performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

8.1 Independent Calibration Verification, LCS and MS/MSD Criteria

Statistical limits are compiled annually for LCS recoveries (archived in QA office). Statistical limits are only calculated when at least 30 usable data points are obtained for any given compound. If insufficient data points are available, nominal limits are set by the Organic Department Manager, Laboratory Operations Manager and Quality Assurance Officer. Refer to Katahdin SOP QA-808, "Generation and Implementation of Statistical QC Limits and/or Control Charts," current revision.

The use of statistical limits versus nominal limits is dependent on the client and project. This information is communicated to the Organic Department Manager through the Katahdin project manager. It is standard practice to use statistical limits for reporting purposes and to evaluate any QC criteria exceedances. However, nominal limits of 60-140% or 70-130% may be used for some projects or states.

The LCS recoveries for all analytes are evaluated. All of the compounds of interest must fall within the established statistical limits with the following sporadic exceedance allowances.

Number of Analytes	Number of Allowable Exceedances
> 90	5
71 – 90	4
51 – 70	3
31 – 50	2
11 – 30	1
<11	0

If less than the number of allowable exceedances fail the statistical limits, no corrective action is needed. If greater than the number of allowable exceedances fail the statistical limits, corrective action may be taken. Corrective actions may vary with each situation. However, in the case where the failures are high and the samples are non-detect for those compounds, then no corrective action is required. Otherwise, corrective action may involve reanalysis or recalibration. The specific corrective actions taken will rely on analyst experience to make sound scientific judgments while considering client objectives, other quality control indicators and/or the ability to reanalyze a sample within holding time.

The MS/MSD recoveries for all analytes are evaluated. If the LCS results are acceptable but the MS/MSD is not, narrate. If both the LCS and MS/MSD are unacceptable reprep the samples and QC.

Please note that for compounds with only nominal limits (i.e. insufficient data points were available to generate statistical limits), no corrective action is required for out-of-criteria recoveries until enough data points are established to generate statistical limits.

For projects or clients requiring DoD QSM 4.1 all project analytes in the ICV must fall between 80-120% of the true value. No samples may be run until the ICV criteria is met. Laboratory established recovery limits for LCS and MS/MSDs must be within 3 standard deviations of the mean LCS recovery. MS/MSD pairs must be run once per analytical/preparatory batch. RPDs must be less than or equal to 30% between MS and MSDs.

For analytes with no available DoD acceptance criteria, laboratory established limits shall be used.

8.2 Surrogate Recovery Criteria

Statistical limits are compiled annually for surrogate recoveries (archived in QA office). Statistical limits are only calculated when at least 30 usable data points are obtained for any given compound. If insufficient data points are available, nominal limits are set by the Organic Department Manager, Laboratory Operations Manager and Quality Assurance Officer. The use of statistical limits versus nominal limits is dependent on the client and project. This information is communicated to the Organic Department Manager through the Katahdin project manager. It is standard practice to use statistical limits for reporting purposes and to evaluate any QC criteria exceedances. However, nominal limits of 60-140% or 70-130% may be used for some projects or states.

8.3 QC Requirements

Refer to Table 1 for a summary of QC requirements, acceptance criteria, and corrective actions. Table 1 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific judgments. These decisions are based on holding time considerations, client and project specific Data Quality Objectives and on review of chromatograms. The Department Manager, Operations Manager, and/or Quality Assurance Officer may be consulted to evaluate data. Due to the 14-day hold time associated with this method, samples may not be able to be reanalyzed

within hold time. In these cases "qualified" data with narration may be advisable after consultation with the client.

9.0 METHOD PERFORMANCE

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDLs are determined annually per type of instrument and filed with the Organic Department Manager and with the QAO. Refer to the current revision of Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, for procedures on determining the MDL.

Refer to the current revision of Method 8260 for other method performance parameters and requirements.

10.0 APPLICABLE DOCUMENTS/REFERENCES

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, USEPA SW846, 3rd Edition, Final Updates I, II, IIA, IIB, III, IIIA, IIIB and IV, February 2007, Method 8260B.

"Department of Defense Quality Systems Manual for Environmental Laboratories" (DoD QSM), Version 4.1, 04/22/09.

"The National Environmental Laboratory Accreditation Conference (NELAC) Standards," June 2003.

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision.

Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, current revision.

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TABLE 1

QC REQUIREMENTS - VOLATILE ORGANICS, METHOD 8260

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Check of mass spectral ion intensities using BFB	Prior to initial calibration and calibration verification	Refer to the criteria listed in Section 7.3 of this SOP	Retune instrument, and verify
Six-point calibration for all analytes	Initial calibration prior to sample analysis	SPCCs average RF ≥0.30, except chloromethane, 1,1-DCA and bromoform ≥0.10; RSD for RFs ≤ 30% for CCCs. Refer to section 7.4.3 also.	Repeat initial calibration
Independent Calibration Verification	Once, immediately following calibration	Statistically derived from lab data or nominal limits depending on the project. Refer to QA records for statistical limits. Nominal limits are used as default limits. See also section 8.1 of this SOP for more information on allowable exceedances	Evaluate the samples and associated QC: i.e. If an MS/MSD was performed and acceptable, narrate. If an LCS/LCSD was performed and only one of the set was unacceptable, narrate. If the surrogate recoveries in the LCS are also low but are acceptable in the blank and samples, narrate. If the LCS recovery is high but the sample results are <PQL, narrate. Otherwise, reprep a blank and the remaining samples.
Calibration verification	Once per each 12 hours, prior to sample analysis in absence of initial cal	SPCCs minimum RF ≥ 0.30, except chloromethane, 1,1-DCA and bromoform ≥ 0.10; RF for CCC analytes ≤ 20% (%D) of average initial multipoint RF	Repeat initial calibration and reanalyze all samples analyzed since the last successful calibration verification
IS	During data acquisition of calibration check standard	Retention time ± 30 seconds; EICP area within -50% to +100% of last calibration verification (12 hours) for each IS	Inspect mass spectrometer or GC for malfunctions; mandatory reanalysis of samples analyzed while system was malfunctioning
Method Blank	One per batch of 20 or fewer samples.	No analytes of interest detected > PQL with the exception of Methylene Chloride	(1) Investigate source of contamination (2) Evaluate the samples and associated QC: i.e. If the blank results are above the PQL, report sample results which are <PQL or > 10X the blank concentration. Otherwise, reprep a blank and the remaining samples.

TABLE 1 (cont.)

QC REQUIREMENTS - VOLATILE ORGANICS, METHOD 8260

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
LCS	One per batch of 20 or fewer samples.	Statistically derived from lab data or nominal limits depending on the project. Refer to QA records for statistical limits. Nominal limits are used as default limits. See also section 8.4 of this SOP for more information on allowable exceedances. .	Evaluate the samples and associated QC: i.e. If an MS/MSD was performed and acceptable, narrate. If an LCS/LCSD was performed and only one of the set was unacceptable, narrate. If the surrogate recoveries in the LCS are also low but are acceptable in the blank and samples, narrate. If the LCS recovery is high but the sample results are <PQL, narrate. Otherwise, reprep a blank and the remaining samples.
Surrogate spike	Every sample, control, standard and method blank	Statistically derived limits.	Reprep and reanalyze for confirmation of matrix interference when appropriate.
MS/MSD	One MS/MSD per every 20 samples.	Statistically derived from lab data or nominal limits depending on the project. Statistical limits are used as default limits. .	(1) Evaluate the samples and associated QC: i.e. If the LCS results are acceptable, narrate. (2) If both the LCS and MS/MSD are unacceptable reprep the samples and QC.
MDL Study	Refer to KAS SOP QA-806, "Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications", current revision.		
Demonstrate ability to generate acceptable P & A using 4 replicate analyses of a QC check standard	Once per year for each analyst; 4 reps	All recoveries within method QC acceptance limits	Recalculate results; locate and fix problem; rerun P & A study for those analytes that did not meet criteria prior to sample analysis

TABLE 2

DOD QSM Version 4.1 QC Requirements

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.	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.
LOD determination and verification	Refer to current revision of SOP QA-806				
LOQ establishment and verification	Refer to current revision of SOP QA-806				
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.	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 ≤ 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).	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.
Second source calibration verification (ICV)	Once after each ICAL.	All project analytes within ± 20% of true value.	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.

TABLE 2 (cont)

DOD QSM Version 4.1 QC Requirements

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
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 initial CCV is used.	NA.	NA.	
Evaluation of relative retention times (RRT)	With each sample.	RRT of each target analyte within ± 0.06 RRT units.	Correct problem, then rerun ICAL.	Flagging criteria are not appropriate.	Laboratories may update the retention times based on the CCV to account for minor performance fluctuations or after routine system maintenance (such as column clipping). 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 ≥ 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 ≤ 20%D (Note: D = difference when using RFs or drift when using least squares regression or non-linear calibration).	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 Q-flag to all results for the specific analyte(s) in all samples since last acceptable CCV.	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.
Internal standards verification	Every field sample, standard, and QC sample.	Retention time ± 30 seconds from retention time of the midpoint standard in the ICAL; EICP area within -50% to +100% of ICAL midpoint standard.	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 Q-flag 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.

TABLE 2 (cont)

DOD QSM Version 4.1 QC Requirements

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Method blank	One per preparatory batch.	No analytes detected > ½ RL (> RL for common lab contaminants) 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.	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result. Contact Client if samples cannot be reprepped within hold time.	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.	The laboratory shall use laboratory control limits (CLs) or use DoD-generated LCS-CLs, if available depending on project requirements. In-house CLs may not be greater than ± 3 times the standard deviation of the mean LCS recovery. A number of analytes may fall outside the CL but within marginal exceedance limit depending on the total number of analytes in the LCS.	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. Refer to Table G-1 for number of marginal exceedences allowed. Contact Client if samples cannot be reprepped within hold time.	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 if sufficient sample is available.	For matrix evaluation, use LCS acceptance criteria.	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 J-flag 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 if sufficient sample is available.	MSD: For matrix evaluation, use LCS acceptance criteria. MS/MSD: RPD ≤ 30% .	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 J-flag if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.

TABLE 2 (cont)

DOD QSM Version 4.1 QC Requirements

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Surrogate spike	All field and QC samples.	The laboratory shall use laboratory surrogate CLs or use DoD-generated surrogate CLs, if available depending on project requirements. .	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. Contact Client if samples cannot be reprepped within hold time.	Apply Q-flag 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.	

TITLE: **ANALYSIS OF VOAs BY PURGE AND TRAP GC/MS: SW-846 METHOD 8260**

TABLE 3

SUMMARY OF METHOD MODIFICATIONS

TOPIC	KATAHDIN SOP CA-202-11	METHOD 8260, current revision
Apparatus/Materials	None	
Reagents	None	
Sample preservation/ handling	Preserved samples analyzed within 14 days. Unpreserved samples analyzed within 7 days.	Preserved samples analyzed within 14 days. No criteria for unpreserved samples.
Procedures	(1) Use laboratory reagent grade water for low level soil calibration, method blanks, and laboratory control samples to minimize clogging of archon soil needles with sand. (2) Internal Standards- pentafluoro-benzene, 1,4-difluorobenzene, chlorobenzene-d5, 1,4-dichloro-benzene-d4	(1) Use an aliquot of a clean (control) matrix similar to the sample matrix. (2) Recommended internal standards – fluorobenzene, chlorobenzene-d5, 1,4-dichloro-benzene-d4
QC - Spikes	None	
QC - LCS	None	
QC - Accuracy/Precision	PQL – Practical Quantitation Level – three to ten times the MDL.	EQL – Estimated Quantitation Level – five to ten times the MDL
QC - MDL	None	

TABLE 4

VOA COMPOUNDS AND CHARACTERISTIC IONS

COMPOUND	1° ION	2° ION
Acetone	43	58
Acetonitrile	41	40, 39
Acrolein	56	55, 58
Acrylonitrile	53	52, 51
Allyl Chloride	76	41, 39
Benzene	78	-
Bromobenzene	156	77, 158
Bromochloromethane	128	49, 130
Bromodichloromethane	83	85, 127
Bromoform	173	175, 254
Bromomethane	94	96
2-Butanone	43	72
n-Butylbenzene	91	92, 134
Sec-Butylbenzene	105	134
Tert-Butylbenzene	119	91, 134
Carbon Disulfide	76	78
Carbon Tetrachloride	117	119
Chlorobenzene	112	77, 114
Chloroethane	64	66
2-Chloroethylvinyl Ether	63	65, 106
Chloroform	83	85
Chloromethane	50	52
Chloroprene	53	88, 90
2-Chlorotoluene	91	126
4-Chlorotoluene	91	126
Cyclohexane	56	84, 60
1,2-Dibromo-3-Chloropropane	75	155, 157
Dibromochloromethane	129	127
1,2-Dibromoethane	107	109, 188
Dibromomethane	93	95, 174
Diethyl Ether	74	45, 59
1,2-Dichlorobenzene	146	111, 148
1,3-Dichlorobenzene	146	111, 148
1,4-Dichlorobenzene	146	111, 148
Dichlorodifluoromethane	85	87
1,1-Dichloroethane	63	65, 83
1,2-Dichloroethane	62	98
1,1-Dichloroethene	96	61, 63
Cis-1,2-Dichloroethene	96	61, 98
Trans-1,2-Dichloroethene	96	61, 98
1,2-Dichloropropane	63	112

TABLE 4 (cont.)

VOA COMPOUNDS AND CHARACTERISTIC IONS

COMPOUND	1° ION	2° ION
1,3-Dichloropropane	76	78
2,2-Dichloropropane	77	97
1,1-Dichloropropene	75	110, 77
Cis-1,3-Dichloropropene	75	77, 39
Trans-1,3-Dichloropropene	75	77, 39
Cis-1,4-Dichloro-2-butene	75	53, 77
Trans-1,4-Dichloro-2-butene	53	88, 75
1,4-Dioxane	88	58, 43
Di-Isopropyl Ether	45	43, 87
Ethylbezene	91	106
Ethyl Methacrylate	69	41, 99
Ethyl Tertiary-Butyl Ether	59	87, 57
Freon-113	151	101
Hexachlorobutadiene	225	223, 227
2-Hexanone	43	58, 57, 100
Idomethane	142	127, 141
Isobutyl Alcohol	43	41, 42
Isopropylbezene	105	120
P-ISOPROPYLTOLUENE	119	134, 91
Methacrylonitrile	41	67, 39
Methylcyclohexane	83	55, 98
Methylene Chloride	84	86, 49
Methyl Acetate	43	74
Methyl Methacrylate	69	41, 100
4-Methyl-2-Pentanone	43	58, 85, 100
Methyl Tert-Butyl Ether	73	57, 41
Naphthalene	128	-
Pentachloroethane	167	130, 132
Propionitrile	54	52, 55
N-PROPYLBENZENE	91	120
Styrene	104	78
Tertiary-Amyl Methyl Ether	73	55, 87, 71
Tertiary-Butyl Alcohol	59	41, 43
1,1,1,2-Tetrachloroethane	131	133, 119
1,1,2,2-Tetrachloroethane	83	131, 85
Tetrachloroethene	164	129, 131, 166
Tetrahydrofuran	42	72, 71
Toluene	92	91
1,2,3-Trichlorobenzene	180	182, 145
1,2,4-Trichlorobenzene	180	182, 145
1,3,5-Trichlorobenzene	180	182, 145
1,1,1-Trichloroethane	97	99, 61
1,1,2-Trichloroethane	83	97, 85
Trichloroethene	95	97, 130, 132

TABLE 4 (cont.)

VOA COMPOUNDS AND CHARACTERISTIC IONS

COMPOUND	1° ION	2° ION
Trichlorofluoromethane	151	101, 153
1,2,3-Trichloropropane	75	77
1,2,3-Trimethylbenzene	105	120
1,2,4-Trimethylbenzene	105	120
1,3,5-Trimethylbenzene	105	120
Vinyl Acetate	43	86
Vinyl Chloride	62	64
Xylenes (Total)	106	91
1-Chlorohexane	91	55,43

TITLE: **ANALYSIS OF VOAs BY PURGE AND TRAP GC/MS: SW-846 METHOD 8260**

TABLE 5

ANALYTE QUANTITATION AND INTERNAL STANDARDS

Pentafluorobenze	**1,4-Difluorobenzene**	**Chlorobenzene - d5**	**1,4-Dichlorobenzene - d4**
Dichlorodifluoromethane	1,2-Dichloroethane	1,3-Dichloropropane	1,1,2,2-Tetrachloroethane
Chloromethane	1,1-Dichloropropene	Tetrachloroethene	1,2,3-Trichloropropane
Bromomethane	Carbon tetrachloride	Dibromochloromethane	Isopropylbenzene
Vinyl chloride	Benzene	Chlorobenzene	Bromobenzene
Chloroethane	1,2-Dichloropropane	1,1,1,2-Tetrachloroethane	2-Chlorotoluene
Trichlorofluoromethane	Trichloroethene	Ethylbenzene	4-Chlorotoluene
Methylene Chloride	Dibromomethane	Xylenes (total)	1,3,5-Trimethylbenzene
Acetone	Bromodichloromethane	Bromoform	Tert-Butylbenzene
1,1-Dichloroethene	cis -1,3-Dichloropropene	Styrene	1,2,4-Trimethylbenzene
1,1-Dichloroethane	4-Methyl-2-pentanone	2-Hexanone	Sec-Butylbenzene
cis-1,2-Dichloroethene	Toluene-d8 (surr.)	Bromoform	1,3-Dichlorobenzene
trans-1,2-Dichloroethene	Toluene		P-Isopropyltoluene
Chloroform	trans-1,3-Dichloropropene		1,4-Dichlorobenzene
2,2-Dichloropropane	1,1,2-Trichloroethane		1,2-Dichlorobenzene
2-Butanone	1,2-Dibromoethane		N-Propylbenzene
Methyl-tert-butylether (MTBE)	Vinyl Acetate		1,2-Dibromo-3-chloropropane
Tetrahydrofuran	Methyl Methacrylate		1,2,4-Trichlorobenzene
Bromochloromethane	Ethyl Methacrylate		Naphthalene
1,1,1-Trichloroethane	1,4-Dioxane		Hexachlorobutadiene
Tertiary-butyl alcohol (TBA)	2-Chloroethylvinyl ether		1,2,3-Trichlorobenzene
Di-isopropyl ether (DIPE)	Bromofluorobenzene (surr.)		cis-1,4-Dichloro-2-butene
Ethyl-tert-butylether (ETBE)			trans-1,4-Dichloro-2-butene
Tertiary-amyl methyl ether			Pentachloroethane
Diethyl Ether			n-Butylbenzene
Carbon Disulfide			1,3,5-Trichlorobenzene
Freon-113			1,2,3-Trimethylbenzene
Iodomethane			
Acrolein			
Isobutyl Alcohol			
Allyl Chloride			
Chloroprene			
Propionitrile			
Methacrylonitrile			
Acrylonitrile			
Cyclohexane			
Methyl Acetate			
Methylcyclohexane			
1-Chlorohexane			
Dibromofluoromethane (surr.)			
1,2-Dichloroethane-d4 (surr.)			

TITLE: **ANALYSIS OF VOAs BY PURGE AND TRAP GC/MS: SW-846 METHOD 8260**

FIGURE 1

EXAMPLE OF VOA RUNLOG PAGE

KATAHDIN ANALYTICAL SERVICES
GCMS-D INSTRUMENT RUNLOG

DATE/TIME OF BFB INJECTION: 040210
Reviewed by/Date:

SAMPLE NAME	DATAFILE	DF	ALS #	METHOD	PREP METHOD 5030	5035	1311	Y/N	MS/MSD	PH	ANALYST	COMMENTS
Rinse	D5399	—	—	—				—			TTC	
50 ng BFB	D5361	—	—	BFB288.AQ				Y				
VSTD010D02A	D5400	1	1	D826.25mL09				N				
VSTD040D02A *	D5401	1	2	D826.25mL10				Y				
20 *	D5402	1	3					Y				Curve
10 B *	D5403	1	4					Y				OK
5 *	D5404	1	5					Y				
2 *	D5405	1	6					Y				
1 *	D5406	1	7					Y				
LCSA WG75857-1	D5407	1	8					Y				
VBLKA	D5408	1	9					N				
VBLKB WG75557-2	D5409	1	10					Y				Target hits
SD1507-13 A	D5410	1	11					Y		<2		
-14 A	D5411	1	12					N				Gas off
-1 A	D5412	1	13					N				
-3 A	D5413	1	14					N				
-5 A	D5414	1	15					N				
-9 A	D5415	1	16					N				
-11 A	D5416	1	17					N				
-15 A	D5417	1	18					N				
-17 A	D5418	1	19					N				
-19 A	D5419	1	20					N				
Rinse	D5420	1	21					—	—	—		
	D5421	1	22					—	—	—		

TTC 4/5/10

STANDARD	CODE
BFB	V3048
CAL. STD.	V341
LCS/MS MIX	V342
EXTRAS MIX	V3102

STANDARD	CODE
IS MIX	V3137
SS MIX	V3138

Circle Methods:
SW846 8260
EPA 624
EPA 524
SIM

OLM 04.2
OLM 03.1
OLC 02.1
OLC 03.2

QAMS423

0000072

TITLE: **ANALYSIS OF VOAs BY PURGE AND TRAP GC/MS: SW-846 METHOD 8260**

FIGURE 2

EXAMPLE OF GC/MS STANDARDS RECEIPT LOGBOOK PAGE

KATAHDIN ANALYTICAL SERVICES

STOCK STANDARDS RECEIVED

GCMS LABORATORY
REVIEWED BY/DATE:

AMP1518 1519 1520 1521 — 1-Chlorohexane (EPA-1208) Lot: CB-2341A Ultra Exp: 11/30/09 1000µg/mL — Rec'd 11/07/07

AMP1522 1523 1524 1525 — RESTEK Cat# 30434 MA VPH Standard 500 – 1600 ug/ml in Purge and Trap Methanol Lot# A040187 Exp: 11/12 Store: Freezer Restek Corporation • 110 Benner Circle • Bellefonte, PA 16823 — Rec'd 11/7/07 EKL

AMP1526 1527 — RESTEK Catalog# 30465 RL Lot # A049252 Exp: 12/11 Store:Freezer — rec'd DMF 11/20/07

AMP1528 1529 — AccuStandard 125 Market St. • New Haven, CT 06513 • USA Tel: 203-786-5290 • www.accustandard.com AS-E0285 Diethyl ether 5000 µg/mL in MeOH Lot: B4070099-1A Exp. Jan 19, 2010 1 mL POISON FOR LABORATORY USE ONLY STORAGE Ambient — rec'd DMF 11/21/07

AMP1530 1531 — AccuStandard 125 Market St. • New Haven, CT 06513 • USA Tel: 203-786-5290 • www.accustandard.com CLP-LC-IS-100X Laboratory Control Sample - Internal Standard Mix 2500 µg/mL in MeOH Lot: B2090027 Exp: Sep 6, 2012 1 mL 3 comps. POISON FOR LABORATORY USE ONLY STORAGE Ambient

AMP1532 1533 — RESTEK Catalog# 30624 RL Lot # A050631 Exp: 3/10 Store:Freezer — rec'd DMF 11/26/07

QAMS342 0000035

TITLE: **ANALYSIS OF VOAs BY PURGE AND TRAP GC/MS: SW-846 METHOD 8260**

FIGURE 3

EXAMPLE OF VOA STANDARDS PREPARATION LOGBOOK PAGE

KATAHDIN ANALYTICAL SERVICES
GC/MS VOA STANDARD PREP LOG BOOK

CODE: V2809	STOCK NAME	STOCK	STOCK CONC ug/mL	VOLUME ADD uL
STANDARD: 8260 LCS	502.2 Cal Mix #1	AMP 2187	2000	150
FINAL CONC (ug/mL): 200	MTBE	AMP 2121		
FINAL VOLUME (mL): 1.5	502.2 Cal Mega Mix	AMP 2143		
PREP DATE: 8/4/09	S-4575-10X	AMP 2147		
EXPIRATION DATE: 8/18/09	M-8260-ADD-10X	AMP 2180		
MEOH VOLUME (uL): 150	1-Chlorohexane	AMP 2109	1000	300
MEOH LOT #: E25E06	cyclohexane	AMP 2183		
INITIALS: HCG				
				8/4/09 (HCG)

CODE: V2810	STOCK NAME	STOCK	STOCK CONC ug/mL	VOLUME ADD uL
STANDARD: 8260 IS "T"	Custom 8260 IS Mix	AMP 2071	5000	50
FINAL CONC (ug/mL): 50				
FINAL VOLUME (mL): 5				
PREP DATE: 8/5/09				
EXPIRATION DATE: 8/19/09				
MEOH VOLUME (uL): 4950				
MEOH LOT #: E25E06				
INITIALS: HCG				
				(HCG) 8/5/09

CODE: V2811	STOCK NAME	STOCK	STOCK CONC ug/mL	VOLUME ADD uL
STANDARD: 8260 SS "T"	8260 Surrogate Mix	AMP 2223	2500	100
FINAL CONC (ug/mL): 50				
FINAL VOLUME (mL): 5				
PREP DATE: 8/5/09				
EXPIRATION DATE: 8/19/09				
MEOH VOLUME (uL): 4900				
MEOH LOT #: E25E06				
INITIALS: HCG				
				(HCG) 8/5/09

Reviewed by/Date:

QAMS401 0000084

TITLE: **ANALYSIS OF VOAs BY PURGE AND TRAP GC/MS: SW-846 METHOD 8260**

STANDARD INFORMATION

VOA Standards

Standard	Concentration	Manufacturer	Catalog Number
1,2,3 Trimethylbenzene	2000 ug/mL	Restek	58733
1,2,3 Trichlorobenzene	2000 ug/mL	Accustandard	M-502-47-10X
1,2,4 Trimethylbenzene	2000 ug/mL	Accustandard	M-502-54-10X
1,3,5 Trichlorobenzene	neat	Supelco	44-2235
1,3.5 Trimethylbenzene	2000 ug/mL	Accustandard	M502-55-10X
2-CEVE	2000 ug/mL	Accustandard	M-601C-10X
502.2 Cal Mix #1 (gases)	2000 ug/mL	Restek	30042
502.2 Cal2000 Mega Mix	2000 ug/mL	Restek	30431
504.1 Cal Mix	200 ug/mL	Accustandard	M-504.1-CSS
Acrolein & Acrylonitrile	5000 ug/mL	Accustandard	M-603-M-5X
Appendix IX Volatiles Mix	various	Accustandard	M-8240C-R3-10X
Bromochloromethane	2000 ug/mL	Accustandard	M-502-03-10X
California Oxygenates Mix #1	2000 - 10,000 ug/mL	Restek	30465
Carbon Disulfide	2000 ug/mL	Restek	30258
Chloroprene	2000 ug/mL	Accustandard	APPX9-048-R1
Custom GC Std	2000 ug/mL	Accustandard	S-11160
Custom VOC mix	various	Accustandard	S-7920-R1
Custom Volatile GC/MS Std	2000 ug/mL	Accustandard	S-3432B
Custom Volatiles GC/MS	2000 ug/mL	Accustandard	S-3432A
Diethyl Ether	5000 ug/mL	Accustandard	AS E0285
Freon 113	2000 ug/mL	Supelco	4-7944
Method 8260 Additions	2000 ug/mL	Accustandard	M-8260-ADD-10X
Method 8260B-Revision	2000 ug/mL	Accustandard	M-8240B-R-10X
MTBE	2000 ug/mL	Supelco	4-8483
Napthalene	2000 ug/mL	Accustandard	M-502-40-10X
THF	2000 ug/mL	Accustandard	S-4575-10X
Vinyl Acetate	2000 ug/mL	Restek	30216
Vinyl Acetate	2000 ug/mL	Accustandard	APPX9-211-20X
VOA Calibration Mix #1 (Ketones)	5000 ug/mL	Restek	30006
TCL Ketone Mix	5000 ug/mL	Accustandard	CLP-022-25X
VOC Liquid Mix	2000 ug/mL	Accustandard	M-502A-R2-10X
Volatile Organic Compounds (gases)	2000 ug/mL	Accustandard	M-502B-10X
IS/SS/Tune			
Custom 8260 IS	5000 ug/mL	Restek	54577
Custom 8260 SS	5000 ug/mL	Restek	54578
4-BFB	2000 ug/mL	Supelco	48083
VOA Tuning Compound (BFB)	5000 ug/mL	Restek	30003
1,2 Dichlorobenzene-D4	2000 ug/mL	Supelco	48952-U
Fluorobenzene	2000 ug/mL	Supelco	
VOA IS (CLP)	2500 ug/mL	Restek	30004
VOA SS (CLP)	2000 ug/mL	Supelco	48943
624 IS	1500 ug/mL	Restek	30023
4-BFB/Fluorobenzene/Pentafl. (EPA 624)	20000 ug/mL	Accustandard	M-624-SS-M
8260A SS	2500 ug/mL	Restek	30240
CLP Only			
04.1 CLP VOA Cal 2000	2000 ug/mL	Restek	30456
LCS-IS	2500 ug/mL	Accustandard	CLP-LCS-IS-100X
LCS-Volatiles	200 ug/mL	Accustandard	CLP-LCS-V
CLP Volatiles DMC Stock Solution	deutrated compds	Cambridge Isotope	ES 5038
3.2 OLC mix	1000 - 2000 ug/mL	Restek	30492

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

SOP Number: CA-336
Revision History
Cover Page
Page 1

TITLE: DISSOLVED GAS ANALYSIS IN WATER SAMPLES USING GC HEADSPACE EQUILIBRATION TECHNIQUE EPA SOP RSK-175

Prepared By: _____ Date: 2/2/06

Approved By:

Department Manager: _____ Date: 2/2/06

Operations Manager: Deborah J. Nadeau Date: 2/2/06

QA Officer: Leslie Dimond Date: 2-2-06

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01	Section 7.9 removed surrogate reference. Added information to section 1.4 for headspace vial disposal. Minor changes throughout.	LAD	03/07	03/07
02	Added LCS to definitions and Sect. 8.2 Added Na Purging to sect.s 7.1 and 7.2	LAD	01/08	01/08
03	Removed all references to method SW846 3810. updated Figure 1 - Logbook Page.	LAD	06/09	06/09

TITLE: DISSOLVED GAS ANALYSIS IN WATER SAMPLES USING GC HEADSPACE EQUILIBRATION TECHNIQUE EPA SOP RSK-175

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document SOP CA-336-03, titled "Dissolved Gas Analysis in Water Samples Using GC Headspace Equilibration Technique EPA SOP RSK-175".

Recipient: _____ Date: _____

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document SOP CA-336-03, titled "Dissolved Gas Analysis in Water Samples Using GC Headspace Equilibration Technique EPA SOP RSK-175".

Recipient: _____ Date: _____

TITLE: DISSOLVED GAS ANALYSIS IN WATER SAMPLES USING GC HEADSPACE EQUILIBRATION TECHNIQUE EPA SOP RSK-175

1.0 SCOPE AND APPLICATION

This SOP describes all aspects of the analysis of aqueous samples for Methane, Ethane and Ethene by RSK-175, as performed by Katahdin Analytical Services, Inc. including sample preparation, sample analysis, data review, standard preparation and instrument calibration.

1.1 Definitions:

ANALYTICAL BATCH: 20 or fewer samples which are analyzed together with the same method sequence and the same lots of reagents and with the manipulations common to each sample within the same time period or in continuous sequential time periods.

METHOD BLANK (LABORATORY REAGENT BLANK): An artificial sample designed to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus.

CALIBRATION STANDARD (WORKING STANDARD): A standard prepared from the stock standard that is used to calibrate the instrument response with respect to analyte concentration.

LABORATORY CONTROL SAMPLE (LCS): A blank that has been spiked with the analyte(s) of interest and is analyzed exactly like a sample. Its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements. The LCS is obtained from a source different from the source of the calibration standards.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD): Predetermined quantities of stock standards of certain analytes are added to a sample matrix prior to sample analysis. Samples are split into duplicates, spiked and analyzed. Percent recoveries are calculated for each of the analytes detected. The relative percent difference between the samples is calculated and used to assess analytical precision. MS/MSD's are spiked with the same standard as the LCS.

STANDARD CURVE (CALIBRATION CURVE): A curve that plots concentration of known analyte standard versus the instrument response to the analyte.

KATAHDIN INFORMATION MANAGEMENT SYSTEM (KIMS): A complete multi-user system with the capabilities of integrating laboratory instrumentation, generating laboratory worksheets, providing complete Lab Order status and generating reports. KIMS utilizes these features through a database.
PE NELSON TURBOCHROM: A data acquisition system that is used to collect chromatographic data. The system can also be used to archive raw data files.

TARGET: A software system that combines full processing, reporting and comprehensive review capabilities, regardless of chromatographic vendor and data type.

TARGET DB: An oracle database used to store and organize all Target data files.

QUICKFORMS: A laboratory reporting software for Target and Target DB. The QuickForms report module for Target is preconfigured with generalized forms and US EPA CLP report forms and disk deliverables, which can be customized.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the analysis of Methane Ethane, Ethene by method RSK-175. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, "Personnel Training & Documentation of Capability".

It is the responsibility of all Katahdin technical personnel involved in the Methane Ethane, Ethene by method RSK-175 to read and understand this SOP, adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, that their work is properly documented and to indicate periodic review of the associated logbooks.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical Health and Safety Manual including the Katahdin Hazardous Waste Management Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the

laboratory. Each analyst should know the location of a respirator and all safety equipment. Each analyst shall receive a safety orientation from their supervisor, or designee, appropriate for the job functions they will perform.

1.4 Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Management Program for further details on pollution prevention techniques.

Wastes generated during the preparation of samples must be disposed of in accordance with the Katahdin Hazardous Waste Plan and Safety Manual and SOP SD-903, "Sample Disposal," current revision. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with this SOP. Used headspace vials are disposed of in the "P" waste satellite accumulation area located under GC05.

2.0 SUMMARY OF METHOD

A water sample is collected in a 40 mL VOA bottle using a Teflon faced septum and cap. In the laboratory, a 5 mL aliquot of a sample is injected into a vial and placed onto a headspace autosampler where each sample is shaken and heated prior to injection. The analyte(s) present in the samples will partition between the water and the gas phase according to Henry's Law. The autosampler pressurizes the sample in order to inject 1 mL of headspace onto a gas chromatographic column where the gaseous compounds are separated and detected by a flame ionization detector (FID).

3.0 INTERFERENCES

The sample integrity is compromised if the sample vial contains headspace prior to sample preparation. The presence of headspace in the sample vial is notated in the laboratory narrative.

4.0 APPARATUS AND MATERIALS

4.1 Gas Chromatograph: GC Hewlett Packard 5890 series I or II connected to the Turbochrom data system, or equivalent
4.2 Headspace Analyzer: Agilent Technologies G1888 Network Headspace Analyzer
4.3 Column: 80/100 mesh Poropak Column 6ft x 1/8"

4.4 Detector: Flame Ionization Detector (FID)

4.5 Data System: A data system which allows the continuous acquisition of data throughout the duration of the chromatographic program must be interfaced to the GC. The data system must be capable of storing and re-integrating chromatographic data and must be capable of determining peak areas using a forced baseline projection. All data editing will be reviewed by the Department Manager or qualified designee before samples are reported.

4.6 Headspace Syringes: various sizes for preparing standards and injecting samples

4.7 5 mL Leur Lock gas-tight syringe with liquid needle

4.8 10 mL headspace vials

4.9 40 mL VOA vials

4.10 Refrigerator for storage of samples

4.11 pH strips (pH 1 – 14 range)

4.12 Tedlar Bags

4.13 Septum cap and crimper

4.14 Brinkmann Pipetter, volume up to 5 mL

5.0 REAGENTS

5.1 Ultra high purity Nitrogen

5.2 Ultra high purity Hydrogen

5.3 Laboratory Reagent Grade Water: Milli-Q, or equivalent

5.4 Certified Gas Standards, Scotty or equivalent

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Samples are collected into 40 mL VOA vials. The vials have been preserved with 1:1 HCL prior to collection. Care should be taken so there are no air bubbles in the vials.

Samples are stored at 4 (±2) °C until time of analysis. Samples must be analyzed within 14 days of sampling. Unpreserved samples must be analyzed within 7 days of sampling.

7.0 PROCEDURES

7.1 Preparing Samples for Analysis:

Allow samples to warm to room temperature prior to preparation. Inspect all VOA vials for bubbles and notate any bubbles in the logbook.

Purge all headspace vials with nitrogen for approximately ten seconds prior to injecting them with sample. The empty headspace vials are purged and then capped. The nitrogen line is located between the headspace sampler and the GC05 oven.

Using a 5 mL Leur lock syringe, pull up 5 mL of Nitrogen from a Tedlar bag. While inverting a VOA vial push the syringe through the vial septa. Insert a second 5 mL syringe into the VOA vial. By injecting the 5 mL of nitrogen, 5 mL of sample will be displaced into the second syringe. Take the syringe containing the sample aliquot out of the VOA vial and immediately inject the aliquot through the headspace vial septa. The sample is now ready to be loaded onto the autosampler.

If a dilution is required in order to bring the sample within range of the calibration curve, the sample is prepared as above, but less than 5 mL of sample is injected into the vial. An aliquot of laboratory reagent grade water is used to bring the liquid volume to 5 mL. The laboratory reagent grade water is purged with the nitrogen line for approximately ten seconds before capping the headspace vials and adding sample. The amounts of sample and water are based on the factor needed to bring the sample within range of the upper half of the calibration curve. The amount of sample and water are notated in the logbook and the proper dilution factor is applied to the final result.

7.2 Standards Preparation

Using a pipetter, inject 5 mL DI water into a headspace vial, purge with nitrogen for approximately ten seconds and crimp the top. A gas standard is then injected into the vial. The standards are calibrated as ug/mL of water.

7.3 GC Conditions

Refer to the instrument logbook for the current column and conditions.

Typical conditions are:

Nitrogen Carrier:	20 mL/min.
Ultra Zero Air:	400 mL/min.
Hydrogen:	40 mL/min.
Injector Temp.:	200
Detector Temp.:	250
Oven Ramp:	40 hold 1 min; 10 degrees/min to 100
Run time:	7 min
Injection size:	1 mL
Column head pressure:	14 psi

7.4 Calibration

The GC system is calibrated using the external standard calibration procedure. A six-point (5-point minimum) calibration is prepared according to the concentrations listed below.

Methane MW=16

Vol of Std inj. (ug)	Std Conc (ppm)	Std. Injected into Vial (ug)	Water Volume (mL)	Water Conc. (ug/mL)
38	1000	0.025	5.0	0.005
200	1000	0.133	5.0	0.027
500	1000	0.333	5.0	0.067
1000	1000	0.665	5.0	0.133
5000	1000	3.326	5.0	0.665
900	10000	5.986	5.0	1.197

Ethene MW=28

Vol of Std inj. (ug)	Std Conc (ppm)	Std. Injected into Vial (ug)	Water Volume (mL)	Water Conc. (ug/mL)
38	1000	0.044	5.0	0.009
200	1000	0.233	5.0	0.047
500	1000	0.582	5.0	0.116
1000	1000	1.164	5.0	0.233
5000	1000	5.819	5.0	1.164
900	10000	10.476	5.0	2.095

Ethane MW=30

Vol of Std inj. (ug)	Std Conc (ppm)	Std. Injected into Vial (ug)	Water Volume (mL)	Water Conc. (ug/mL)
38	1000	0.047	5.0	0.009
200	1000	0.249	5.0	0.050
500	1000	0.624	5.0	0.125
1000	1000	1.247	5.0	0.249
5000	1000	6.236	5.0	1.247
900	10000	11.224	5.0	2.245

Each calibration standard is injected using the technique that is used to introduce the actual samples into the GC. The Target system will calculate a peak height or area for each compound. A calibration curve can be prepared in Target using the peak height or area against the concentration of the standard. An average calibration applying a first order polynomial equation is used to prepare the curve.

7.4.1 Calculating the concentration of the calibration standard (x)

$$\text{ug std. injected into vial} = \frac{(\text{ppmv of std.})(\text{MW of gas})(\text{mL injected})}{\text{Henry's Constant } 24055}$$

$$\text{conc.} = \frac{\text{ug std. injected into vial}}{\text{amount mL of water in vial}}$$

7.5 Retention Time Study

Three injections are made of all the analytes throughout the course of a 72-hour period.

A major peak from the envelope is chosen and a standard deviation is calculated using the three retention times for that peak.
Plus or minus three times the standard deviation of the retention times for each standard is used to define the retention time window; however, the experience of the analyst should weight heavily in the interpretation of chromatograms. Retention time windows are calculated for each standard on each GC column and whenever a new GC column is installed. The data is kept on file in the laboratory.

7.6 Sample Analysis

Each vial may only be analyzed once. If a second analysis is required, the sample must be re-prepped. The samples and standards are loaded onto the autosampler, which heats and shakes the vials. The autosampler then pressurizes the sample to fill

the 1 mL sample loop. The 1 mL headspace sample is then injected into the GC instrument.

Samples are analyzed in a set referred to as an analytical sequence. The sequence begins with instrument calibration as listed in section 7.4 followed by sample aliquots interspersed with mid-concentration calibration standards.

Before any samples are analyzed the instrument must be calibrated by analyzing a five-point (minimum) calibration or a mid-concentration standard (calibration verification standard). If a CV is run, the calculated concentration must not exceed a difference of ± 30%. Each sample analysis must be bracketed with an acceptable initial calibration and a closing CV, or an opening CV and a closing CV. The calibration standard must also be injected at intervals of not less than once every twenty samples (or every 12 hours), whichever is more frequent, and at the end of the analysis sequence.

If the CV fails, the instrument is checked for any obvious problems and maintenance is performed if deemed necessary. All samples that were injected after the last standard that last met the QC criteria must be evaluated to prevent mis-quantitations and possible false negative results, and re-injection of the sample extracts may be required. However, if the standard analyzed <u>after</u> a group of samples exhibits a response for an analyte that is <u>above</u> the acceptance limit, i.e. >30%, and the analyte was not detected in the specific samples analyzed during the analytical shift, then the analyses for those samples do not need to be reanalyzed, as the CV standard has demonstrated that the analyte would have been detected were it present. In contrast, if an analyte above the QC limits <u>was</u> detected in a sample analysis, then re-injection is necessary to ensure accurate quantitation. If an analyte was not detected in the sample and the standard response is more than 30% below the initial calibration response, then re-injection is necessary to ensure that the detector response has not deteriorated to the point that the analyte would not have been detected even though it was present.

Absolute retention time windows are established using the mid-point of the window of that day if after analyzing the mid-point it is determined that one or more of the analytes fall outside of the previously established absolute retention time window. The daily retention time window equals the mid-point ±three times the standard deviations.

The identification of methane, ethane and ethene is based on agreement between the retention times of peaks in the sample chromatogram with the retention time windows established through the analysis of standards of the target analytes. An analyte is tentatively identified when a peak from a sample falls within the daily retention time window.

If the response for an analyte exceeds the calibration range of the system, the sample must be diluted and reanalyzed.

If the amount recovered is not detectable or below the PQL, then the compound is not considered to be present in the sample and is reported as <PQL.

When a GC system is determined to be out of control because either a CV can not pass or a six-point calibration does not meet the correlation coefficient criteria, instrument maintenance is likely necessary. Routine instrument maintenance may involve changing the septum, replacing the liner, or replacing the column. This information is recorded in the instrument run log (Figure 1). When an instrument requires more severe maintenance like replacing the FID or an electronic board, this information is written in the instrument maintenance logbook.

7.7 Calculations

The concentration of an analyte is calculated by using the calibrated curve that is prepared in Target. When an analyte is identified, Target displays a concentration when the file is processed through the appropriate calibrated method.

$$\text{Dilution Factor} = \frac{\text{Amt. sample added to headspace vial}}{\text{Total Vol. added to headspace vial}}$$

7.8 Data Review

The initial data review is accomplished by the analyst who ran the samples. This review is of sufficient quality and detail to provide a list of samples that need to be reanalyzed or diluted and reanalyzed. The initial data review is performed in Target Review. This data review examines criteria that directly impact whether or not the sample needs to be reanalyzed and/or reextracted.

These criteria include:

- QC criteria for method blank, LCS, MS/MSD, and calibration – refer to section 8.0.
- Chromatography: cleanups, manual integration.
- Target compound detection: quantitation and false positives.
- The requirement of the GC laboratory is that this initial data review be completed no later than the end of the next workday. After the analyst has

completed his or her initial data review, the information is then ready to be processed for reporting. Refer to section 7.10.

7.9 Chromatography

The chromatography should be examined for the presence of any non-target peaks, which can be used as an indication of whether or not matrix interference might be influencing surrogate recoveries. Manual integrations are to be performed when chromatographic conditions preclude the computer algorithm from correctly integrating the peak of concern. In no instance shall a manual integration be performed solely to bring a peak within criteria.

In Target Review, each peak of concern is examined by the primary analyst to ensure that the peak was integrated properly by the computer algorithm. Should a manual integration be necessary (for instance, due to a split peak, peak tailing, or incomplete resolution of isomeric pairs), manual integration is performed in Target Review. An "m" qualifier will automatically be printed on the quantitation report summary indicating that a manual integration was performed. For specific procedures on how to manually integrate, refer to Katahdin SOP QA-812, Manual Integration, current revision.

7.9.1 Target Compound Detection

The chromatogram is evaluated to determine if a target analyte is indicated. The concentration of the analyte(s) is then evaluated to determine if it is above the PQL and within the calibration range.

7.10 Reporting

After the chromatograms have been reviewed and any target analytes have been quantitated using Target, the necessary files are brought into QuickForms. Depending on the QC level requested by the client, a Report of Analysis (ROA) and additional reports, such as LCS forms and chronology forms, are generated. The package is assembled to include the necessary forms and raw data. The data package is reviewed by the primary analyst and then forwarded to the secondary reviewer. The secondary reviewer validates the data and checks the package for any errors. When completed, the package is sent to the Department Manager for final review. A completed review checklist is provided with each package. The final data package from the Organics department is then processed by the Data Management department.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

Refer to Table 1 for a summary of QC requirements, acceptance criteria, and corrective actions. Table 1 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific judgments. These decisions are based on holding time considerations, remaining sample volume and client and project specific Data Quality Objectives. The Department Manager, Laboratory Operations Manager, and/or Quality Assurance Officer may be consulted to evaluate data.

In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

Every instance of noncompliant method quality control requires the generation of a Corrective Action Report describing the problem, suspected cause and final resolution. Corrective action reports must be signed by the initiator, Department Manager, QA officer, and lab management.

8.1 Continuing Calibration Verification (CV)

A mid-level concentration standard is analyzed daily prior to sample analysis. The calibration standard must also be injected at intervals of not less than once every twenty samples (or every 12 hours), whichever is more frequent, and at the end of the analysis sequence. The acceptance criterion is ±30% of the expected value. If recovery of a compound, in the opening CV, fails to met the criterion, the system is checked, the standard reprepped and analyzed. In the event the criterion cannot be met, the instrument is recalibrated.

8.2 Laboratory Control Sample (LCS)

An LCS is a mid-level concentration standard using a source different from the source of the calibration standards. This can include a different lot from the same manufacturer. An LCS is analyzed prior to sample analysis. The acceptance

criterion is ±30% of the expected value. If the compound recovery fails to meet this criterion, the system is checked, and another LCS is prepped and analyzed. In the event the criterion cannot be met, the instrument is recalibrated.

8.3 Laboratory Blank

The Laboratory Blank is prepared by injecting 5 mL of DI water into a 10 mL headspace vial. A Laboratory Blank is analyzed between analysis of standards and project samples. If analytes are detected above the detection limit, the blank is reprepped and analyzed. If analytes are still detected above the detection limit, the possibility exists that all the vials in the batch contain contamination. In this case all samples and QC are reprepped in new vials.

8.4 Sample Duplicates

Sample duplicates are analyzed as required for certain clients. The duplicate is prepared using a second VOA sample using the procedures in section 7.1.

8.5 Detection Limits

An annual Method Detection Limit (MDL) study is preformed using a minimum of seven vials of low level standards (3 to 5 times the MDL) as described in 40 CFR Pt. 136 App. B. The MDL must be less than or equal to the detection limit.

Compound	Det. Limit (ug/L)
Methane	10
Ethane	10
Ethene	10

8.6 Matrix Spikes and Matrix Spike Duplicates (MS/MSD)

For projects requiring MS/MSD sets, aliquots of the sample are prepared using the procedures in section 7.1. The MS/MSD's are then spiked in the same fashion as the LCS. After analysis, the original sample amount is subtracted out and the % recovery is calculated. The acceptance criterion for MS/MSD sets are 70-130% recovery and 30% RPD. If the criteria are not met, the data is flagged and the incident is narrated. Since samples are analyzed using an autosampler, it is not possible to know in advance the concentration of the sample. Consequently, the concentration of analytes in the unspiked analysis may be greater than four times the concentration of the added spike, making the spike amount insignificant to the original concentration. In these situations, recoveries and RPD may not meet the acceptance criterion. In addition, as MS/MSD's are typically taken from separate vials, sample heterogeneity may contribute to failed criteria.

TITLE: DISSOLVED GAS ANALYSIS IN WATER SAMPLES USING GC HEADSPACE EQUILIBRATION TECHNIQUE EPA SOP RSK-175

9.0 METHOD PERFORMANCE

9.1 The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDLs are determined annually per type of instrument and filed with the Department Manager and with the QAO. Refer to the current revision of Katahdin SOP QA-806, Method Detection Limit and Instrument Detection Limit Studies, for procedures on determining the MDL.

Refer to the current revision of Method RSK-175 for other method performance parameters and requirements.

10.0 APPLICABLE DOCUMENTS/REFERENCES

EPA SOP RSK-175, Revision No. 0, 8/11/94

LIST OF TABLES AND FIGURES

Table 1 Summary of Calibration and QC Procedures
Table 2 Summary of Method Modifications
Figure 1 Example of Runlog

TITLE: DISSOLVED GAS ANALYSIS IN WATER SAMPLES USING GC HEADSPACE EQUILIBRATION TECHNIQUE EPA SOP RSK-175

TABLE 1

SUMMARY OF CALIBRATION AND QC PROCEDURES

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
ICAL	Initial calibration prior to sample analysis	RSD ≤ 30%	Investigate and repeat initial calibration
CV	If initial calibration analyzed, daily and after 20 samples, and at end of sequence.	%D for all analytes within 30%	(1) Evaluate the samples: (2) If the %RPD >30% and sample results are < PQL, narrate. (3) If %RPD >30% and is likely a result of matrix interference, narrate. (4) Otherwise, reanalyze all samples after last acceptable CV.
LCS	One LCS per 20 samples	Recovery must be between 70% and 130%	(1) Evaluate the samples and associated QC. (2) If an MS/MSD was performed and acceptable, narrate. (3) If the LCS recovery is high but the sample results are < PQL, narrate. Otherwise, reprep.
Method Blank	One per batch of 20 or fewer samples	No analytes detected > PQL	(1) Investigate source of contamination (2) Evaluate the samples and associated QC: i.e. If the blank results are above the PQL, report samples results which are < PQL >10X the blank concentration. Otherwise, reprep a blank and the remaining samples.
Matrix Spike/Matrix Spike Duplicate	One MS/MSD as requested by clients.	Recovery must be between 70% and 130%, RPD ≤30.	(1) Evaluate the samples and associated QC. (2) If the LCS is acceptable, narrate. (3) If both the LCS and MS/MSD are unacceptable, reprep the samples and QC.
Sample Duplicate	If requested by the client	%RPD of duplicate must be less than 30%.	(1) Check calculations for errors (2) Evaluate QC
Demonstration of capability - four replicate analyses of a QC check sample	One time per analyst initially and annually thereafter	All recoveries within method QC acceptance limits.	Investigate; reprep
MDL study	Once per year	Ideally, PQL at least 3X MDL.	Investigate; reprep

TITLE: DISSOLVED GAS ANALYSIS IN WATER SAMPLES USING GC HEADSPACE EQUILIBRATION TECHNIQUE EPA SOP RSK-175

TABLE 2

SUMMARY OF METHOD MODIFICATIONS

Topic	Katahdin SOP CA-336-03	Method: EPA SOP RSK-175
Apparatus/Materials		
Reagents		
Sample preservation/ handling	(1) Collect sample in 40 mL VOA vial. (2) HCL added in field; hold time is 14 days, un-preserved is 7 days.	(1) Collect sample in 60 mL crimp top vial. (2) HCL is added in field; hold time is 14 days.
Procedures	(1) 5 mL of sample is displaced with 5 mL of nitrogen and transferred to a capped autosampler vial. Headspace is then generated in the autosampler vial. (2) Prior to injection, autosampler shakes sample for 15 min while heating to 40°C. (3) Autosampler pressurizes sample to fill 1 mL loop with headspace sample. (4) Calibration is obtained by spiking headspace samples with gas phase analyte and analyzing using the same procedure as the samples. Quantitation of samples is directly obtained using the calibration curve that relates ug analyte/mL water sample to peak area. (5) ICAL using average response factor	(1) Headspace is generated in 60 mL vials by displacing volume of liquid with helium. The amount of liquid should be 10% of sample volume in bottle, up to 10mL. (2) Sample is shaken 5 min to equilibrate analyte between headspace and liquid phase. (3) Syringe injections of 300 uL headspace into GC. (4) Direct injections of gas phase standards are used to obtain a calibration curve. Henry's law is used to calculate mg of gas per L of water. Calculation requires recording total volume of serum bottle and headspace, and sample temperature. (5) ICAL using linear regression
QC - Spikes		
QC - LCS		
QC - Accuracy/Precision		
QC - MDL	See Section 9 of this SOP.	No information.

TITLE: DISSOLVED GAS ANALYSIS IN WATER SAMPLES USING GC HEADSPACE EQUILIBRATION TECHNIQUE EPA SOP RSK-175

FIGURE 1

EXAMPLE OF RUNLOG

Katahdin Analytical Services, Inc.
GC Laboratory Instrument Runlog
Instrument: GC05

Date: 5-29-09

Methods: SW846 3810 / RSK SOP-175
EPA Region 1

Sample Name	Data File	Sample Amt.	DF	Method	Y/N	pH	Analyst	Comments
prime	5CE2269	5mL	1	MEEB14A	N	-	EKC	
LV	270				Y	-		
WG64351-1	271					-		
-2	272					-		
SC2514-2DL.0	273	500uL	10		Y	<2		
-3DL	274							
-1DL	275	1mL	5					
-5DL	276	2.5mL	2					
-4	277	5mL	1					
-6	278							
-7	279							
SC2545-1 G	280							
-2 G	281				Y			
-3 H	282							
-4 G	283							
-5 G	284							
-6 H	285							
-7 G	286							
SC2546-1	287				Y			
-2	288							
-3	289							
LV	290				Y	-		
							EKC 05290S	

STANDARD	STOCK #	CONC.	AMOUNT
ICAL		1000 ug/mL	see comments
CV	AMP1464	1000 ug/mL	500 uL
LCS	AMP1486	1000 ug/mL	1 mL

Reviewed by / Date:_____

TITLE: ANIONS BY ION CHROMATOGRAPHY USING EPA METHOD 300.0 AND SW-846 9056

Prepared By: Deborah McGrath Date: 05/00

Approved By:

Group Supervisor: Keith Tongley Date: 05/24/01

Operations Manager: [illegible] Date: 5/23/01

QA Officer: Deborah J. Nadeau Date: 5.22.01

General Manager: [illegible] Date: 5/24/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
02	Format changes, added pollution prevention, added SW846 method 9056 reference and requirements. Updated logbook attachments.	DN	5.22.01	
03	Added reference to KIMS data entry (Sect. 7.14). Replaced fig.s 2 & 5. added wording to sect. 8. minor changes throughout to reflect current practices	LAD	031805	031805
04	Added information on Retention time Windows. Added reference for SOP CA 107 to Section 1.4	LAD	04/06	04/06
05	Sect. 5.0 - edited to reflect current Std. prep procedures. Sect. 7.0 - changed base range, added syringe pursing procedure, added info for setting up calibration in active sequence, added need for new sequence at beginning of every month	LAD	06/08	06/08
06	Minor revisions to sections 1.1 and 4 for clarity. Revisions to Section 8, 10, Table 2 and 3 to update from SW846 method 9056 to 9056A. Added LLQC criteria to Section 8.	LAD	02/09	02/09

TITLE: ANIONS BY ION CHROMATOGRAPHY USING EPA METHOD 300.0 AND SW-846 9056

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
07	Sect. 1.1- Added definitions. Sect. 4.1- Added computer and software references. Sect. 8, Table 1 and Table 2 - added DoD QSM requirements. Sect. 10. Added references.	LAD	08/09	08/09

TITLE: ANIONS BY ION CHROMATOGRAPHY USING EPA METHOD 300.0 AND SW-846 9056

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy _____ of document **SOP CA-742-07,** titled **ANIONS BY ION CHROMATOGRAPHY USING EPA METHOD 300.0 AND SW-846 9056.**

Recipient: _____Date:_____

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy _____ of document **SOP CA-742-07,** titled **ANIONS BY ION CHROMATOGRAPHY USING EPA METHOD 300.0 AND SW-846 9056.**

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1.0 SCOPE AND APPLICATION

This SOP describes the procedures used by Katahdin Analytical Services, Inc. technical personnel to determine the concentration of the following inorganic anions using ion chromatography (IC) by EPA Method 300.0 and SW-846 9056, current version: Sulfate, Bromide, Phosphate-P, Chloride, Nitrate-N, and Nitrite-N. This method may be used for the analysis of the following matrices: Drinking water, Surface water, Mixed Domestic and Industrial Waste waters, Ground water, Reagent waters, solids (after aqueous extraction), and Leachates (when no acetic acid is used).

1.1 Definitions

Analytical Batch – A group of 20 or fewer samples that are analyzed together on the same day.

Calibration Blank (CB) - A volume of laboratory reagent grade water fortified with the same matrix as the calibration standards but without the analytes. In most cases the CB will consist of laboratory reagent grade water.

Continuing Calibration Blank (CCB) – An aliquot of reagent water that is analyzed after each CCV to ensure continuing calibration accuracy.

Continuing Calibration Verification (CCV) – A midrange standard containing all method analytes that is run at the beginning of each run, after every 10 samples, and at the end of each run to ensure continuing calibration accuracy. The CCV is prepared from the same source as the calibration standards. The CCV is sometimes called the Instrument Performance Check Solution (IPC).

Laboratory Control Sample (LCS) / Initial Calibration Verification (ICV) – An aliquot of reagent water to which known amounts of the method analytes are added, and that is processed through the entire analytical procedure in the same manner as a sample. One LCS is processed and analyzed with each batch of 20 or fewer samples. The LCS/ICV is prepared from a different standard source than the calibration standards. LCSs provide a sample of known concentration to assess the accuracy of the analytical system, and when analyzed in duplicate may be used to a measure of precision for the analytical system. The LCS/ICV is sometimes called the Laboratory Fortified Blank (LFB).

Laboratory Duplicate – A duplicate is a second aliquot of a sample that is analyzed to to assess the precision of the analysis.

LOD – Limit of Detection. The smallest amount or concentration of an analyte that must be present in a sample to be detected at a 99% confidence level. At the LOD, the false negative rate is 1%.

Matrix Spike (MS) – An aliquot of an environmental sample to which known quantities of the method analytes are added in the laboratory. The MS is analyzed exactly like a samples, and its purpose is to determine whether the sample matrix contributes bias to the analytical results. The background concentrations of the analytes in the sample matrix must be determined in a separate aliquot and the measured values in the MS corrected for the background concentrations. The MS is sometimes called the Laboratory Fortified Matrix (LFM).

Method Blank (MB) – An aliquot of reagent water that is carried through the entire analytical procedure in the same manner as a sample. One method blank is processed and analyzed with each batch of 20 or fewer samples. For the purposes of this analysis the MB water is filtered through a 0.45 μm filter.

Method Detection Limit (MDL) – The minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero.

Practical Quantitation Limit (PQL) – The lowest concentration of an analyte that is routinely reported by the laboratory; nominally three to five times the MDL.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the analysis of anions by IC using EPA Method 300.0 and SW-846 9056. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability”.

It is the responsibility of all Katahdin technical personnel involved in analysis of anions by IC using EPA Method 300.0 or SW-846 9056 to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab logbook. Any deviations from the test or irregularities with the samples should also be recorded in the lab logbook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to initiate periodic review of the associated logbooks.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all

personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical Environmental Health and Safety Manual including the Katahdin Hazardous Waste Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Plan for further details on pollution prevention techniques.

The outflow from the chromatograph, WISP needle wash, WISP waste and regenerate wash is collected in a single container and disposed of in a Satellite Waste “A” Acid for proper disposal in main waste area “A”. Other wastes generated during the preparation of samples must be disposed of in accordance with the Katahdin Analytical Environmental Health and Safety Manual and SOPs SD-903, “Sample Disposal” and CA-107, “The Management of Hazardous Waste as it Relates to the Disposal of Laboratory Process Waste, Reagents, Solvents and Standards,” current revisions. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with this SOP.

2.0 SUMMARY OF METHOD

A small volume of sample is introduced into an ion chromatograph. The anions of interest are separated and measured using a system comprised of a guard column, analytical column, suppressor device and conductivity detector. An aqueous extraction procedure must be performed in order to utilize this method for solid matrices.

3.0 INTERFERENCES

3.1 Interferences can be caused by substances with retention times that are similar to and overlap those of the anion of interest. Large amounts of an anion can interfere with the peak resolution of an adjacent anion. Sample dilution and/or spiking can be used to solve most interference problems. The most common source of interference is high chloride concentrations.

3.2 The water dip or negative peak that elutes near and can interfere with the chloride peak can usually be eliminated by the adding the equivalent of 1mL of eluent concentrate to 100 mL of each sample.

3.3 The acetate anion elutes early during the chromatographic run. The retention times of the anions also seem to differ when large amounts of acetate are present. Therefore, this method is not recommended for leachates of solid samples when acetic acid is used for pH adjustment.

3.4 Method interferences may be caused by contaminants in the water, reagents, glassware, and other sample processing apparatus that lead to discrete artifacts or elevated baseline in the ion chromatograph.

3.5 Samples that contain particles larger than 0.45 μ and reagent solutions that contain particles larger than 0.2 μm require filtration to prevent damage to instrument columns and flow systems.

3.6 Any anion that is not retained by the column or only slightly retained will elute in the area of fluoride and interfere. Known coelution is caused by carbonate and other small organic anions. At concentrations of 1.5 mg/L fluoride this interference may not be significant.

4.0 APPARATUS AND MATERIALS

4.1 Ion chromatograph capable of delivering 1 to 5 mL of eluent per minute at a pressure of 1000 to 4000 psi. The chromatograph is controlled with a Windows-based PC running Turbochrom software. The chromatograph must be equipped with an injection valve, a 25- to 100-uL sample loop, and set up with the following components.

4.1.1 Autosampler – Waters Model 717plus or equivalent

4.1.2 Ion chromatography pump - Spectra System Model P4000 or equivalent

4.1.3 Conductivity detector – Waters Model 431 or equivalent

4.1.4 Precolumn – A guard column placed before the separator column to protect the separator column from fouling by particulates or organic constituents. Dionex Guard Cartridge AG4 or equivalent.

4.1.5 Separator column – A column packed with an anion exchange resin, suitable for resolving the anions of interest. Dionex Ionpac AS4A or equivalent.

4.1.6 Conductivity suppressor – An ion exchange-based device that is capable of converting the eluent and separated anions into their respective acid forms. Dionex Micromembrane Suppressor Model AMMS 300 or equivalent.

4.2 2 Liter regenerant reservoir

4.3 Analytical balance capable of accurately weighing to the nearest 0.0001g.

4.4 5 mL disposable syringes

4.5 Syringe filters - 45 μm Whatman Puradisc or equivalent

4.6 Autosampler rack with 1 mL sample vials and caps

4.7 Class "A" pipets, assorted volumes, Auto pipets or equivalent

4.8 Class "A" volumetric flasks, assorted volumes

4.9 Turbochrom Navigator software

4.10 Masterflex C/L regenerant pump or equivalent

5.0 REAGENTS

5.1 Regenerant, 0.025N H_2SO_4: Dilute 2.8 mL conc. H_2SO_4 to the 4 L with laboratory reagent grade water. Regenerant is made fresh on the day of the analysis.

5.2 Eluent, 1.7mM sodium bicarbonate, 1.8mM sodium carbonate: Dissolve 0.2856g sodium bicarbonate ($NaHCO_3$) and 0.3816g sodium carbonate (Na_2CO_3) in reagent water and dilute to 2 L. Vacuum filter through a 0.20 u or 0.45 u filter before use. Prepare fresh daily.

5.3 Laboratory reagent water

5.4 Needle wash solution: Reagent water containing 10% methanol by volume to inhibit bacterial growth.

5.5 Stock Standard Solutions: Stock standard solutions may be purchased as certified solutions or prepared from ACS reagent grade material. All purchased standards prepared from high purity salts and supplied by the vendors with certificates of purity and analysis. All purchased stock standards are given an expiration date as indicated by the manufacturer.

5.5.1 Bromide (Br^-), 1000 mg/L, purchased.

5.5.2 Chloride (Cl^-), 1000 mg/L, purchased

5.5.3 Nitrate (NO_3^--N), 225.8 mg/L as N, purchased

5.5.4 Nitrite (NO_2^--N), 304.4 mg/L as N, purchased

5.5.5 Phosphate ($PO_4^{\equiv}$-P), 326.3 mg/L as P, purchased

5.5.6 Sulfate ($SO_4^{=}$), 1000 mg/L, purchased

5.6 Primary Mixed Calibration Standard - Combine the following and dilute to 200 mL with laboratory reagent grade water:

Analyte	Amount of Stock Std. Added (mL)	Concen-tration in Stock Std. (mg/L)	Final Volume of Primary Mixed Cal. Std. (mL)	Final Conc. In Primary Mixed Cal. Std. (mg/L)
Cl^-	2.0	1000	200	10.0
NO_2^--N	2.63	304.4		4.0
NO_3^--N	3.54	225.8		4.0
Br^-	4.0	1000		20.0
$SO_4^{=}$	4.0	1000		20.0
$PO_4^{\equiv}$-P	3.06	326.3		5.0

NOTE: At any time a stock may be prepared with an abbreviated list of analytes and should be clearly labeled with the list of analytes contained.

5.7 Primary Working Calibration Standards (WCS) – Dilute Primary Mixed Calibration Standard as follows to prepare the five-point level working calibration standards:

Work-ing Std. ID	Amount of Primary Mixed Cal. Std. Added (mL)	Final Volume of Working Cal. Std. (mL)	Analyte Conc. In Working Cal. Std. (mg/L)					
			Cl^-	NO_2^- as N	NO_3^- as N	Br^-	$SO_4^{=}$	$PO_4^{\equiv}$ as P
IC1	1	1	10	4	4	20	20	5
IC2	0.5	1	5	2	2	10	10	2.5
IC3	0.25	1	2.5	1	1	5	5	1.25
IC4	0.1	1	1	0.4	0.4	2	2	0.5
IC5	0.01	1	.1	0.04	0.04	0.2	0.2	0.05

5.8 Primary Continuing Calibration Verification Standard (CCV1) – The CCV will be prepared using the same stock as the calibration standards and will be prepared at the same concentration as calibration standard IC2. Volumetrically pipet 25 mL Primary

Mixed Calibration Stock Standard into 50 mL volumetric flask and bring to volume with reagent water.

5.9 Primary LCS Stock Standard – LCS Stock must be comprised of independent sources for all analytes relative to the calibration standard stock. Combine the following using purchased standards from second source and dilute to 200 mL with laboratory reagent grade water: 1.5 mL of standard solution "A" and 1.5 mL of standard solution "B".

Final Concentrations (mg/L):

Cl	NO2(as N)	NO3 (as N)	Br	SO4	PO4 (as P)
7.50	2.28	1.69	7.50	7.50	2.45

5.8.1 Standard Solution "A"- Multi-element standard which contains analytes in the following concentrations:

- Nitrate (as N) – 225.8 mg/L
- Bromide- 1000 mg/L
- Orthophosphate (as P)- 326.3 mg/L
- Chloride – 1000 mg/L
- Fluoride – 1000 mg/L
- Sulfate- 1000 mg/L

5.8.2 Standard Solution "B" – Contains Nitrite (as N) only in the concentration of 304.4 mg/L

5.9 Primary Matrix Spike Mixed Standard - The Primary Matrix Spike Mixed Standard is prepared from the same anion stock standards as the Primary LCS stock standard. The mixed standard is prepared as follows: 7.5 mL of standard solution "A" and 7.5 mL of standard solution "B" diluted to 100 mL with DI water. Adding 0.05 mL of the mixed standard to 1.0 mL of sample yields the following concentrations(mg/L):

Cl	NO2 (as N)	NO3 (as N)	Br	SO4	PO4 (as P)
3.75	1.14	.845	3.75	3.75	1.22

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Samples should be collected in clean glass or polyethylene bottles. Sample preservation and holding times for the anions that can be determined by this method are as follow.

ANALYTE	PRESERVATION	HOLDING TIME
Bromide	None required	28 days
Chloride	None required	28 days
Nitrate-N	Cool to 4°C	48 hrs
Nitrite-N	Cool to 4°C	48 hrs
Ortho-Phosphate-P	Cool to 4°C	48 hrs
Sulfate	Cool to 4°C	28 days

NOTE: Due to the potential of and persistence of chloride contamination and the associated short hold times for nitrite, nitrate and ortho-phosphate, it is recommended that these ions are run concurrently by alternate methods.

7.0 PROCEDURES

7.1 SAMPLE PREPARATION

Refer to Katahdin Analytical Services SOP CA-106, "Basic Laboratory Technique", current revision for information on subsampling.

7.1.1 Solid Samples Extraction – Add an amount of laboratory reagent grade water equal to ten times the weight of the dry sample. This slurry is mixed for ten minutes using a magnetic stirrer. The resulting slurry is allowed to stand or may be centrifuged prior to filtration through 0.45 μm filter. Hold times for analytes of interest should be considered to commence upon the generation of the extract.

7.1.2 All samples are filtered through 0.45 μm filter by means of a syringe with attached filter disk just prior to loading the auto sampler tray.

7.2 TURNING ON INSTRUMENT

7.2.1 The instrument is configured as illustrated in Figure 1.

7.2.2 Prepare sufficient volumes of fresh eluent and regenerant solutions.

NOTE: Both Eluent and Regenerant should be prepared DAILY.

7.2.3 Using the P4000 pump, press the run button on the front. Make sure the flow rate is set at 2.0 mL/min.

7.2.4 Using the peristaltic pump, crimp the tubing around the rollers by snapping the clamp up. Turn the pump on by pressing the black button down.

NOTE: The peristaltic tubing easily crimps shuts. Make sure regenerant is flowing, especially if the pump has been off for more than a few hours. You may have to replace the section of the tubing that runs through the

pump head. Fittings are provided to easily allow for changing the crimped section of the tubing.

7.2.5 Monitor and record the backpressure on the HPLC pump. The pressure should not exceed 3500 psi. If this occurs it would indicate either you need to replace or clean the column, see column care and maintenance in the column manual.

7.3 TURNING ON THE CONDUCTIVITY DETECTOR

7.3.1 The Waters 431 conductivity detector is used for all of the anion determinations. If this detector does not pass QC criteria the system is out of control and maintenance must be initiated. Corrective action may include cleaning the injector with multiple purge cycles, blank injections, recalibration or more extensive column cleanup, replacement, or instrument maintenance.

7.3.1.1 The "*BASE RANGE* "should be set To 50 μS and the "*SENSITIVITY* " should be set to 0.05. The scale should be set to "*% FULL SCALE*" and the reading should be about 20 when the system has equilibrated. The reading can be adjusted using the up and down arrows on the keypad.

NOTE: It is important that this setting is positive. If the setting is at zero the baseline will be at 0V. Chromatography should be examined for indications of "*electrical zero*".

7.4 PURGING THE SYRINGE

7.4.1 The syringe should be purged daily. Make sure there is enough methanol in the bottle and that the green line is submerged in the methanol. Also make sure that the clear line and the yellow line are in the waste beaker.

7.4.2 To purge the syringe, select purge page from the main page. Click start purge. The syringe will proceed to purge for however long the time is set for.

7.5 CALIBRATION

7.5.1 A new calibration curve must be prepared at least one time every 6 months (check the runlog for the date of the last calibration) or if one of the following occurs:

7.5.1.1 The daily calibration verification is outside of the method criteria (Refer to section 8.0).

7.5.1.2 Major maintenance has been performed on the instrument (Refer to maintenance log, Figure 2).

NOTE: If one of the above is true, a new calibration curve must be prepared even if it has been less than 6 months since the last calibration.

7.5.2 If a calibration curve is required, prepare the standards as described in section 5.0.

7.5.3 Record the standards in the runlog (Figure 3) and load onto the autosampler. When entering the calibration points into the sample sequence, change the sample type to “cal: replace” and type the calibrator names in the level column. Make sure you go into the method first to save a new calibration file. This is done by opening an old file with the same method and saving over it with a new file name. In the active sequence, change the instrument, processing, and calibration methods to match the new curve file name.

7.5.4 The acceptance criteria for the calibration is a 0.995 correlation coefficient for the full curve. It is important to compare curves and responses vs. standard concentration with those previously generated to insure quality of data. Printouts of calibrations are filed in the Lab for approximately 3 months. Prior calibrations are archived. All are available in the database. Significant changes should be investigated. Switching to fresh standards or fresh reagents may change response slightly. Check historical data. Operator discretion in approving or rejecting calibrations is encouraged. The decision and rationale should be recorded in the logbook.

7.5.5 Retention time windows should be established when a new column is installed, if there is a change in instrument conditions or at least annually if there are no changes. Three injections of the CCV must be analyzed over the course of a 72 hour period. The standard deviation of the three retention times is calculated for each anion. Plus or minus three times the standard deviation of the retention times is used to define the retention time window. The retention time window should not extend beyond 5% of the retention time for each anion. However, the experience of the analyst should weigh heavily in the interpretation of chromatograms.

7.6 LOADING SAMPLES

7.6.1 Select autosampler rack for 96 samples.

7.6.2 Write sequence in IC Run Log; follow page format and proper sample coding.

7.6.3 Filter all samples through 0.45 μm filters into the appropriate sample vials.

7.6.4 If high sample concentrations are suspected, steps should be taken to minimize reruns and protect the system from contamination and/or carryover. In general samples from potable sources, drinking water samples, may be analyzed at an as received concentration. Monitoring wells, leachates, and estuarine samples may have extremely high concentrations of chloride and/or sulfate. To avoid contaminating the system, analyze these samples at an initial dilution. In the

event that the analyzed aliquot does have higher concentrations, inject water samples after the sample to clean out the system. For highly concentrated samples it may take as many as 5 or more water injections to clean out the injector and remove the carryover.

7.6.5 Make sure that the autosampler and the TurboChrom software are set up and ready to acquire data. It is recommended that the tray is initially set up to run the opening QC before loading samples. Opening QC consists of a CCV, CCB, and LCS. Evaluate the opening QC to ensure adequate separation, good chromatography, acceptable recovery as it relates to the calibration, and clean blanks. If the opening QC is within criteria and the chromatographic system is in control proceed to load samples. If QC criteria are not met or chromatography is not acceptable initiate appropriate corrective action.

7.6.6 To automatically run tray:

- Place sample carriage in carriage drive.
- Press "*START AUTO BUTTON*".
- Enter your starting and ending vial locations.
- Make sure the injection volume is 20 and the run time is ten minutes.
- Press "START BUTTON" after performing section 7.7.

7.7 PREPARING THE TURBOCHROM NAVIGATOR

7.7.1 Click on "*MODIFY*" under "*ANALYSIS VIEW*"

7.7.2 Click on "*ACTIVE SEQUENCE*". This will take you to the last sequence used or the sequence currently running.

NOTE: At the start of each month, a new sequence must be started. This is done by clicking the sequence box, opening the last sequence file, and renaming the sequence to reflect the current month. Make sure all of the columns are changed to the correct information. Also rename the files by selecting change data file, rename file, and then clicking the folder icon. Select the W:\data\IC01 file and type in the basefile name to match the new sequence. Select Channel B and click all three boxes. Click save and exit out. Before running any samples for the new month, open the setup box and the sequence to the new sequence name.

7.7.3 Place cursor on the first empty cell.

7.7.4 Type in sample sequence of run under name, if samples are being diluted enter your dilution factor in the dilution column.

7.7.5 Go to "*FILE*" and select "*EXIT*".

7.7.6 At "*RESUME SEQUENCE- STARTING ROW*" enter the row number of the first row of the new sequence. "*RESUME SEQUENCE- ENDING ROW*" enter the last row of the new sequence.

7.7.7 Click "*OK*". At this point the status should say "*READY*" and the LINC box light should be green.

7.8 SHUT DOWN PROCEDURE – **It is CRITICAL to explicitly follow long term shutdown storage for columns to prevent damage.**

7.8.1 Turn off both the eluent and regenerant pumps

7.8.2 **If the system will not be used for more than a week it is critical to fill the columns with the appropriate storage solution and cap them to prevent evaporation. If a column dries out it is most likely useless.**

7.8.3 Flush the lines in the WISP and in the detectors with DI for storage.

7.8.4 **It is critical to fill the suppressor with fresh regenerant and cap it. If the suppressor dries out it is likely to be ruined.**

DATA ANALYSIS, CALCULATIONS & REPORTING

7.9 If a sample is run and the analyte of interest concentration is above the calibration range the sample must be diluted and reanalyzed. Multiple dilutions may be required to obtain results for all analytes of interest in the calibration range. For samples run at multiple dilutions, the analysis of greatest concentration, qualified retention time, good peak shape, and satisfactory resolution should be quantitated and reported. However, all dilutions should be assessed comparing the consistency of the determinations and possible matrix effects. In certain instances, the more diluted analysis may be the more appropriate reported result.

7.10 If a sample is run at dilution and the concentration of the analyte of interest is below the PQL the sample should be reanalyzed at a greater concentration. Where there is coelution of higher relative concentration analytes to adjacent analytes, e.g. chloride to nitrite, a sufficient dilution of the sample should be analyzed to maximize the resolution of the two analytes and report the affected analyte concentration at an elevated PQL narrated to that effect.

7.11 If the chromatogram fails to produce adequate resolution, or if the identification of specific anions is questionable, the sample may be spiked with an appropriate amount

of standard and reanalyzed. In some instances dilution of the sample may provide sufficient resolution for identification and quantitation.
NOTE: Retention time is inversely proportional to concentration. Nitrate and sulfate exhibit the greatest amount of change, although all anions are affected to some degree. In some cases this peak migration may produce poor resolution or identification.

7.12 Calculations are performed by TurboChrom using responses measured during analysis of the calibration standards for the operating curve that has been calculated based upon a linear regression formula. Individual calibration curves are calculated for each detector. The analyst must assure that the method file is calculating against the appropriate curve. Aqueous and soil sample analyte concentrations are calculated using the following equation:

$$A = (mR + B) * DF$$

where:
- A = analyte concentration mg/L
- m = slope
- R = response in peak area
- B = y intercept
- DF = dilution factor prior to analysis

NOTE: In order for the dilution factor to be applied during calculation by TurboChrom it must be entered at the time the sequence is entered and/or edited.

7.13 In the event that the software interpretation of integration is not appropriate manual integration may be performed. It is expected that the same sound technical judgments and assessments will be equally applied to both samples and standards in the review of integrations and the decisions to perform or not perform manual integrations. In accordance with Section 7.7 of the Katahdin Analytical Services Quality Assurance Manual, any manual integration must be initialed and dated by both the analyst performing the integration and by the reviewer. **Under no circumstances is the original software generated result file to be overwritten with a manually edited file. Both the original software generated integration and the manual integration must be preserved with the raw data.** The analyst should rarely be required to manually integrate any QC elements. This is usually indicative of poor system performance and corrective action should be taken through proper maintenance.

7.14 The final raw data report will include information on initial and continuing calibrations and results of all quality control data. The instrument printout Includes Result File Name, Calibration File Name, Sample #, Analyst, Date Analyzed, Ion Initial Volume, Dilution Factor, Observed Concentration, Reported Concentration, % Recovery. (See Figure 4.)

7.15 Sample preparation information is entered manually into the Katahdin Information Management System (KIMS). Instrument data files are then imported electronically into KIMS for calculation and reporting of sample results and quality control data. Refer

to the current revision of SOP CA-762 ("W et Chemistry Data Entry and Review Using Katahdin Information Management System") for further information.

7.16 A batch sheet is generated (Figure 5). Raw data and batch sheets are reviewed for completeness and accuracy by the Department Manager or other qualified designee.

7.17 Printouts of instrument calibrations and sample data are filed in the lab for approximately 3 months for reference by analysts. Prior calibrations are archived and all are available in the TurboChrom database.

TROUBLESHOOTING

7.18 High biased blanks, CCVs, and LCSs for Cl^- may indicate a contaminated system. The most common cause of this type of contamination is the intrinsically high chloride concentration of many samples. Chloride contamination can contribute to the failure of QC criteria for both chloride and nitrite. A number of techniques can be used to return the system to normal operation.

7.18.1 The WISP, auto-sampler, is equipped with a purge function that serves to wash out the injection assembly. Running 4-5 purges can remove much contamination.

7.18.2 The injection of water blanks after injecting high Cl^- concentrations samples (e.g. estuarine water) may be effective. However, in some cases it can take 10-15 DI injections to return the system to normal operation.

7.18.3 Consult source and/or history of samples to make an educated judgment relative to dilutions that will place the samples within the linear calibration range.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

Refer to Table 2 for a summary of QC requirements, acceptance criteria, and corrective actions. Table 2 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 2, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 2 may rely on analyst experience to make sound scientific judgments. These decisions are based on holding time considerations, remaining sample volume and client and project specific Data Quality Objectives. The Department Manager, Operations Manager, General Manager and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases "qualified" data with narration may be advisable after consultation with the client.
In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work

performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

8.1 Initial Instrument Calibration – Instrument calibration, which is generated using a blank the five standards listed in Section 5.6, is performed at least once every six months or whenever there is a significant change in instrument operating conditions or hardware. One of the calibration standards must be at or below the Practical Quantitation Limit for each analyte. The curve fit is accomplished using least squares linear regression, and the correlation coefficient for the curve must be at least 0.995. Sample results that exceed the calibration range of the instrument may not be reported; the sample must be diluted and reanalyzed until the measured concentration of the analyte is within the calibration range. Because calibration linearity is established each time the instrument is calibrated (at least every six months) and because sample results that fall outside the calibration range may not be reported, a separate linear calibration range study is not performed.

8.2 Lower Limit of Quantitation - The laboratory should establish the LLOQ for each analyte as the lowest reliable laboratory reporting concentration or in most cases the lowest point in the calibration curve which is less than or equal to the desired regulatory action levels, based on the stated project requirements. Analysis of a standard prepared at the LLOQ concentration levels or use of the LLOQs as the lowest point calibration standard provides confirmation of the established sensitivity of the method. The LLOQ recoveries must be within 50% of the true values to verify the data reporting limit.

8.3 Continuing Calibration Verification (CCV) and Continuing Calibration Blank (CCB) – Ongoing calibration accuracy is verified by analyzing a CCV standard (a mid-range check standard) and a CCB at the beginning of each run, after every ten samples, and at the end of each run. The recovery of each CCV must be within 90% - 110% of the true value for each analyte. The measured concentration of each analyte in the CCB must be below the Practical Quantitation Limit for the analyte. If a CCV or CCB fails, the analysis must be stopped, the problem corrected, and the previous ten samples must be reanalyzed, with the following exception. If one or both CCVs bracketing a sample result are biased high and the sample concentration is <PQL, the sample result may be reported. CCVs or CCBs that are biased high may be indicative of carryover or contamination in the system by high concentration samples.

NOTE: High bias for chloride may be indicative of chloride contamination in the injector. If the run is attended and chloride is an analyte of interest, halt the run and take corrective action if bias is observed.

8.4 Laboratory Control Sample (LCS) / Initial Calibration Verification (ICV) – One LCS/ICV, prepared from a separate standard source from the Initial Instrument Calibration, must be analyzed with each batch of 20 or fewer samples. LCS/ICV recovery acceptance limits are 90% - 110% for EPA Method 300.0 and 80% - 120% for SW846 Method 9056.

8.5 Method Blank (MB) – A method blank consisting of reagent water that filtered in the same fashion as the associated samples must be analyted with each batch of 20 or fewer samples. The measured concentration of each analyte in the MB must be less than the PQL (for DoD QSM, no analyte may be detected in the MB at a concentration greater than ½ PQL or greater than 1/10 the amount measured in any sample). In the instance where there is a value in excess of the CCB, the filter source should be suspected as contributing contamination. Repeat the analysis with additional cartridges.

8.6 Matrix Spike (MS) Sample – Matrix spike samples must be prepared and analyzed at a frequency of 10% (one sample in 10) for EPA Method 300.0 or 5% (one sample in 20) for SW846 Method 9056A. Matrix spikes is prepared by adding 0.05 mL of Primary Matrix Spike Mixed Standard (Section 5.9) to 1.0 mL of the filtered sample prior to loading. If the concentration of the spike is less than 25% of the native sample concentration the matrix spike recovery should not be calculated. The matrix spike recovery acceptance limits are 90% - 110% for EPA Method 300.0 and 80% - 120% for SW846 Method 9056A. If the recovery of any analyte falls outside the criteria range and the LCS and CCVs are within criteria, the poor recovery should be attributed to sample matrix.

8.7 Matrix Spike Duplicate (MSD) – Prepared at a frequency of one per 20 samples. Acceptance limits are 80% - 120% recovery and ≤15% RPD.

8.8 Laboratory Duplicate (Dup) - One duplicate sample must be analyzed with each batch of 20 or fewer samples (one per 10 samples for DoD QSM). Analytes with measured values ≥ 5 times the PQL should achieve duplicate/MSD sample precision of ≤ 20% RPD (≤10% for DoD QSM).

9.0 METHOD PERFORMANCE

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDLs are determined annually per type of instrument and filed with the Department Manager and with the QAO. Refer to the current revision of Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, for procedures on determining the MDL.

Refer to the current revisions of the applicable methods for other method performance parameters and requirements.

10.0 APPLICABLE DOCUMENTS/REFERENCES

"Methods for the Determination of Inorganic Substances in Environmental Samples", EPA - 600/R - 93 - 100, August 1993.

“Test Methods for the Evaluation of Solid Waste: Physical/Chemical Methods”, SW-846, Third Edition, Final Update IV, February 2007, Method 9056A.

Katahdin SOP CA-101, Equipment Maintenance

Katahdin SOP CA-762, Wet Chemistry Data Entry and Review Using Katahdin Information Management System (KIMS)

Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications.

Department of Defense Quality Systems Manual for Environmental Laboratories (DoD QSM), Version 4.1, 04/22/09

The National Environmental Laboratory Accreditation Conference (NELAC) Standards, June 2003

WISP717plus Autosampler Operator Manual

Waters 510 HPLC Pump Manual

Dionex 200i Manual

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TABLE 1

QC REQUIREMENTS

Parameter/ Method	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Anions by Ion Chromato-graphy / EPA Method 300.0 and SW846 Method 9056A	Retention time (RT) window width calculated for each analyte	After method setup and after major maintenance (e.g. column change)	RT width is ± times standard deviation for each analyte over a 24-hour period.	N.A.
	Initial Instrument Calibration (ICAL): Blank + 5 standards, lowest standard at or below PQL	Every 6 months or with each change in instrument operating conditions or equipment	1) Correlation coefficient ≥ 0.995 2) Recovery of lowest standard within 50%-150%	Correct problem and recalibrate
	Retention time window established for each analyte	Once per ICAL or at the beginning of each day of use	Position shall be set using the midpoint standard of the ICAL when ICAL is performed. On days when ICAL is not performed, the initial CCV is used.	N.A.
	Method blank	One per prep/analysis batch of 20 or fewer samples	No analyte detected ≥PQL(For DoD QSM, no analyte detected > ½ PQL and > 1/10 the amount measured in any sample).	(1) Investigate source of contamination (2) Report all sample results <PQL. (3) Report sample results >10X the blank result and flag results with a “B”. (4) Reanalyze all other samples associated with the failing blank. (5) For DoD QSM, problem must be corrected and samples reanalyzed. Flagging is only appropriate if samples cannot be reanalyzed.
	LCS/ICV	One per prep/analysis batch of 20 or fewer samples, prepared from a separate source than calibration standard	90%-110% Recovery	(1) If the ICV/LCS fails high, report samples that are <PQL. (2) Recalibrate and/or reanalyze other samples. (3) For DoD QSM, problem must be corrected and samples reanalyzed.

TABLE 1

QC REQUIREMENTS (Continued)

Parameter/ Method	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Anions by Ion Chromato-graphy / EPA Method 300.0 and SW846 Method 9056A	CCV	At beginning of run, after every 10 samples, and at end of run	(1) 90%-110% recovery. (2) All analytes within estabilished RT windows.	(1) If the CCV fails high, report samples that are <PQL. (2) Recalibrate and/or reanalyze samples back to last acceptable CCV recovery. (3) For DoD QSM, problem must be corrected and samples reanalyzed. Flagging is only appropriate if samples cannot be reanalyzed.
	CCB	Immediately following each CCV	No analyte detected ≥PQL	1) Investigate source of contamination (2) Report all sample results <PQL. (3) Report sample results >10X the blank result and flag results with a “B”. (4) Reanalyze all other samples associated with the failing CCB.
	Matrix Spike	One for every set of 10 samples (EPA 300.0) or one for every set of 20 samples (SW846 9056A)	90%-110% recovery (EPA 300.0) 80%-120% recovery (SW846 9056A)	(1) Evaluate the samples and associated QC: i.e. If the LCS results are acceptable, flag result and narrate. (2) If both the LCS and MS are unacceptable reprep and reanalyze the samples and QC. (3) Notate sample result in raw data if matrix interference suspected.
	Matrix Spike Duplicate	One per 20 samples	(1) 90%-110% recovery (EPA 300.0) 80%-120% recovery (SW846 9056A) (2) RPD ≤15%	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD still out, report original result with flagging and narration.
	Sample Duplicate	One per 20 samples (For DoD QSM, one per 10 samples)	RPD ≤20% (For DoD QSM, RPD ≤10%)	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD still out, report original result with flagging and narration.
	Demonstration of analyst proficiency; accuracy and precision	One time initially by each analyst performing the method and annually thereafter.	Must pass all applicable QC for method	Repeat analysis until able to perform passing QC; document successful performance in personnel training file
	MDL study	Refer to KAS SOP QA-806, “Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications”, current revision.		

TABLE 2

EXAMPLE ANALYTICAL SEQUENCE WITH ACCEPTANCE CRITERIA

Sample Number	Instrument Runlog	Acceptance Limit
1	CCV	90%-110%
2	CCB	< PQL
3	ICV / LCS	90 -110% (300.0) 80%-120% (9056A)
4	Sample 1	
5	Sample 2	
6	Sample 3	
7	Sample 4	
8	Sample 5	
9	Sample 6	
10	Sample 7	
11	Sample 8	
12	Sample 9 -Duplicate	20% RPD (10% for DoD)
13	Sample 10 - Matrix Spike	90 -110% (300.0) 80%-120% (9056A)
14	CCV	90%-110%
15	CCB	< PQL
16	Sample 11	
17	Sample 12	
18	Sample 13	
19	Sample 14	
20	Sample 15	
21	Sample 16	
22	Sample 17	
23	Sample 18	
24	Sample 19	
25	Sample 20 - Matrix Spike	90 -110% (300.0) 80%-120% (9056A)
26	CCV	90%-110%
27	CCB	< PQL

TABLE 3

SUMMARY OF METHOD MODIFICATIONS

Topic	Katahdin SOP CA-742-07	Method 300.0/9056, current revisions
Calibration	1) Calibration consists of blank + 5 standards 2) Linearity verified by performing calibration at least every 6 months, and diluting all samples exceeding calibration range	1) Calibration consists of blank + at least 3 standards 2) Linear range verification required every 6 months (Method 300.0)
QC – Method Blank	Acceptance limit < PQL	Acceptance limit <MDL (Method 300.0) Acceptance limit <10% of LLOQ or regulatory limit or lowest sample (Method 9056A)
QC – LCS/ICV	Combined LCS and ICV with tighter acceptance limits (90%-110% recovery)	LCS acceptance limits 80%-120%, ICV acceptance limits 90%-110% (Method 9056A)
QC – Duplicate / Matrix Spike Duplicate	RPD acceptance limit ≤20%.	RPD acceptance limit ≤15% for samples at or above midrange, ≤50% for samples near LLOQ (Method 9056A)

TITLE: ANIONS BY ION CHROMATOGRAPHY USING EPA METHOD 300.0 AND SW-846 9056

FIGURE 1

IC SYSTEM CONFIGURATION

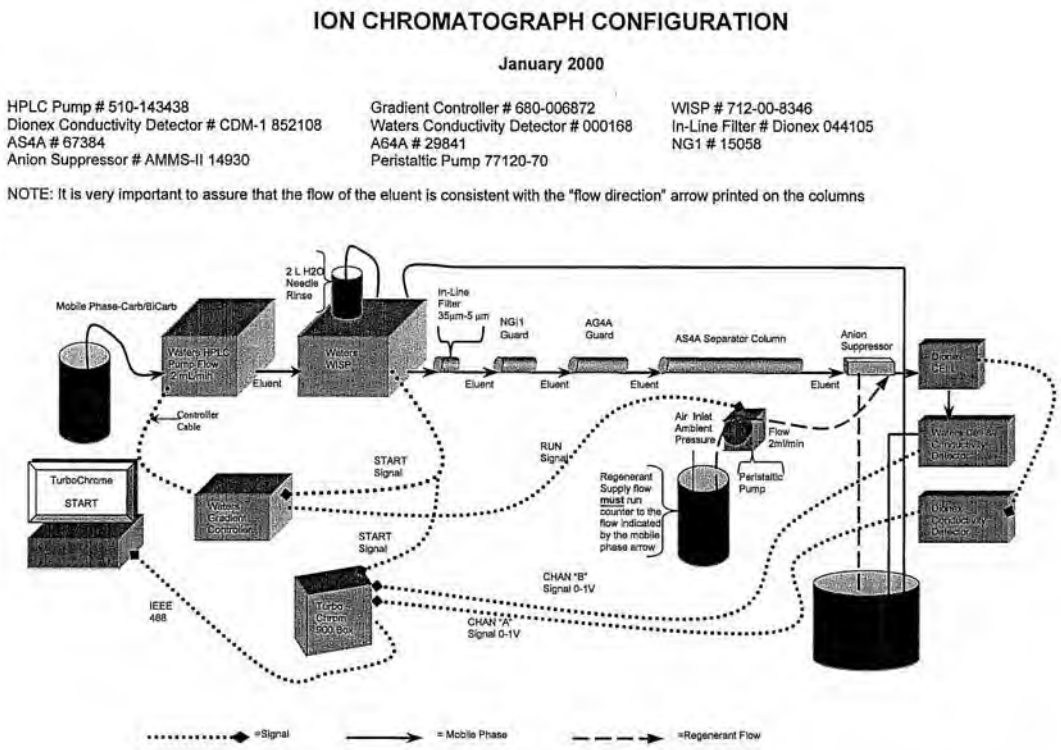


FIGURE 2

FIGURE 2

EXAMPLE IC MAINTENANCE LOG PAGE

KATAHDIN ANALYTICAL SERVICES, INC.
WATERS IC (ION CHROMATOGRAPHY) - MAINTENANCE LOGBOOK
SERIAL NO. 001457

DAILY INSTRUMENT PERFORMANCE

GRADIENT CONTROLLER/HPLC PUMP

ANIONS	SET AT 2 ML/MIN	☐	LINE PRESSURE	
PERCHLORATE	SET AT 1.0ML/MIN	☐		

WATERS DETECTOR - CHANNEL B

WATERS DETECTOR

DESCRIPTION	SETTING
BASE RANGE	
SENSITIVITY	

WATERS WISP

DESCRIPTION	SETTING
INJECTION VOLUME	
RUN TIME	

MAINTENANCE (AS NEEDED)

TASK	DATE	ANALYST	COMMENTS
Clean surfaces of system unit as needed.			
Check regenerate pump tubing & replace as needed.			
Clean or regenerate column as needed.			
Change analytical column as needed.			
Change guard column as needed.			
Change suppressor as needed.			

NON ROUTINE MAINTENANCE

Initials:_____Date:_____

Reviewed By:_____Date:_____

0000050

TITLE: ANIONS BY ION CHROMATOGRAPHY USING EPA METHOD 300.0 AND SW-846 9056

FIGURE 3

EXAMPLE OF ANIONS BY IC RUNLOG PAGE

KATAHDIN ANALYTICAL SERVICES, INC. - ION CHROMATOGRAPHY RUN LOG

METHODS – EPA 300.0 (E) SW846 9056 (S)						DATE OF LAST INITIAL CALIBRATION : 2/14/08			INSTR. ID.: IC01	
ANALYTES OF INTEREST						STANDARD	CONCENTRATION	PREPARATION	STANDARD CODE	
						IC CAL MIX	SEE FRONT COVER	SEE FRONT COVER	From Standards Log	W 7173
CL	NO2	BR	NO3	PO4	SO4	IC LCS MIX	SEE FRONT COVER	SEE FRONT COVER	From Standards Log	W 7174
✓	✓	✓	✓	✓	✓	ICV/CCV STD	CAL STD #2	SEE FRONT COVER	ICV plus Date	ICV MS W7175

Date	Init	Result File	Sample #	Method	Dilution	Accept ? Check Analytes (R = Rerun) CL	NO2	BR	NO3	PO4	SO4	Manual Integration? List Analytes	Comments
2/14/08	CP	FYB2048	IC1	E	1	✓	✓	✓	✓	✓	✓		
		49	IC2									Cl, NO2	
		50	IC3									Cl, NO2	
		51	IC4									All anions	
		52	ICS									Cl, NO3, NO2, Br	
		53	ICL6			✓	✓	✓	✓	✓	✓	All anions	
		54	Blank			✓	✓	✓	✓	✓	✓	All anions	~~Rerun Br for low~~ CP
		55	LCS		1	✓	✓	✓	✓	✓	✓	All anions	~~Rerun~~ CP
		56	CP ~~LCS~~ SB0570-8		1	R	R	R	R	✓	R	PO4	dilute
		57	CP ~~Blank~~ LCS SB0570-9		1		✓					NO2	
		58	SB0474-7		1					✓		PO4	
		59	SB0570-8DUP		1					✓		PO4	
		60	-8MS		1					✓			
		61	SB0570-8DUP		5	✓			✓		✓		
		62	-8MS CP		5	✓			✓		✓		
		63	SB0570-8 ~~DUP~~ MS		5	✓			✓		✓		
✓	✓	64	SB0570-8	F	10								-dilution not needed

REVIEWED BY [signature] ON 3/12/08

WG48859
R77295

QAWL465

0000044

TITLE: ANIONS BY ION CHROMATOGRAPHY USING EPA METHOD 300.0 AND SW-846 9056

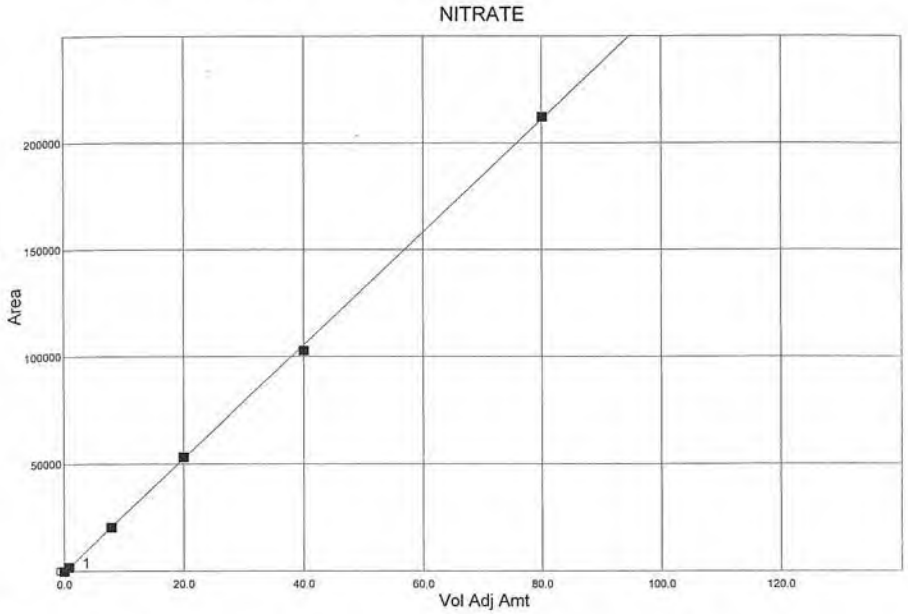
FIGURE 4

IC CALIBRATION CURVE

Fit Analysis Output For Method File: "W:\DATA\IC01\METHODS\EICC088.MTH"
Component Name: "NITRATE"
Date: 02/14/2008 Time: 05:11 PM

Curve Parameters:

Curve #1 : 1st Order - Incl Origin
Weighting Factor = 1.0 (No Weighting) r^2 = 0.999758
Calibration Curve = (-377.872938) + (2644.867657)X



Level Name	Observed X-Value	Calculated X-Value	Delta	%Diff.	Observed Y-Value	Calculated Y-Value	Delta	%Diff.
IC8	0.002000	0.142870	-0.140870	-98.600	0.000	-372.583	372.583	-100.00
IC5	0.800000	0.859919	-0.059919	-6.968	1896.500	1738.021	158.479	9.118
IC4	8.000000	7.920575	0.079425	1.003	20571.000	20781.068	-210.068	-1.011
IC3	20.000000	20.293468	-0.293468	-1.446	53295.663	52519.480	776.183	1.478
IC2	40.000000	39.016649	0.983351	2.520	102816.000	105416.833	-2600.833	-2.467
IC1	80.000000	80.425648	-0.425648	-0.529	212337.323	211211.540	1125.784	0.533

CP
2/14/08

TITLE: ANIONS BY ION CHROMATOGRAPHY USING EPA METHOD 300.0 AND SW-846 9056

FIGURE 5

IC BATCH SHEET

WET CHEMISTRY BATCH REPORT
Apr 16 2008, 09:01 am
Batch: WG50311

Parameter: Nitrate as N

Date Analyzed: 15-APR-08

Analyst Initials: AMB

Prep Date: N/A

Prep Method: N/A

Prep Chemist: N/A

Sample	Samp Type	Method	Initial Amt.	Final Amt.	Rpt. DF	Result	Rpt Result	TS(%)	PQL	MDL	Adj PQL	RPD	%Rec
SB1835-1	SAMP	SW846 9056	1.0000mL	1.0000mL	5	19.9079	19.3 mg/L	NA	.05	.058	.25		
WG50311-1	MBLANK	SW846 9056	1.0000mL	1.0000mL	1	.0147	U0.050 mg/L	NA	.05	.012	.05		
WG50311-2	LCS	SW846 9056	1.0000mL	1.0000mL	1	1.672	1.7 mg/L	NA	.05	.012	.05		99
WG50311-3	DUP	SW846 9056	1.0000mL	1.0000mL	5	18.8796	18.9 mg/L	NA	.05	.058	.25	5	
WG50311-4	MS	SW846 9056	1.0000mL	1.0000mL	10	25.885	25.9 mg/L	NA	.05	.12	.5		78

Comments:

WG50311-1	SB1835-1
WG50311-2	SB1835-1
WG50311-3	SB1835-1
WG50311-4	SB1835-1

Entered by: AMB Date: 4/16/08 Accepted by: [illegible] Date: 04/16/08

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

SOP Number: CA-763
Revision History
Cover Page
Page 1

TITLE: ANALYSIS OF TOC, DOC, AND TIC IN AQUEOUS SAMPLES USING THE SHIMADZU CARBON ANALYZER: EPA METHOD 415.1, SW846 9060 AND SM 5310B

Prepared By: Chad Delaney Date: 07.14.04

Approved By:

Department Manager: George Brewer Date: 07/14/04

Operations Manager: Deborah J. Nadeau Date: 7.14.04

QA Officer: Maria Crouch Date: 07.14.04

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01	Revised Title and text to incorporate analysis for Total Inorganic Carbon (TIC) minor changes throughout Updated Figures	LAD	04/06	04/06
02	Changed SM5310B to SM5310C throughout. Added reference to SW846 9060 throughout. Updated Figure 6. Updated Table 2 to include that we do not subtract the blank, from the sample.	LAD	03/07	03/07
03	Added LCS/ICV, CCV, and CCB definitions. Added calibration criteria. Added quadruplicate criteria for SW9060. Added repeat injection for SM 5310B. Added wording regarding SC criteria to Sect. 8. Changed CCV criteria to 90>~~100~~110% LAD	LAD	06/08	06/08
04	Updated reference from 9060 to 9060A. Sect. 7.9 - Changed C"npocAQ.met for TOC/DOC to C"doubleinject.met for TOC/DOC.	LAD	03/09	03/09
05	Added EHSM, QA-806, ~~subsampling~~, QA-801 DoD, NELAC & CA-101 references.	DM	08/09	08/09

TITLE: ANALYSIS OF TOC, DOC, AND TIC IN AQUEOUS SAMPLES USING THE SHIMADZU CARBON ANALYZER: EPA METHOD 415.1, SW846 9060 AND SM 5310B

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
06	Removed figures 1 and 2. Updated figures 2-4 (formally 4-6). Updated references.	LAD	06/10	06/10

TITLE: **ANALYSIS OF TOC, DOC, AND TIC IN AQUEOUS SAMPLES USING THE SHIMADZU CARBON ANALYZER: EPA METHOD 415.1, SW846 9060 AND SM 5310B**

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SOP CA-763-06** titled **Analysis of TOC, DOC, and TIC in Aqueous Samples using the Shimadzu Carbon Analyzer: EPA Method 415.1, SW846 9060 and SM5310B**.

Recipient: _____Date:_____

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SOP CA-763-06** titled **Analysis of TOC, DOC, and TIC in Aqueous Samples using the Shimadzu Carbon Analyzer: EPA Method 415.1, SW846 9060 and SM5310B**.

Recipient: _____Date:_____

TITLE: **ANALYSIS OF TOC, DOC, AND TIC IN AQUEOUS SAMPLES USING THE SHIMADZU CARBON ANALYZER: EPA METHOD 415.1, SW846 9060 AND SM 5310B**

1.0 SCOPE AND APPLICATION

The purpose of this SOP is to describe the procedures used by Katahdin Analytical Services, Inc. technical personnel for analyzing total organic carbon (TOC), dissolved organic carbon (DOC), and total inorganic carbon (TIC) in aqueous samples using the Shimadzu Carbon Analyzer in accordance with EPA method 415.1, SW846 9060A and SM 5310B.

This procedure applies to drinking and surface waters, domestic and industrial wastewater. The Practical Quantitation Limit (PQL) is 1 mg/L.

1.1 Definitions

Total Organic Carbon (TOC) – Carbon that is bound with hydrogen or oxygen in organic compounds, analyzed from an unfiltered sample.

Dissolved Organic Carbon (DOC) - Carbon that is bound with hydrogen or oxygen in organic compounds, analyzed from a filtered sample.

Total Inorganic Carbon (TIC) – Carbon contained in carbonates, hydrogen carbonates, or dissolved carbon dioxide.

Method Blank - A laboratory reagent grade water sample that is carried through the entire analytical procedure in the same manner as a sample.

LCS/ICV - Laboratory Control Sample/ Initial Calibration Verification. One LCS/ICV per batch is prepared from a separate source from the CCV and calibration curve standards. LCS/ICV verifies the calibration curve.

CCV - Continuing Calibration Verification. The CCV is made from the same source as the calibration. One CCV is run every ten samples.

CCB - Continuing Calibration Blank. The CCB is laboratory reagent grade water with no reagents added. One CCB is run every ten samples.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of, analysts experienced in the preparation and analysis of samples for TOC, DOC, and TIC using EPA Method 415.1, SW846 9060 and SM5310 B. Each analyst must demonstrate his/her ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability.”

It is the responsibility of all Katahdin technical personnel involved in the determination of TOC and DOC to read and understand this SOP, to adhere to the

procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to initiate periodic review of the associated logbooks.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method have not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with the Katahdin Analytical Environmental Health & Safety Manual including the Katahdin Hazardous Waste Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Program for further details on pollution prevention techniques.

Waste generated during the preparation and analysis of samples must be discarded appropriately. Place all analyzed samples, standards, and rinsings in a Satellite Waste “A” Acid for proper disposal in main waste area “A”.

Other wastes generated during the preparation of samples must be disposed of in adherence with the Katahdin Analytical Environmental Health & Safety Manual and SOP SD-903, Sample Disposal, current revision. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with this SOP SD-903.

TITLE: **ANALYSIS OF TOC, DOC, AND TIC IN AQUEOUS SAMPLES USING THE SHIMADZU CARBON ANALYZER: EPA METHOD 415.1, SW846 9060 AND SM 5310B**

2.0 SUMMARY OF METHOD

Organic carbon analysis – Sample is drawn into a syringe in the instrument, and hydrochloric acid is then drawn into the syringe to acidify the sample to pH 2 to 3. Oxygen is then bubbled through the acidified sample in the syringe to drive off the inorganic carbon component. The sparged sample is then introduced into the total carbon combustion tube, where it is heated to 680° C in the presence of an oxidation catalyst. The organic carbon remaining in the sample after sparging is converted to carbon dioxide during combustion. Carrier gas sweeps the sample combustion gases through an electronic dehumidifier, where they are cooled and dehydrated, and then through a halogen scrubber to remove chlorine and other halogens. Finally, the carrier gas delivers the combustion gases to the cell of a non-dispersive infrared (NDIR) gas analyzer, where carbon dioxide is detected and quantitated. The amount of carbon dioxide in a sample is directly proportional to the concentration of organic carbon (TOC or DOC) in the sample. Strictly speaking, this method measures non-purgeable organic carbon (NPOC), because purgeable (volatile) organic compounds are lost during sparging of the sample. However, the amount of purgeable organic compounds in natural waters is small, and NPOC is nearly equivalent to total organic carbon. When necessary, total organic carbon can be indirectly determined by measuring total carbon on an unsparged sample, measuring inorganic carbon on a separate aliquot of the sample, and calculating TOC by difference.

Inorganic carbon analysis – Inorganic carbon (IC) consists of the carbon contained in carbonates and in carbon dioxide dissolved in water. IC is measured by injecting an aliquot of unpreserved sample into the instrument's IC reaction vessel, where it is acidified with hydrochloric acid and inorganic carbon is converted to carbon dioxide. The carbon dioxide is then sparged from solution with oxygen and carried to the NDIR detector, where it is detected and quantitated.

3.0 INTERFERENCES

High salt samples can affect the oxidation rate, leading to low recoveries. Interference begins at ~0.1% total dissolved solids and becomes severe at > 0.35%.

4.0 APPARATUS AND MATERIALS

4.1 Shimadzu Carbon Analyzer Model TOC-V

4.2 Shimadzu carousel autosampler Model ASI-V

4.3 Glass 40 mL VOA Vials

4.4 Class A volumetric flasks (100 mL and 200 mL)

4.5 Adjustable pipets (0.1, 1.0 and 5.0 mL)

4.6 Oxygen gas

5.0 REAGENTS

NOTE: All standards and reagents should be prepared <u>daily</u> except where noted. Record all standard and reagent preparation in the appropriate logbook.

5.1 Phosphoric acid (H_3PO_4), concentrated, reagent grade.

5.2 Phosphoric acid (H_3PO_4), 1:1 – Slowly add 100 mL concentrated H_3PO_4 to 100 mL and mix. Prepare fresh every six months.

5.3 Hydrochloric acid (HCl), concentrated, reagent grade.

5.4 Hydrochloric acid (HCl), 2M – Slowly add 42.5 mL concentrated HCl to 200 mL of reagent water and bring to a final volume of 250 mL. Prepare fresh every six months.

5.5 Potassium hydrogen phthalate ($HOCOC_6H_4COOK$), primary standard grade. Two different lots of potassium hydrogen phthalate are required – one is used to prepare organic carbon calibration standards, and the other is used to prepare a laboratory control sample (second source).

5.6 Sodium carbonate (Na_2CO_3), 1 N – Purchased certified standard solution, inorganic carbon true value = 6000 mg/L. This solution is used to prepare the inorganic carbon stock standard and the alkalinity check standard.

5.7 Sodium carbonate (Na_2CO_3), anhydrous – ACS reagent grade. Store in a desiccator. This reagent is used to prepare the inorganic carbon laboratory control sample.

<u>Organic Carbon (OC) Standards</u>

5.8 OC Stock Standard (used in preparing OC calibration standards and CCV): Prepare a 2000 mg/L standard by dissolving 0.4250g of potassium hydrogen phthalate in 100 mL of laboratory reagent grade water. Add 0.10 mL of concentrated phosphoric acid. Stored in an amber bottle in the refrigerator, this solution may be used for three months.

5.9 OC Calibration Standards – Prepare a series of five calibration standards by diluting the OC Stock Standard with reagent water in accordance with the following table:

Calibration Std.	mL of OC Stock	Final Volume

Conc. (mg/L OC)	Std. Added	(mL)
1.0	0.10	200
5.0	0.50	200
20.0	2.0	200
50.0	5.0	200
200.0	20.0	200

5.10 OC CCV Standard - Prepare a 100 mg/L standard for the CCV by diluting 25 mL of the OC Stock Standard to 500 mL using laboratory reagent grade water. Stored in an amber bottle in the refrigerator, this solution may be used for three months.

5.11 OC Laboratory Control Sample (LCS) – Prepare a 50 mg/L standard from a different source from the calibration standards, as follows. Fill a 1 L volumetric flask half full with laboratory reagent grade water and add one mL of concentrated phosphoric acid as a preservative. Add 0.1062 g of potassium hydrogen phthalate and bring to a final volume of 1 L with laboratory reagent grade water. Stored in an amber bottle in the refrigerator, this solution may be used for three months.

5.12 OC Matrix Spike (MS) sample – OC matrix spike aliquots are prepared by adding 2.0 mL of OC Stock Standard to 38 mL of sample in a VOA vial. The added matrix spike concentration is 100 mg/L.

5.13 Alkalinity Check Sample - Prepare by diluting 2.5 mL of 1.0 N Na_2CO_3 to one liter with laboratory reagent grade water. The inorganic carbon content of this solution is 15 mg/L. This standard is used to monitor for false positives during OC analysis from incomplete removal of inorganic carbon.

<u>Inorganic Carbon (IC) Standards</u>

5.14 IC Stock Standard (used in preparing IC calibration standards and CCV): Prepare a 2000 mg/L standard by diluting 100 mL of 1 N Na_2CO_3 to a final volume of 300 mL in a graduated cylinder. Stored in a glass bottle in the refrigerator, this solution may be used for three months.

5.15 IC Calibration Standards – Prepare a series of five calibration standards by diluting the OC Stock Standard with reagent water in accordance with the following table:

Calibration Std. Conc. (mg/L IC)	mL of IC Stock Std. Added	Final Volume (mL)
1.0	0.10	200
5.0	0.50	200

20.0	2.0	200
50.0	5.0	200
200.0	20.0	200

5.16 IC CCV Standard - Prepare a 100 mg/L standard for the CCV by diluting 25 mL of the OC Stock Standard to 500 mL using laboratory reagent grade water. Stored in a glass bottle in the refrigerator, this solution may be used for three months.

5.17 IC Laboratory Control Sample (LCS) – Prepare a 50 mg/L standard from a different source from the calibration standards, as follows. Fill a 1 L volumetric flask half full with laboratory reagent grade water and add 0.4417 g of anhydrous sodium carbonate. Mix the solution until the sodium carbonate has dissolved, and bring to a final volume of 1 L with laboratory reagent grade water. Stored in a glass bottle in the refrigerator, this solution may be used for three months.

5.18 IC Matrix Spike (MS) sample – IC matrix spike aliquots are prepared by adding 2.0 mL of IC Stock Standard to 38 mL of sample in a VOA vial. The added matrix spike concentration is 100 mg/L.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Collect samples in glass jars or VOA vials. For organic carbon analysis, preserve with H_2SO_4 at time of collection and store at 4 (±2) °C prior to analysis. For inorganic carbon analysis, do not add acid to the sample, but store at <6 °C, without freezing, prior to analysis. The holding time for TOC, DOC, and IC analysis is 28 days from the time of collection.

If dissolved organic carbon (DOC) is to be determined, the sample must be filtered through a 0.45 micron glass fiber filter prior to preservation with H_2SO_4. If the sample has not been filtered in the field, sample log-in must inform the Inorganic Department Manager that samples need to be filtered upon receipt by the laboratory. Please refer to the current revision of Katahdin SOP SD-902, Sample Receipt and Internal Control, section 7.7.5, for further filtration procedures.

7.0 PROCEDURES

ANALYZER START-UP PROCEDURE

7.1 Turn on the TOC-V module, computer, and oxygen tank.

7.2 Fill rinse water reservoir with laboratory reagent grade water. Verify that there is sufficient room in the satellite waste container to contain the day's waste. Verify that the instrument's humidifier water level is between the "High" and "Low" lines**,** and add laboratory reagent grade water if needed. Also verify that the diution water, hydrochloric acid, and phosphoric acid reservoirs are full.

7.3 Carrier gas flow rate should be set at 150 mL/min. The oxygen pressure should read 200 kPa on the gauge inside the instrument.

7.4 From the main screen, double-click on the **TOC-Control V** icon.

7.5 Double-click the **Sample Table Editor** icon. Enter the User ID and Password.

7.6 At the menu bar, click on File , then click New. Double-click on the **Sample Run** icon.

7.7 Make certain that the System setting is set for "TOC-Vcph/ASI-V", then click OK.

7.8 Click on the **Connect (yellow lightning bolt)** icon to connect the computer to the instrument. Click "Use Settings on PC". This turns on the furnace inside the instrument, and turns on the gas flows. The furnace must be allowed to heat up for one half hour before beginning analysis.

SAMPLE ANALYSIS

7.9 At the menu bar, click on Insert, then click Auto Generate. Double-click on the appropriate method ("doubleinjection.met for TOC/DOC, "INORG CARB AQ.met" for inorganic carbon). Then click Next.

7.10 Enter the number of samples as "60" and the start vial as "5", then click Next.

7.11 At the Calibration Curve screen (Screen 3), click Next. You must verify the calibration curve is current (within three months of analysis) by going into the NPOC Method Menu. If the curve is more than three months old, a new curve must be run.

7.12 Click to put a checkmark in all three boxes (beside "At The Beginning", "After Every Ten Samples", and "At The End of Sample Group") under Quality Control.

7.13 Select (1) by clicking on the number (it will highlight the (1) in blue). Click Add. Then click "CCV". This inserts a CCV in autosampler position (1).

7.14 Repeat 7.13 for autosampler position (2), clicking "Blank", and then for autosampler position (3), clicking "LCS".

7.15 Click Finish.

7.16 You may bypass the vial selection screen at this time by clicking OK.

7.17 An autosampler table now appears on the screen. Fill in sample numbers in the "Sample Name" column. If a manual dilution has been performed on the sample in the VOA vial, enter the dilution factor in the "Dilution" column for each diluted sample.

7.18 Unneeded Quality Control and Sample rows may be deleted by selecting each row and then clicking the **Cut (scissors)** icon.

7.19 Print the autosampler table (Figure 1) by clicking File on the menu bar, then clicking Print, then clicking Table. Some of the autosampler positions listed will be incorrect, because the computer does not account for vials that are sampled twice (vials may be sampled twice for duplicate or matrix spike duplicate analysis). Write autosampler table corrections on the autosampler table printout. Using the corrected autosampler table for reference, place each sample vial in its appropriate position on the autosampler carousel. Matrix spikes are prepared by adding 2 mL of the OC or IC Stock Standard to a VOA vial and adding 40 mL of sample.

7.20 Place the autosampler carousel on the ASI auto sampler and replace the ASI cover.

7.21 Click the **Start (traffic light)** icon, the enter a data file name and click "Save". Data files are named according to the analyte (TOC or TIC), the matrix (AQ), and the date (MMDDYY format), e.g. "TOC_AQ_031505" for an aqueous TOC run performed on 03/15/05.

7.22 Click "Standby".

7.23 An image of the carousel will appear on the screen, along with a table listing the sample numbers and corresponding autosampler positions. Carefully enter the corrected autosampler positions in accordance with the previously printed list that was used to set up the autosampler carousel.

7.24 Click "OK".

7.25 The instrument will then run samples until it has finished with the programmed autosampler sequence.

ANALYTICAL QUALITY CONTROL

7.26 A calibration curve is analyzed as necessary but at least every 3 months. Standards are prepared as described in section 5. Acceptance criteria for the calibration is a 0.9950 correlation coefficient for the full curve including the blank. Operator discretion in approving or rejecting calibrations is encouraged. The decision and rational must be recorded in the instrument log.

A linear calibration applying a first order equation is used to prepare the curve. The equation is:

$$y = mx + b$$

where: y = Instrument response
m = Slope of the line
x = Concentration of the calibration standard
b = The intercept

Acceptance criterion is a 0.995 correlation coefficient or better.

7.27 An analytical batch consists of 20 or fewer field samples (not counting method blanks, laboratory control samples, duplicates, and matrix spikes).

7.28 The operating range of OC and IC analysis for a 150 uL sample injection is 0-200 mg/L. Samples with measured concentrations greater than 200 mg/L must be diluted and reanalyzed.

7.29 Each analytical sequence must start with analysis of a CCV, followed by analysis of a method blank consisting of laboratory reagent grade water. Analyze an second-source laboratory control sample (LCS) with each analytical batch.

7.30 Each TOC or DOC sample is sparged with oxygen to remove residual inorganic carbon. To check for sparging efficiency, analyze an alkalinity check standard near the beginning of each run.

7.31 Samples analyzed by Standard Methods 5310 B must be injected at least twice and have results within ± 10% of each other. If results are greater than ± 10%, the sample should be reinjected until consecutive measurements are within ± 10% of each other.

7.32 Samples analyzed by method SW846 9060 must be analyzed in quadruplicate

7.33 One matrix spike (MS) should be analyzed for every ten (or fewer) samples.

7.34 One sample in every batch of 20 or fewer samples must be analyzed in duplicate. Method SW9060 requires a sample in every batch of 20 or fewer samples be analyzed in quadruplicate.

DATA REVIEW AND REPORTING

7.35 After completion of analysis, instrument data files are imported electronically into the Katahdin Information Management System (KIMS) for calculation and reporting of sample results and quality control samples. After data processing by KIMS, a batch

sheet (Figure 3) listing Katahdin Sample Numbers with associated reported results and associated quality control data is printed out of KIMS for each analytical batch. Refer to the current revision of SOP CA-762 ("Wet Chemistry Data Entry and Review Using Katahdin Information Management System") for further information.

7.36 Analytical data are stored in the instrument's computer during analysis, and data reports are printed after each analytical run has been completed. The instrument data printout shows the signal versus run time plot that was obtained for each sample, as well as the peak area and measured concentration, the dilution factor, and the analysis date and time. A run data summary table (Figure 2) is also printed out from the instrument, containing all of this information except peak plots in analysis order. Copies of the run data summary tables are bound in the Aqueous Carbon Analysis Run Logbook.

7.37 A Carbon Analysis Run Information Sheet (Figure 4) is completed by the analyst for each analytical run. This form lists the analysis methods, dates, and times, calibration information, and the standard IDs for each standard used in the run.

7.38 The raw data package for each analytical run is assembled by the analyst, and consists of the following information (in the order listed):

- KIMS batch sheets (Figure 3) for each batch contained in the run
- The Carbon Analysis Run Information Sheet (Figure 4)
- The run data summary table (Figure 2)
- The raw data printouts which include peak plots
- Associated calibration data

7.39 All raw data packages are stored on site for at least three months, and are subsequently stored off site by the laboratory.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

See below and refer to Table 1 for a summary of QC requirements, acceptance criteria, and corrective actions. These criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific judgments. These decisions are based on holding time considerations and client and project specific Data

Quality Objectives. The Department Manager, Operations Manager, and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases "qualified" data with narration may be advisable after consultation with the client.

In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP), in a program specific Quality Systems Manual (QSM) or in state specific criteria. The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

INITIAL DEMONSTRATION OF PERFORMANCE

8.1 Method detection limits (MDL) are determined annually for each analyte analyzed by each method on each instrument. This determination requires at least seven replicate digestions and analyses of reagent water spiked at 3-5 times the anticipated MDL for each analyte. The standard deviation of the 7 (or more) replicate analyses is multiplied by the Student's t-value to obtain the MDL. For more information on performing MDL determinations, refer to the current revision of Katahdin SOP QA-806.

ANALYTICAL RUN QC SAMPLES

8.2 A Continuing Calibration Verification (CCV) standard is analyzed for each analyte after every ten samples and at the end of the analytical run. The CCV solution is as described in Section 5. Results of the CCVs must fall within 90% to 110% of the expected value. If a CCV fails, sample results that are associated with (bracketed by) the failing CCV may not be reported from the run. The samples must be reanalyzed after the problem is corrected and a passing CCV has been analyzed.

8.3 A Continuing Calibration Blank (CCB) consisting of reagent water is analyzed after each CCV. The absolute values of results of CCBs must be less than the Practical Quantitation Level (PQL) for each analyte. If a CCB fails, sample results that are associated with (bracketed by) the failing CCB may not be reported from the run, with the following exception. If the absolute value of a result for a CCB is greater than the PQL, sample results that are less than the PQL or greater than or equal to ten times the measured CCB concentration may be reported. All other samples must be reanalyzed after the problem is corrected and a passing CCB has been analyzed.

8.4 An Alkalinity Check Sample, prepared as described in Section 5.13, is analyzed in each TOC and DOC run. This sample is used to monitor for false positives during OC analysis from incomplete removal of inorganic carbon. The absolute value of results of the Alkalinity Check Sample must be less than the Practical Quantitation Level (PQL) for each analyte. If the Alkalinity Check Sample fails, associated sample results may not be reported from the run. The samples must be reanalyzed after the problem is corrected and a passing Alkalinity Check has been analyzed.

BATCH QC SAMPLES

8.5 A Method Blank, consisting of reagent water, is analyzed with each batch of twenty or fewer samples. The results of method blanks must be less than the Practical Quantitation Level (PQL) for each analyte. If a method blank fails, results for associated samples may not be reported from the batch, with the following exception. If the result for a method blank is greater than the PQL, associated sample results that are greater than or equal to ten times the measured preparation blank concentration may be reported with “B” notation. Associated sample results that are less than the PQL may be reported with no additional notation.

8.6 A laboratory control sample (LCS), prepared as described in Section 5, is analyzed with each batch of twenty or fewer samples. The LCS recovery must be 80-120% for USEPA Method 415.1 and SW846 9060. The LCS recovery must be 90-110% for SM5310B. If a laboratory control sample fails, results for the associated samples may not be reported from the batch, and the samples must be reanalyzed, with the following exception: if the LCS recovery is greater than the upper acceptance limit, samples with measured concentrations below the PQL may be reported with appropriate narration.

MATRIX QC SAMPLES

8.7 Duplicate samples are analyzed at a minimum frequency of one per batch of 20 or fewer samples. The relative percent difference (RPD) between duplicate sample results is calculated as follows:

$$\text{RPD (\%)} = \frac{|D_1 - D_2|}{(|D_1 + D_2|)/2} \times 100$$

where: D_1 = First sample result
D_2 = Second (duplicate) sample result

A control limit of 20% RPD is applied to duplicate analysis. If the matrix duplicate analysis fails, the associated sample result must be flagged on the report of analysis.

8.8 Matrix spiked samples are prepared at a minimum frequency of one per 10 samples. The recovery for each element in a spiked sample must fall within 75%-125% for USEPA Method 415.1 and SW846 9060 or 80%-120% for SM 5310B if the result for the unspiked sample is less than four times the amount of spike added. If a recovery fails, the associated sample result must be flagged on the report of analysis. The spike recovery should be calculated as follows:

$$\text{Recovery (\%)} = \frac{S-U}{SA} * 100\%$$

where: S = Measured concentration of spiked aliquot
U = Measured concentration of unspiked aliquot
SA = Amount of spike added

9.0 METHOD PERFORMANCE

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDLs are determined and filed with the Inorganic Department Manager and with the QAO. Refer to the current revision of Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, for procedures on determining the MDL.

Refer to the current revision of USEPA Method 415.1, SW846 9060 and SM5310B for other method performance parameters and requirements.

10.0 APPLICABLE DOCUMENTS/REFERENCES

EPA Method 415.1 “Methods for Chemical Analysis of Water and Wastes”, EPA 600/4-79-020, Revised March, 1983.

“Test Methods for the Evaluation of Solid Waste: Physical/Chemical Methods”, SW-846, third Edition, Final Update IIIB, November, 2004, Method 9060A.

"Standard Methods for the Examination of Water and Wastewater", 18th edition, 1992, APHA-AWWA-WPCF, Method 5310 B.

Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Version 4.1, 04/22/09.

The National Environmental Laboratory Accreditation Conference (NELAC) Standards, June 2003.

TITLE: **ANALYSIS OF TOC, DOC, AND TIC IN AQUEOUS SAMPLES USING THE SHIMADZU CARBON ANALYZER: EPA METHOD 415.1, SW846 9060 AND SM 5310B**

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision.

Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, current revision.

LIST OF TABLES AND FIGURES

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Table 2 Summary of Method Modifications
Figure 1 Example of Autosampler Table
Figure 2 Example of Run Data Summary Table
Figure 3 Example of TOC Batch Sheet (from KIMS)
Figure 4 Example of Carbon Analysis Run Information Sheet

TITLE: **ANALYSIS OF TOC, DOC, AND TIC IN AQUEOUS SAMPLES USING THE SHIMADZU CARBON ANALYZER: EPA METHOD 415.1, SW846 9060 AND SM 5310B**

TABLE 1

QC REQUIREMENTS

Analytical Method/ Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
EPA 415.1 SW846 9060A & SM 5310B TOC/TIC/ DOC	Initial Calibration (including five standards plus blank)	At a minimum every 3 months or as necessary	Linear Regression Correlation Coefficient ≥0.995	(1) Investigate source of problem (2) Recalibrate
	Continuing Calibration Verification (CCV)	At beginning of run, after every 10 samples, and at end of run.	90%-110% of true value	Reanalyze all associated samples.
	Continuing Calibration Blank (CCB)	After every CCV	Absolute value <PQL	1) If sample result < PQL, or >10x measured CCB value, report result 2) Else, reanalyze
	Method blank	One per analytical batch of 20 or fewer samples	No analyte detected >PQL	(1) Investigate source of contamination (2) Evaluate the samples and associated QC: i.e. If the blank results are above the PQL, report sample results which are <PQL or > 10X the blank concentration. Otherwise, reprep a blank and the remaining samples.
	Laboratory control sample (LCS)	One LCS per analytical batch of 20 or fewer samples	80%-120% for EPA 415.1 and SW846 9060 90%-110% for SM5310B	(1) Investigate source of problem. (2) If the LCS recovery is high but the sample results are <PQL, narrate. Otherwise, reprep the LCS and reanalyze the remaining samples.
	Matrix spike	One MS per ten samples	75%-125% for EPA 415.1 and SW846 9060 80%-120% for SM5310B	If LCS in criteria and matrix interference suspected, flag data
	Sample Duplicate	One sample duplicate per twenty samples	RPD ≤ 20	If lab QC in criteria and matrix interference suspected, flag data
	Initial demonstration of performance (4 replicate analyses of LCS)	Once per analyst per year	Precision and accuracy within method acceptance limits	Correct problem and repeat initial demonstration of performance
	MDL study and/or LOD and LOQ verifications.	Refer to KAS SOP QA-806, "Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications", current revision.		

TITLE: **ANALYSIS OF TOC, DOC, AND TIC IN AQUEOUS SAMPLES USING THE SHIMADZU CARBON ANALYZER: EPA METHOD 415.1, SW846 9060 AND SM 5310B**

TABLE 2

SUMMARY OF METHOD MODIFICATIONS

TOPIC	KATAHDIN SOP CA-763-06	METHODS 415.1, SW846 9060 and SM5310B, current revisions
Apparatus/Materials	None	
Reagents	None	
Sample preservation/ handling	None	
Procedures	None	
QC – Blanks	Blank Subtraction not performed	Method SM5310B requires subtraction of method blank concentration from results for associated samples.
QC - Spikes	None	
QC - LCS	None	
QC - Accuracy/Precision	None	
QC - MDL	None	

TITLE: **ANALYSIS OF TOC, DOC, AND TIC IN AQUEOUS SAMPLES USING THE SHIMADZU CARBON ANALYZER: EPA METHOD 415.1, SW846 9060 AND SM 5310B**

FIGURE 1

EXAMPLE OF AUTOSAMPLER TABLE

	Type	Analysis	Sample Name	Dilution	Comment	Vial
1	Control	NPOC	blank	1.000		1
2	Control	NPOC	ccv	1.000		2
3	Control	NPOC	lcs	1.000		3
4	Unknown	NPOC	alkalinity check	1.000		4
5	Unknown	NPOC	ALKALINITY	1.000		4
6	Unknown	NPOC	WW1798-1	1.000		5
7	Unknown	NPOC	WW1798-1DUP	1.000		5
8	Unknown	NPOC	WW1798-1MS	1.000		6
9	Unknown	NPOC	WW1590-1	1.000		7
10	Unknown	NPOC	WW1501-12	1.000		8
11	Unknown	NPOC	WW1719-5	1.000		9
12	Unknown	NPOC	WW1719-6	10.00		10
13	Unknown	NPOC	WW1719-7	1.000		11
14	Unknown	NPOC	WW1719-8	1.000		12
15	Unknown	NPOC	WW1725-1	1.000		13
16	Control	NPOC	blank	1.000		1
17	Control	NPOC	ccv	1.000		2
18	Unknown	NPOC	WW1725-2	1.000		14
19	Unknown	NPOC	WW1725-3	1.000		15
20	Unknown	NPOC	WW1725-4	1.000		16
21	Unknown	NPOC	WW1725-5	1.000		17
22	Unknown	NPOC	WW1725-6	1.000		18
23	Unknown	NPOC	WW1725-7	1.000		19
24	Unknown	NPOC	WW1725-8	1.000		20
25	Unknown	NPOC	WW1725-9	1.000		21
26	Unknown	NPOC	WW1725-10	1.000		22
27	Unknown	NPOC	WW1725-11	1.000		23
28	Control	NPOC	blank	1.000		1
29	Control	NPOC	ccv	1.000		2
30	Unknown	NPOC	WW1725-12	1.000		24
31	Unknown	NPOC	WW1798-2	1.000		25
32	Unknown	NPOC	WW1798-2MS	1.000		26
33	Control	NPOC	blank	1.000		27
34	Control	NPOC	ccv	1.000		28

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TITLE: **ANALYSIS OF TOC, DOC, AND TIC IN AQUEOUS SAMPLES USING THE SHIMADZU CARBON ANALYZER: EPA METHOD 415.1, SW846 9060 AND SM 5310B**

FIGURE 2

EXAMPLE OF RUN DATA SUMMARY TABLE

	Typ	Ana	Sample Name	Diluti	Result	Comment	Date / Time	Vial
1	Con	NP	BLANK	1.00	NPOC:0.000 mg/L		05/07/10 08:37:03 AM	2
2	Con	NP	BLANK	1.00	NPOC:0.000 mg/L		05/07/10 08:45:56 AM	2
3	Con	NP	BLANK	1.00	NPOC:0.000 mg/L		05/07/10 08:54:49 AM	2
4	Con	NP	CCV	1.00	NPOC:102.9 mg/L		05/07/10 09:15:42 AM	1
5	Unk	NP	LFB	1.00	NPOC:1.078 mg/L		05/07/10 09:27:59 AM	5
6	Con	NP	BLANK	1.00	NPOC:0.000 mg/L		05/07/10 09:39:07 AM	2
7	Con	NP	ALK CHECK	1.00	NPOC:22.49 mg/L		05/07/10 09:52:11 AM	4
8	Con	NP	ALK CHECK	1.00	NPOC:0.4115 mg/L		05/07/10 10:12:38 AM	4
9	Con	NP	BLANK	1.00	NPOC:0.000 mg/L		05/07/10 10:23:46 AM	2
10	Con	NP	LCS	1.00	NPOC:52.19 mg/L		05/07/10 10:38:18 AM	3
11	Unk	NP	SD2145-2	1.00	NPOC:64.21 mg/L		05/07/10 11:04:12 AM	6
12	Unk	NP	SD2145-2	1.00	NPOC:64.35 mg/L		05/07/10 11:17:00 AM	6
13	Unk	NP	SD2145-2M	1.00	NPOC:160.6 mg/L		05/07/10 11:32:19 AM	7
14	Unk	NP	SD2145-2MS	1.00	NPOC:159.8 mg/L		05/07/10 11:45:34 AM	7
15	Unk	NP	SD2145-3	1.00	NPOC:1.265 mg/L		05/07/10 11:57:36 AM	8
16	Unk	NP	SD2145-3	1.00	NPOC:1.139 mg/L		05/07/10 12:07:47 PM	8
17	Unk	NP	SD2145-4	1.00	NPOC:8.423 mg/L		05/07/10 12:20:56 PM	9
18	Unk	NP	SD2145-4	1.00	NPOC:8.437 mg/L		05/07/10 12:32:05 PM	9
19	Unk	NP	SD2145-5	1.00	NPOC:50.49 mg/L		05/07/10 12:46:07 PM	10
20	Unk	NP	SD2145-5	1.00	NPOC:50.33 mg/L		05/07/10 12:58:08 PM	10
21	Con	NP	CCV	1.00	NPOC:100.5 mg/L		05/07/10 01:13:21 PM	1
22	Unk	NP	LFB	1.00	NPOC:1.168 mg/L		05/07/10 01:25:38 PM	5
23	Con	NP	BLANK	1.00	NPOC:0.000 mg/L		05/07/10 01:36:47 PM	2
24	Unk	NP	SD2145-6	1.00	NPOC:0.8219 mg/L		05/07/10 01:48:49 PM	11
25	Unk	NP	SD2145-6	1.00	NPOC:0.7910 mg/L		05/07/10 01:58:45 PM	11
26	Unk	NP	SD2145-6MS	1.00	NPOC:98.96 mg/L		05/07/10 02:13:40 PM	12
27	Unk	NP	SD2145-6MS	1.00	NPOC:97.77 mg/L		05/07/10 02:26:25 PM	12
28	Unk	NP	SD2145-7	1.00	NPOC:9.466 mg/L		05/07/10 02:39:37 PM	13
29	Unk	NP	SD2145-7	1.00	NPOC:9.542 mg/L		05/07/10 02:50:58 PM	13
30	Unk	NP	SD2145-8	1.00	NPOC:1.533 mg/L		05/07/10 03:03:14 PM	14
31	Unk	NP	SD2145-8	1.00	NPOC:1.497 mg/L		05/07/10 03:13:20 PM	14
32	Unk	NP	SD2145-9	1.00	NPOC:50.03 mg/L		05/07/10 03:27:35 PM	15
33	Unk	NP	SD2145-9	1.00	NPOC:50.05 mg/L		05/07/10 03:39:46 PM	15
34	Con	NP	CCV	1.00	NPOC:100.5 mg/L		05/07/10 03:54:58 PM	1
35	Unk	NP	LFB	1.00	NPOC:1.156 mg/L		05/07/10 04:07:13 PM	5
36	Con	NP	BLANK	1.00	NPOC:0.000 mg/L		05/07/10 04:18:23 PM	2
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TITLE: **ANALYSIS OF TOC, DOC, AND TIC IN AQUEOUS SAMPLES USING THE SHIMADZU CARBON ANALYZER: EPA METHOD 415.1, SW846 9060 AND SM 5310B**

FIGURE 3

EXAMPLE OF TOC BATCH SHEET (FROM KIMS)

WET CHEMISTRY BATCH REPORT
May 07 2010, 04:55 pm
Batch: WG77219

Parameter: Total Organic Carbon (1)

Date Analyzed: 07-MAY-10

Analyst Initials: CP

Prep Date: N/A

Prep Method: N/A

Prep Chemist: N/A

Sample	Samp Type	Method	Initial Amt.	Final Amt.	Rpt. DF	Result	Rpt Result	TS(%)	PQL	MDL	Adj PQL	RPD	%Rec
SD2145-2	SAMP	EPA 415.1	20mL	20mL	1	64.21	64. mg/L	NA	1	.1	1		
SD2145-3	SAMP	EPA 415.1	20mL	20mL	1	1.265	1.3 mg/L	NA	1	.1	1		
SD2145-4	SAMP	EPA 415.1	20mL	20mL	1	8.423	8.4 mg/L	NA	1	.1	1		
SD2145-5	SAMP	EPA 415.1	20mL	20mL	1	50.49	50. mg/L	NA	1	.1	1		
SD2145-6	SAMP	EPA 415.1	20mL	20mL	1	.8219	J0.82 mg/L	NA	1	.1	1		
SD2145-7	SAMP	EPA 415.1	20mL	20mL	1	9.466	9.5 mg/L	NA	1	.1	1		
SD2145-8	SAMP	EPA 415.1	20mL	20mL	1	1.533	1.5 mg/L	NA	1	.1	1		
SD2145-9	SAMP	EPA 415.1	20mL	20mL	1	50.03	50. mg/L	NA	1	.1	1		
WG77219-1	MBLANK	EPA 415.1	20.000mL	20.000mL	1	0	U1.0 mg/L	NA	1	.1023	1		
WG77219-2	LCS	EPA 415.1	20.000mL	20.000mL	1	52.19	52. mg/L	NA	1	.1023	1		104
WG77219-3	MS	EPA 415.1	20.000mL	20.000mL	1	160.6	160 mg/L	NA	1	.1023	1		96
WG77219-4	MS	EPA 415.1	20.000mL	20.000mL	1	98.96	99. mg/L	NA	1	.1023	1		98
WG77219-5	MSD	EPA 415.1	20.000mL	20.000mL	1	97.77	98. mg/L	NA	1	.1023	1	1	97

Comments:

SD2145-2	rpt as mg/L
SD2145-6	MS/MSD
WG77219-1	SD2145-2
WG77219-2	SD2145-2
WG77219-3	SD2145-2
WG77219-4	SD2145-6
WG77219-5	SD2145-6

Entered by: CP Date: 5/7/10 Accepted by: [illegible] Date: 05/10/10

TITLE: **ANALYSIS OF TOC, DOC, AND TIC IN AQUEOUS SAMPLES USING THE SHIMADZU CARBON ANALYZER: EPA METHOD 415.1, SW846 9060 AND SM 5310B**

FIGURE 4

EXAMPLE OF CARBON ANALYSIS RUN INFORMATION SHEET

KATAHDIN ANALYTICAL SERVICES, INC.
CARBON ANALYSIS RUN INFORMATION SHEET

INSTR. ID: WC2 (Shimadzu TOC-V_{CPH}) ANALYST: CP DATE: 5/7/10

FILE NAME: TOC050710 METHOD(S): TOC DOC TIC

TOC	DOC	TIC
EPA 415.1	EPA 415.1	EPA 415.1
SM5310B	SM5310B	SM5310B

CALIBRATION DATE: 2/22/10 CALIBRATION ANALYST: CP

Calibration standards were prepared by performing dilutions of the following standard on the day of calibration:

Calibration Source Standard ID	Prep Date	Expiration Date	Standard Conc. (mg/L)
W8811	1/26/10	4/26/10	2000ppm

Note: Calibration must be performed quarterly or whenever a change in analysis conditions warrant. A copy of the associated calibration data is attached to this run.

STANDARDS USED:

Standard Name	Standard ID	Prep Date	Expiration Date	Standard Conc.
CCV	W9001	4/10/10	7/10/10	100 mg C/L
LCS	W8922	3/18/10	6/18/10	50 mg C/L
MS Stock Std. *	W9000	4/10/10	7/10/10	2000 mg C/L
Alkalinity Check	W81081	12/3/09	10/31/10	15 mg/L (Inorg. C)

* Matrix spikes are prepared by adding 2.0 mL of MS Stock Std. to 38 mL of sample.

Additional Comments and Notes:

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

SOP Number: SD-902
Revision History
Cover Page
Page 1

TITLE: **SAMPLE RECEIPT AND INTERNAL CONTROL**

Prepared By: Andrea Colby Date: 6/2002

Approved By:

Group Supervisor: Andrea Colby Date: 6/6/02

Lab Operations Mgr: Jol C. Burton Date: 6/5/02

QA Officer: Deborah J. Nadeau Date: 6.6.02

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
04	Changed cover sheet, minor changes to sections 7.1, 7.6 7.7.4, 7.10 + 7.20. Complete rewrite of sections 7.11 + 7.12 to comply with new KIMS	DN	6.6.02	6.6.02
05	Added verbal date entry to KIMS. Added reference to immediate internal COC book. Added Department Manager reference. Added section 7.7.3. Updated new incoming	DN	05.04	05.04
06	Added procedure + logbook page for checking turbidity of drinking water samples. Changed wet chem shorts board to a book (included example page). Added custody procedures for food/micro. Added VOA soil freezer storage.	DN	01.26.04	01.26.04
07	Added instructions to create lettered labels. Changed sample locations to reflect new building. Removed Figures 8 and 10. Updated Table and Figures w/ current ones. Added wording to Sect. 7.7.5 to clarify how pH measurements are taken.	LAD	02/07	02/07
08	Added summary stating sample acceptance policy. Deleted all references to radiation checks (not performed). Add IR gun usage. Reorganized section 7.0 to prioritize time sensitive tasks. Added wireless thermometer monitoring. Updated SRCR. Other minor changes.	DN	05/09 08/09 8.4.09	05/09 08/09

Added section concerning locking of coolers. Added more detail to 7.18 on unique container IDs. Added more detail on immediate COCs + a section on retention of samples.

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SD-902-08**, titled **Sample Receipt and Internal Control**.

Recipient: _____Date:_____

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SD-902-08**, titled **Sample Receipt and Internal Control**.

Recipient: _____Date:_____

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

1.0 SCOPE AND APPLICATION

Katahdin Analytical Services, Inc. requires the use of specific receiving, acceptance, identification, storage, and distribution procedures for samples it accepts for analyses. These procedures assure that:

- samples are uniquely identified,
- samples are protected from loss or damage,
- essential sample characteristics are preserved,
- any alteration of samples (e.g., filtration, preservation) is documented,
- the correct samples are analyzed, and
- a record of continuous sample custody and utilization is established.

The purpose of this SOP is to describe the procedures used for the receipt and tracking of samples received by Katahdin Analytical Services, Inc. (Katahdin).

1.1 Definitions

SDG: Sample Delivery Group – A group of samples to be reported as one data package.

1.2 Responsibilities

It is the responsibility of all Katahdin staff who receive samples or handle samples in the course of analysis to follow the procedures set forth in this SOP, to document their understanding of the procedures in their training files (refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability”), and to suggest changes and revisions when appropriate. All technical staff are responsible for monitoring their immediate areas, stopping an activity when a problem is detected or suspected, initiating corrective action when needed, documenting any actions taken, and notifying the appropriate individual (e.g., Department Manager, Operations Manager, QAO). The primary responsibility for implementing real-time corrective actions and maintaining an effective QA self-inspection system resides with Katahdin staff. When problems are identified Katahdin personnel are expected to attempt to resolve situations within the scope of their technical knowledge, and to seek assistance from peers and the Department Manager as necessary.

It is the responsibility of Department Managers to oversee the adherence to Katahdin QC practices and internal documentation of laboratory activities within their area, to take corrective actions where needed and communicate problems to the Operations Manager, QAO or Vice President/President when warranted.

It is the responsibility of the Operations Manager to oversee adherence to Katahdin QA/QC practices by all laboratory groups under his/her authority, to help identify

problems and assure resolution, to facilitate corrective action where needed, and to communicate problems and concerns to the QAO and Vice President/President.

It is the responsibility of the Quality Assurance Officer (QAO) to oversee adherence to this SOP, to conduct periodic audits of each laboratory, to track corrective action reports, resolution, and documentation, and to communicate concerns and report findings to the Vice President/President. The QA Officer shall function independently from laboratory operations and be able to evaluate data objectively and perform assessments without outside influence. The QA Officer has the authority to independently halt production operations (including data reporting) if warranted by quality problems.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical safety procedures and the Katahdin Environmental Health & Safety Manual and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Program for further details on pollution prevention techniques.

Wastes generated during the receipt of samples must be disposed of in accordance with the Katahdin Environmental Health & Safety Manual and SOPs SD-903, “Sample Disposal” and CA-107, “The Management of Hazardous Waste as it Relates to the Disposal of Laboratory Process Waste, Reagents, Solvents and

Standards,” current revisions. Expired standards are placed in the Katahdin hazardous waste storage area, and disposed of in accordance with these SOPs.

2.0 SUMMARY OF METHOD

Regulatory, program, and/or method requirements dictate the specifics of sample acceptance. These requirements include, but are not limited to, temperature upon receipt, chemical preservation, container type, sample amount, holding time considerations and complete and accurate documentation of all of these conditions, as well as sample identification. Katahdin's sample acceptance policy is to note any anomalies, discrepancies or non-compliances concerning the receipt of samples. The client is always notified with these issues to direct Katahdin on how and whether to proceed with analysis. All guidance from the client is recorded in the project phone logs and/or on the Sample Receipt Condition Report, which becomes part of the final report. Conditions or analyses performed which do not meet the necessary requirements are narrated or notated as described in the individual analytical SOPs.

3.0 INTERFERENCES

Not applicable.

4.0 APPARATUS AND MATERIALS

4.1 Thermometer – Oakton® Non-Contact Infrared Thermometer, or equivalent, capable of reading 0.1°C and digital probe style capable of reading 0.1°C (used for back-up).

4.2 Capillary tubes – 75 mm Hematocrit Tubes, disposable

4.3 Wide range pH test strips, pH 0 to 14 pH, EMD ColorpHast or equivalent.

4.4 Narrow range pH test strips, pH 0 to 2.5 pH, EMD ColorpHast or equivalent.

4.5 Narrow range pH test strips, pH 11 to 13 pH, EMD ColorpHast or equivalent.

5.0 REAGENTS

Preservatives - refer to Table 1, Sampling and Preservation Requirements, for specifics.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Refer to Table 1, Sampling and Preservation Requirements, for specifics.

7.0 PROCEDURES

PROCEDURES FOR SAMPLE CUSTODIAN

The following procedures include all steps to be completed for satisfactory receipt and acceptance of samples at Katahdin. These steps do not necessarily have to be performed in the exact order as described. Sample deliveries occur constantly throughout the day, so the sample custodian must multi-task and move back and forth between different procedures to accomplish the most critical tasks of checking receipt temperatures and checking for "RUSH" or quick hold time parameters.

7.1 When samples (except for non-environmental food samples) are dropped off, by either a delivery service (i.e. FEDEX or UPS) or by the client, the Chain-of-Custody (COC) should be signed immediately. The client (who is delivering or that has shipped samples with a delivery service) shall sign (at the lab upon delivery or prior to shipment of samples) that they have relinquished custody to the laboratory. The laboratory shall sign and record the date and time that custody is accepted. (Refer to Figures 1-3 for a Katahdin standard COC, a Katahdin Homeowner COC, and a Katahdin Food/Microbiology COC).

7.2 Cut custody seals and open all coolers. Remove the packets containing the client Chains-of-Custody (COCs).

7.3 Using the COCs, enter the date and time of sample receipt and the client name into the next available work order/login number in the sample receipt logbook (Figure 4). Initial each entry (line) to maintain a record of the individual who assigned each group of samples a discreet lab work order/login number. Record the assigned work order numbers in the appropriate space on the client COCs. Complete the log-in entry date and time once samples are logged in as described below.

7.4 Inventory the COCs for any "RUSH" or quick hold time analyses. Notify the appropriate section managers of these analyses. List any samples for analyses that have short hold times in the "Wet Chemistry Shorts and Rushes Logbook" (Figure 5) in the wet chemistry laboratory. Be sure to list the client, number of samples and date and time of the earliest sample. GC or GC/MS personnel must be informed when ENCORES are received so that they may be scheduled for extrusion. Microbiology personnel should also be informed of any microbiology samples that arrive. Parameters that routinely require short analytical hold times are:

Coliforms	Color	pH
Nitrate/Nitrite	Dissolved Oxygen	Turbidity
Ferrous iron	Orthophosphate	Hex. Chromium
MBAS	TBOD	Free CO_2
Sulfite	ENCORE soil samples	Settleable Solids
Odor	Residual Chlorine	CBOD

7.5 Inspect the condition of custody seals, cooler, ice condition and samples received. Note any non-intact conditions on the Sample Receipt Condition Report (SRCR - Figure 6). Notify the Katahdin project manager (PM) of any discrepancies or problems with sample receipt. The PM contacts the client as necessary. If breakage of a potentially hazardous sample is discovered, close and seal the packing container with all the samples inside and move to a hood in the organic extractions area or to the smaller hood in the login area if space permits. One of the three Katahdin Emergency Response Coordinators or the Katahdin Environmental Health & Safety Manager must be notified. Disposition of the broken and other possibly contaminated samples will be determined on a case-by-case basis in accordance with the laboratory's handling procedures for hazardous waste as outlined in the Katahdin Environmental Health & Safety Manual. Generally, when a sample has broken and has mixed with any ice in the cooler, that liquid will be poured off into 2 liter plastic containers and labeled as "do not use". These containers will be disposed of as soon as the disposition of the appropriate samples has been determined through analysis.

7.6 If there is no breakage of a potentially hazardous sample:

Check cooler temperatures using the IR thermometer assigned to the sample receipt area. If a cooler temperature blank is present, aim the IR gun at the temperature blank; otherwise aim the IR gun at any sample in the cooler if no temperature blank is present. Be sure that the IR gun is within 6 inches of the bottle and not aimed at a label on the bottle. Press the trigger on the handle and be sure the red dot is visible on the bottle surface. The IR gun has been set to read in degrees celcius. If checking the temperature of a plastic bottle, set the emissivity at 0.90. If checking the temperature of a glass bottle (either amber or clear), set the emissivity at 0.85. Refer to Figure 7 for manufacturer’s instructions on changing the emissivity. Record the temperature on the Sample Receipt Condition Report. Receipt temperatures should be <6 °C, without freezing. Any temperature falling outside of this range must be noted on the SRCR and reported to the appropriate Katahdin project manager.

Note: Samples received for metals analysis only do not have to meet any temperature receipt requirements.

Note: A probe type thermometer is retained as back-up in case there is a problem with the IR thermometer.

7.7 Note the condition of the ice or ice packs. If the ice has melted and the temperature is out of acceptance criteria, note this on the SRCR. For samples that are hand delivered to the laboratory immediately after collection (i.e. sample collection times are <6 hours old), the temperature blank and/or cooler temperature will most likely not meet the acceptance criteria. The samples shall be considered acceptable if there is evidence that the chilling process has begun such as arrival on ice. Note this on the SRCR. If samples (that were just collected) have not arrived on ice, note this on the SRCR, and start the cooling process as soon as possible after arrival at the laboratory.

Note: All clients must be notified when samples are received that do not meet the appropriate temperature requirements. In these cases, certain regulatory requirements may not be met and may invalidate certain data.

7.8 Inventory the samples against the chain of custody (COC). If the COC is incomplete, the sample custodian must inform the appropriate Katahdin project manager (PM). The PM may make changes to correct or complete the COC, but all changes must be initialed and dated. Changes must be noted on the SRCR. Any discrepancies between the samples and the COC must also be noted on the SRCR.

7.9 Using the Sampling and Preservation Requirements Table (Table 1) as a reference, check if samples are in proper containers and received correct pretreatment (e.g., filtration, preservation) for the analyses requested. For aqueous parameters requiring preservation, check pH by inserting a clean capillary tube into the sample and dabbing the tube on wide range pH paper. If the pH is not clearly either less than 2 or greater than 12, the appropriate narrow range pH paper must be used. NOTE: The pH of volatile organic (VOA) samples is checked and recorded by the analyst after completion of analysis and not by sample receipt personnel. The used capillary tube is discarded and a new capillary tube is used for each sample.

Additional preservative is added to samples if the pH is not in the range specified in the Sampling and Preservation Requirements Table. No more than 10% of the original sample volume should be added as preservative. If the client has noted that the sample reacts violently (i.e., foams and bubbles) upon preservation, add no more preservative to the sample. Some clients may wish to be contacted if their samples are found to be improperly preserved. Record all preservation discrepancies on the Sample Receipt Condition Report including the lot number of the preservative added. If additional preservative is added, a sticker with the type of preservative must be placed on the sample container.

Note: Preservatives are obtained from the larger containers in the bottle preparation area.

Note: If samples are received unpreserved for 200.7 or 200.8 analysis, the samples must be preserved to pH <2 with nitric acid. Samples must be held for 16 hours after preservation before sample preparation can begin.

7.10 For samples requiring filtration as pretreatment (i.e. for dissolved metals), the work order/login numbers are recorded in the filtration logbook (see Figure 8). The samples are filtered by the Metals Group.

7.10.1 A 500 mL filter flask and filter funnel are acid rinsed three times in a 10% nitric acid bath, then three times with Laboratory Reagent Grade Water.

7.10.2 A vacuum pump is attached.

7.10.3 A 0.45 micron filter is rinsed three times with 5% nitric acid and three times with Laboratory Reagent Grade Water. The rinsate is discarded.

7.10.4 A sufficient sample aliquot is filtered and preserved with concentrated nitric acid to pH <2.

7.10.5 The bottles are labeled with the work order/login number and other sample information and stored at <6 ° C until the time of digestion.

7.11 Using the Sampling and Preservation Requirements Table (Table 1) as a reference, determine if sufficient volume of sample is present for analysis. Note discrepancies on the SRCR.

7.12 For drinking water samples, enter the appropriate information (work order, date, etc.) into the Measured Turbidity and Preservation of Incoming Samples Logbook. Inform the appropriate analyst of the sample. The turbidity must be measured prior to sample preparation. If the turbidity is <1 NTU, the sample does not have to be digested prior to metals analysis. If the turbidity is >1 NTU, the sample must be digested prior to metals analysis. The sample must be preserved after the turbidity measurement is taken. Record the appropriate information in the logbook (Figure 9).

7.13 Notify the PM immediately if there are any discrepancies or problems with sample receipt. The PM will contact the client for information and resolution as necessary. All decisions to proceed or not to proceed with analysis associated with samples received that do not meet specified acceptance criteria (i.e. cooler temperature, preservation, container, etc.) must be fully documented on the SRCR. Although this form is included with all client reports, additional narration or flagging of data may be necessary.

7.14 Review any additional paperwork that accompanies the sample(s) submitted for analysis along with laboratory-generated information. This includes shipping forms, letters, chain-of-custody forms, sample labels, Incoming Sample Information Sheets (ISIS), quotes, memos, etc. These forms may provide details on specific client requests. The ISIS will provide information on specifics for log-in. Refer to Figure 10 for an example.

7.15 Resolve any questions or concerns raised by steps 7.1-7.14 by consulting the correspondence files or client services personnel or communicating directly with the client. Note in the <u>notes section of the SRCR</u> any deviations from normal sample handling or analytical procedures (e.g., client requests analysis although hold-time expired).

7.16 When non-environmental food samples are delivered to the laboratory, they are taken immediately to the food/microbiology laboratory and stored in the refrigerators there. A copy of the Chain-of-Custody is left with the analysts. The original paperwork is forwarded to sample log in where the job is logged into the KIMS system.

7.17 The following information is documented via the Katahdin Information Management System (KIMS) and a work order/login COC report (Figure 11) is generated for the samples received:

7.17.1 Log onto KIMS by entering employee ID under “Username”, employee specific password under “Password” and KIMS under “Database”.

7.17.2 Once logged onto KIMS select “Sample Management” and then “Login”.

7.17.3 Select “New” and the next available Login ID number will automatically be entered. Select “OK” and the Sample Definition screen will open.

Note: If a Work Order number has already been opened, select “change” and type in the appropriate number to access the information.

7.17.4 In the Sample Definition Screen, enter the following information.

Client ID -	Enter client sample description.
ReceiveDate -	Enter in date that samples were received in the lab in the format YY-Month-DD.
CollectDate -	Enter in date that samples were collected in the format YY-Month-DDTIME.
TAT -	Enter TAT for hardcopy report.
DueDate -	Due date will automatically be calculated based on calendar days.
VerbalDate -	Manually type in verbal due date.
QuoteRef -	Enter quote number if applicable.
Project -	Enter project number if applicable.
Account -	Enter client specific account number.
Account Name -	Account name will automatically be entered.
Collected By -	Enter name/initials of sampler listed on COC. If unknown, enter “Client”.
Locator -	May be used for client ID information when requested by the project manager.
Site -	Enter project site name.

Description -	May be used for long client Ids when requested by the project manager.
Discount -	No entry-not currently used.
Priority -	No entry-not currently used.
Fact. -	No entry-not currently used.
Expected -	No entry-not currently used.
Comments -	Enter MS/MSD, verbal due date and any sample irregularities if applicable.
OrderDate -	Current date is automatically entered.
Matrix -	Enter sample matrix code where AQ = Aqueous SLD = Food Solid SL = Solid, Soil, Sludge AR = Air FP = Free Product SWAB = Swab WP = Wipe SAL = Saline NOAQ = NonAqueous TIS = Tissue DW = Drinking Water
Product Code -	Enter analysis code per test requested on COC.
Type -	Product code type will automatically be entered where S = Stand alone P = Parent C = Children
Fact. -	No entry-default is 1.
Price -	This is left as is by sample log-in. During project management review of the work order, the prices are entered based on quotes or standard prices.
Cost -	No entry needed.
Lev -	No entry needed.
Type -	Container type will automatically be entered.
Bot -	Enter number of containers per test for printing of labels.

Login Info - Parameter Data Screen will open. Enter following information

KAS Proj. Manager-	Initials of Katahdin person overseeing the project.
Client PO#-	Client purchase order.
Project-	Project name.
Cooler Temperature-	Temperature blanks or cooler temps.
Delivery Services-	Method of delivery to the lab.
QC Level-	QC Level of report and regulatory agency (ie., IV NFESC).
SDG ID-	Sample Delivery Group ID if applicable.
SDG Status-	Begin, Continue or End.
Analysis Instructions-	PM will enter special instructions regarding project.
Report Instructions-	PM will enter special instructions regarding project.
Regulatory List-	Used for federal programs.
EDD Format-	Specific KAS EDD format.

Select “SAVE” and then “CANCEL”.

Addresses - Select “Addresses” and the Address Links screen will open. The billing address is the default address of the account. Enter the client account code under “Project/Account” and select the report to contact under “Address Type”. Select the appropriate boxes for report, report CC and invoice CC. Select “SAVE” and then “CLOSE”.

Create Containers - Select “Create Containers”. Letters will be assigned to each sample number. Select “OK” until letters have been assigned to each sample number. To manually assign letters, Select “Enter Container IDs” and “OK”. Enter sample numbers including letters and select “OK”, “Close”, “Yes” to save changes, “Cancel” and “Cancel”.

7.17.5 To print the login report, select “Reports”, “Login” and “Login COC”. Enter login number under “Login Number”. Select “OK”, “Run Report” and then “Print”.

7.18 To print labels unique to each bottle, select “Reports”, “Login” and “Labels”. Enter login number under “Login/Prelogin”, select “Background (IDXL)” and select F9 on keyboard under “Select Sample Label”. Select “OK” and then “Print”. After labels print out select “Cancel”.

Note: As stated in “create containers” above, each sample bottle is assigned a unique ID. The job is given a work order number. Each different client sample ID is given a numerical number following the work order number and each sample container with the same client ID is given a container ID using alphabetical letters. This series of work order, sample number and container ID is transcribed throughout the raw data for traceability purposes.

Example: One job containing one client sample with 3 different containers:

SC9001-001(a), SC9001-001(b), SC9001-001(c)

Example: One job containing two client samples with 2 different containers for each:

SC9002-001(a), SC9002-001(b), SC9002-002(a), SC9002-002(b)

7.19 Affix permanent sample number labels to sample containers, assuring that sample IDs on labels correspond to sample bottle IDs. Do not obscure client ID on the bottles.

7.20 Place samples in their designated storage locations and log them in, noting initials, date and time, work order/login and sample numbers, and storage location on the internal laboratory chain of custody form (Figure 12). Place form in the appropriate binder in the log in area. Non-environmental food samples do not get an internal COC and are taken immediately to the food/microbiology lab for storage.

Storage location of the samples is determined by type of sample and/or type of analysis, as outlined below. Most samples are stored in the walk-in cooler, which is organized by test type and work order/login number.

Specific storage locations are described below.

7.20.1 Aqueous samples for wet chemistry (except hardness, see 7.19.4 below) - left aisle, both sides, as you enter walk-in cooler. TOC vials are to be stored in the trays designated for TOC samples.

7.20.2 Aqueous samples for organic extractions – right aisle, left side, as you enter walk-in cooler.

7.20.3 Non-aqueous samples (all analyses except volatile organics) - to the right and towards the back as you enter walk-in cooler. Non-aqueous samples for

volatile organics are stored in “VOA Refrigerator 2” located in the Volatiles Laboratory.

7.20.4 Aqueous samples for metals and/or hardness analyses – right aisle, right side towards the front as you enter walk-in cooler.

7.20.5 Samples (aqueous and solid) for volatile organics analyses (VOA) – All aqueous samples and soil samples in VOA vials (preserved with methanol or sodium bisulfate) are stored in “VOA Refrigerator 1” in the Volatiles Laboratory. VOA soils in jars or ENCORE samplers are stored in “VOA Refrigerator 2” in the Volatiles Laboratory. VOA samples known or suspected to be hazardous (such that cross-contamination of other samples might occur) are placed in a “paint can” and stored in the walk-in.

7.20.6 Soil samples for volatile organics analyses (VOA) that are unpreserved or preserved with Laboratory Reagent Grade Water are stored in “VOA Freezer 1” in the volatiles laboratory.

Sample storage coolers are not locked, but internal chain-of-custody is documented with respect to native samples, extracts and digestates within the laboratory. The laboratory maintains a secure facility with respect to unauthorized personnel, as described in the current revision of Katahdin SOP, AD-004, Laboratory Facility Security and Confidentiality. All sample storage coolers are equipped with locks if specific project or regulatory requirements deem it necessary.

7.21 Sample Receipt gives the Work order/login COC report and confirmation of the job, as logged-in, to the appropriate Katahdin project manager. All chain-of-custody and other receipt documentation must accompany the job. The project manager reviews the job for accuracy and completeness. Any unresolved issues should be resolved at this time. Any project or program specific forms should be included with the paperwork at this time. These forms may include CLP forms or state-specific forms. The project manager then dispatches the work order/login to the individual department worklists. The dispatched work order/login package is then filed in Data Management where the complete package will eventually be compiled.

7.22 The temperature of all sample storage refrigerators and freezers is recorded daily by assigned individuals. Notebooks containing a record of each refrigerator and freezer temperature history are used for this purpose and are maintained by the assigned individuals. Temperatures above or below the acceptance range are to be brought to the attention of a Department Manager, Operations Manager, or Quality Assurance Officer. Such an occurrence and the actions taken to correct it must be noted in the comments column of the temperature recording notebook next to the temperature measurement. (See Figure 13).

Additionally, temperatures of storage units are monitored continuously by wireless thermometers. A temperature is recorded electronically every 10 minutes. The QAO

can generate a specified report as needed, including every reading or maximum/minimum temperatures for a given timeframe. These monitoring devices ensure continual compliance seven days per week. The data can be used to check for problems.

PROCEDURES FOR CHEMISTS

7.23 When removing a sample from its storage location, record on the laboratory internal chain-of-custody (from the appropriate department) the sample number, date and time it was removed, chemist who removed it, and the analysis to be conducted or reason for removal.

7.24 If the samples have not been logged in yet and they need to be pulled in order to analyze short holding time parameters, the analyst taking the sample must use the designated logbook (Immediate Internal COC – Figure 14) to sign the samples out. Many circumstances lead to analysts having to pull samples before they are logged into the KIMS system. It is everyone's responsibility to ensure that all samples can be accounted for at all times. Failure to do so can create confusion and bottle necks for others trying to access the samples. Samples that are pulled before log-in must be returned to the designated bin in the sample receipt area. When the logbook for Immediate Internal COC's is used, the standard internal COC's do not have to be signed at a later date. The Immediate Internal COC Logbook must always be consulted if there is ever a question about whether an internal COC has been completed.

7.25 If a sample is not consumed by an analysis, return the remaining sample to its assigned storage location and enter the date and time returned on the laboratory internal chain-of-custody record.

7.26 If analysis consumes the entire sample, indicate this on the laboratory internal chain-of-custody record.

7.27 After the completion of all analyses, the original "left over" sample containers will remain in sample storage until their final disposal. Samples are held during this period for the purposes of retesting if required by a laboratory corrective action or by a client. Refer to the current revision of Katahdin SOP, SD-903, Sample Disposal, for details on final disposal of samples.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

Each thermometer used to monitor sample storage or cooler temperatures must be calibrated annually against a NIST traceable thermometer. The QAO is responsible for ensuring that the thermometer(s) are scheduled for annual calibration and for maintaining the calibration records. All other procedures and documentation listed in this SOP must be followed at all times.

9.0 METHOD PERFORMANCE

Not applicable.

10.0 APPLICABLE DOCUMENTS/REFERENCES

"Handbook for Analytical Quality Control in Water and Wastewater Laboratories," U.S. EPA EMSL Office of Research and Development, March 1979.

Code of Federal Regulations 40, Parts 136 and 141.

"Test Methods for Evaluating Solid Waste: Physical/Chemical Methods," SW-846 Chapters 1 & 2, USEPA, Third Edition, including Updates I, II, IIA, and IIB, III June, 1997.

Katahdin Analytical Services, Inc., Environmental Health & Safety Manual, current revision.

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TABLE 1

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER – AQUEOUS MATRICES	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
GENERAL CHEMICAL ANALYSES					
Acidity	305.1	100 mL	P,G	1,2	14 days
Alkalinity-Manual Titrimetric	310.1	100 mL	P,G	1,2	14 days
Ammonia-Nitrogen with distill-Auto. Phenate	350.1	1 L	P,G	1,3	28 days
Ammonia-Nitrogen-Automated Phenate	350.1, 350.2	250 mL	P,G	1,3	28 days
Anions (Cl, Br, SO4, NO2, NO3)	300.0	250 mL	P, G	1	48hr/28days
Bicarbonate, Carbonate (see pH & alkalinity)	calc.				
Biochemical Oxygen Demand-Carbonaceous	405.1	1 L	P,G	1	48 hours
Biochemical Oxygen Demand-Total	405.1	1 L	P,G	1	48 hours
Bromide	320.1	500 mL	P,G	1	28 days
Chemical Oxygen Demand-Manual Colorimetric	410.4	100 mL	P,G	1,3	28 days
Chloride-Automated Ferricyanide	325.2	100 mL	P,G	1	28 days
Chlorine, Residual	SM4500-Cl G	100 mL	P,G	1,9	ASAP
Chromium, Hexavalent	SM3500Cr D / SW7196	200 mL	P,G	1,9	24 hours
Color, Apparent	110.2	100 mL	P,G	1,2	48 hours
Cyanide, Amenable-Spectrophotometric	335.1	250 mL	P,G	1,5	14 days
Cyanide, Total-Spectrophotometric	SM4500CN C 335.3, 335.4	250 mL	P,G	1,5	14 days
Dissolved Oxygen(Lab)-Membrane Electrode	360.1	500 mL	G	1	ASAP
Ferrous Iron - Colorimetric	SM3500-Fe D	250mL	P	1	24 hrs
Fluoride with distillation, Potentiometric ISE	SM4500F C/340.2	500 mL	P only	1	28 days
Fluoride, Potentiometric ISE	340.2	200 mL	P only	1	28 days
Free CO_2	SM4500-CO_2 C	250mL	P	1	24 hrs.
Hardness, Total-Manual Titrimetric	130.2,SM2340C	250 mL	P,G	4	6 months
MBAS, Extraction-Colorimetric	SM5540C	1 L	P,G	1	48 hours
Nitrate+Nitrite-Automated Cadmium Reduction	353.2	100 mL	P,G	1,3	28 days
Nitrate-Automated Cadmium Red./Diazotization	353.2	100 mL	P,G	1	48 hours
Nitrite-Automated Diazotization	353.2	100 mL	P,G	1	48 hours
Oil & Grease-Total Recoverable, Gravimetric N-Hexane extractable material N-Hexane extractable material w/ silica gel cleanup	1664	(2) 1 L	glass only	1,11	28 days
pH (Laboratory)	150.1	100 mL	P,G	1,2	24 hours
Phenolics, Total Recoverable-Manual 4AAP	420.1	1000 mL	glass only	1,3	28 days
Phosphate, Ortho- Ascorbic Acid	365.2	100 mL	P,G	1	48 hours
Phosphate,Total	365.4	100 mL	P,G	1,3	28 days
Solids-Filterable Residue (TDS),Gravimetric180	160.1	250 mL	P,G	1	7 days
Solids-Nonfilterable Residue (TSS)	160.2	500 mL	P,G	1	7 days
Solids-Settleable Solids (SS)	160.5	1 L	P,G	1	48 hours

TABLE 1 (cont.)

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER – AQUEOUS MATRICES	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
GENERAL CHEMICAL ANALYSES					
Solids-Total Solids	160.3	250 mL	P,G	1	7 days
Solids-Total Volatile (TVS)	160.4	250mL	P,G	1	7 days
Solids-Volatile Filterable Residue (VDS)	160.1/160.4	250 mL	P,G	1	7 days
Solids-Volatile Nonfilterable Residue (VSS)	SM 2540 F	500 mL	P,G	1	7 days
Specific Conductance-Wheatstone Bridge	120.1	100 mL	P,G	1,2	28 days
Sulfate-Turbidimetric	375.4	100 mL	P,G	1	28 days
Sulfide-Iodometric	376.1	500 mL	P,G	1,7	7 days
Sulfite-Titrimetric	377.1	500 mL	P,G	1,9	ASAP
Tannin/Lignin-Colorimetric	SM 5550 B	100 mL	P,G	1	7 days
TKN-Auto Block Digest, Spect.	351.2	100 mL	P,G	1,3	28 days
Total Inorganic Carbon	415.1	(2) 40 mL	VOA vial	1	28 days
Total Inorganic Carbon if with TOC	415.1	(2) 40 mL	VOA vial	1	28 days
Total Organic Carbon-Oxidation	415.1	(2) 40 mL	VOA vial	1,3	28 days
Total Organic Halogen	9020	500 mL	Amber Glass	1,3	28 days
Turbidity	180.1	100 mL	P,G	1	48 hours
ELEMENTAL ANALYSES					
Chromium, Hexavalent	7196/6010	500 mL	P,G	1,9	24 hrs
GFAA(Furnace) Elements	SM 3113/ 200 series	500 mL	P,G	4	6 months
ICP Elements	200.7/6010	500 mL	P,G	4	6 months
ICP MS Elements	200.8/6020	500 mL	P,G	4	6 months
Low Level Mercury	1631	500 mL	G	NA	90 days
Mercury	245.1/7470	500 mL	P,G	4	28 days
GC ORGANIC ANALYSES					
BTEX & MTBE	602 & 8021	(2) 40 mL	VOA vial	1,8,9	14 days(~)
EDB, DBCP & 1,2,3-TCP	504.1	(2) 40 mL	VOA vial	1,8,9	14 days(~)
Extractable Petroleum Hydrocarbons	MADEP/EPH	(2) 1000 mL	Amber Glass	12	14days/40days
Formaldehyde	556	(2) 40 mL	VOA vial	1,8,9	14 days(~)
Fuel Oil in Water	8015Modified	(2) 1000 mL	Amber Glass	1,8	7days/40days
Fuel Oil in Water	ME HETL 4.1.25	(2) 1000 mL	Amber Glass	1,8	7days/40days
Gasoline in Water	8015Modified	(2) 40 mL	VOA vial	1,8	14 days
Gasoline in Water	ME HETL 4.2.17	(2) 40 mL	VOA vial	1,8	14 days
Glycols	8015Modified	(2) 40 mL	VOA vial	1,8,9	14 days(~)
Herbicides	8151	(2) 1000 mL	Amber Glass	1	7days/ 40days
Methane, Ethane & ethene	RSK 175	(2) 40 mL	VOA vial	1,8,9	14 days(~)
PCB's (& Congeners)	608 & 8082	(2) 1000 mL	Amber Glass	1	7days/40days

TABLE 1 (cont.)

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER – AQUEOUS MATRICES	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
GC ORGANIC ANALYSES					
Pesticides	608 & 8081	(2) 1000 mL	Amber Glass	1	7days/40days
Pesticides and PCB's	608 & 8081/8082	(2) 1000 mL	Amber Glass	1	7days/40days
Purgeable Aromatics	602 & 8021	(2) 40 mL	VOA vial	1,8,9	14 days(~)
Purgeable Halocarbons	601 & 8021	(2) 40 mL	VOA vial	1,8,9	14 days(~)
Purgeables, Total	601 & 602	(2) 40 mL	VOA vial	1,8,9	14 days(~)
Purgeables, Total	8021	(2) 40 mL	VOA vial	1,8,9	14 days(~)
Solvents (Direct Injection)	8015M	(2) 40 mL	VOA vial	1	14 days
Volatile Petroleum Hydrocarbons	MADEP/VPH	(2) 40 mL	VOA vial	11	14days
GC/MS ORGANIC ANALYSES					
Acid Extractables-Priority Pollutants	625	(2) 1000 mL	Amber Glass	1	7days/40days
Acid Extractables-TCL	8270	(2) 1000 mL	Amber Glass	1	7days/40days
Base Neutral Extract.-Priority Pollutants	625	(2) 1000 mL	Amber Glass	1	7days/40days
Base Neutral Extractables-TCL	8270	(2) 1000 mL	Amber Glass	1	7days/40days
Drinking Water Volatiles - Low Level	524.2	(3) 40 mL	VOA vial	1,8,9,10	14 days(~)
PCB Homologues	680	(2) 1000 mL	Amber Glass	1	7days/40days
Polyaromatic Hydrocarbons	8270/8270 SIM	(2) 1000 mL	Amber Glass	1	7days/40days
Semivolatile Extractables-Priority Pollutants	625	(2) 1000 mL	Amber Glass	1	7days/40days
Semivolatile Extractables-TCL	8270	(2) 1000 mL	Amber Glass	1	7days/40days
Volatile Organics	8260	(2) 40 mL	VOA vial	1,8,9	14 days(~)
Volatile Organics-Priority Pollutants	624	(2) 40 mL	VOA vial	1,8,9	14 days(~)
HPLC ANALYSES					
HPLC-Explosives	8330, 8332	(2) 1000 mL	Amber Glass	1	7days/40days
MICROBIOLOGICAL ANALYSES					
Coliform, Fecal	SM 9222D, SM 9213D Mod.	100 mL	P,G	1,6	6 hours
Coliform, Total	SM 9222B	100 mL	P,G	1,6	30 hours
Coliform and E-coli, Total	SM9223B/Colitag	100 mL	P,G	1,6	30 hours
E-coli	SM9213D, Colilert/Quantitray	100 mL	P,G	1,6	6 hours
Heterotrophic Plate Count	SM9215B SIMPLATE	100 mL	P,G	1,6	30 hours

TABLE 1 (cont.)

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER – SOLID MATRICES	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
GENERAL CHEMICAL ANALYSES		**4 oz=100 g**			
% Carbon	9060 mod.	4 oz	Soil Jar	1	28 days
Ammonia-Nitrogen-Automated Phenate	350.1 mod.	4 oz	Soil Jar	1	28 days (^)
Anions	9056	4 oz	Soil Jar	1	48hrs to 28 days from slurry (^)
Cation Exchange Capacity	9081	4 oz	Soil Jar	1	14days/7days (^)
Chloride-Automated Ferricyanide	9251/300.0	4 oz	Soil Jar	1	28days from slurry (^)
Cyanide, Amenable-Spectrophotometric	9012	4 oz	Soil Jar	1	14 days
Cyanide, Total-Spectrophotometric	9012	4 oz	Soil Jar	1	14 days
Fluoride, Potentiometric ISE	300.0 mod./340.2	4 oz	Soil Jar	1	28 days (^)
Lime Equivalency	310.1 mod.	4 oz	Soil Jar	1	28 days (^)
Nitrate+Nitrite-Automated Cadmium Reduction	300.0 mod./353.2	4 oz	Soil Jar	1	28 days (^)
Nitrate-Automated Cadmium Red./Diazotization	300.0 mod./353.2	4 oz	Soil Jar	1	48 hrs from slurry (^)
Nitrite-Automated Diazotization	300.0 mod./353.2	4 oz	Soil Jar	1	48 hrs from slurry (^)
Oil & Grease-Total Recoverable, Gravimetric N-Hexane extractable material N-Hexane extractable material w/ silica gel cleanup	9071	4 oz	Soil Jar	1	28 days (^)
Organic Nitrogen-Auto. Block Digest.,Spectro.	350.1/351.2 mod.	4 oz	Soil Jar	1	28 days (^)
pH (Laboratory)	9045	4 oz	Soil Jar	1	24 hours (^)
Phenolics, Total Recoverable-Manual 4AAP	Mod. 9065	4 oz	Soil Jar	1	28 days (^)
Phosphate, Ortho- Ascorbic Acid	300.0 mod./365.2	4 oz	Soil Jar	1	48 hrs from slurry (^)
Phosphate,Tot.-Auto Ascorbic Acid/Block Dig.	Mod. 365.4	4 oz	Soil Jar	1	28 days (^)
Solids-Ash	SM 2540 F	4 oz	Soil Jar	1	28 days (^)
Solids-Total Solids	CLP-CIP	4 oz	Soil Jar	1	28 days (^)
Solids-Volatile Solids	SM 2540 F	4 oz	Soil Jar	1	28 days (^)
Specific Conductance-Wheatstone Bridge	Mod. 9050	4 oz	Soil Jar	1	28 days (^)
Sulfate-Turbidimetric	9036/9038	4 oz	Soil Jar	1	28 days from slurry (^)
Sulfide-Iodometric	9030	4 oz	Soil Jar	1	7days from slurry (^)
Sulfide-Monier-Williams	40CFR-425	4 oz	Soil Jar	1	28 days (^)
Sulfite-Titrimetric	ASTM D3987/377.1 mod.	4 oz	Soil Jar	1	24 hrs from slurry (^)
TKN-Auto Block Digest,Spectro.	351.2 mod.	4 oz	Soil Jar	1	28 days (^)
Total Organic Halogen	9020/9021	4 oz	Soil Jar	1	28 days (^)
Total Petroleum Hydrocarbons-Extraction, IR	9071	4 oz	Soil Jar	1	28 days (^)
ELEMENTAL ANALYSES					
ICP Elements	6010	4 oz	Soil Jar	1	6 months
ICP MS ELements	6020	4 oz	Soil Jar	1	6 months
GFAA(Furnace) Elements	7000series	4 oz	Soil Jar	1	6 months
Mercury	7471	4 oz	Soil Jar	1	28 days

TABLE 1 (cont.)

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER – SOLID MATRICES	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
ELEMENTAL ANALYSES **(cont.)**		**4 oz=100 g**			
Chromium, Hexavalent	3060/7196	4 oz	Soil Jar	1	30dys/24hrs
GC ORGANIC ANALYSES					
BTEX & MTBE	8021	(2) 40 mL	VOA Vial	1	14 days
Explosives - HPLC	8330, 8332	4 oz	Soil Jar	1	14days/40days
Extractable Petroleum Hydrocarbons	MADEP/EPH	4 oz	Soil Jar	1	7days/40days
Fuel Oil	ME HETL 4.1.25	4 oz	Soil Jar	1	14days/40days
Fule Oil	8015 mod.	4 oz	Soil Jar	1	14days/40days
Gasoline	ME HETL 4.2.17	(2) 40 mL	VOA Vial	1	14 days
Gasoline	8015 mod.	(2) 40 mL	VOA Vial	1	14 days
Herbicides	8151	4 oz	Soil Jar	1	14days/40days
PCB's (& Congeners)	8082	4 oz	Soil Jar	1	14days/40days
PCB's in Oil	8082	4 oz	VOA Vial	1	40 days
Pesticides	8081	4 oz	Soil Jar	1	14days/40days
Pesticides and PCB's	8081/8082	4 oz	Soil Jar	1	14days/40days
Purgeable Aromatics	8021	(2) 40 mL	VOA Vial	1	14 days
Purgeable Halocarbons	8021	(2) 40 mL	VOA Vial	1	14 days
Purgeables, Total	8021	(2) 40 mL	VOA Vial	1	14 days
Solvents (Direct Injection)	8015M	(2) 40 mL	VOA Vial	1	14 days
Volatile Petroleum Hydrocarbons	MADEP/VPH	(2)40 mL	VOA vial	13	28days
HPLC ANALYSES					
HPLC-Explosives	8330, 8332	4 oz	Soil Jar	1	7days/40days
GC/MS ANALYSES					
Acid Extractables-Priority Pollutants	8270	4 oz	Soil Jar	1	14 days/40 days
Acid Extractables-TCL	8270	4 oz	Soil Jar	1	14 days/40 days
Base Neutral Extractables-Priority Pollutants	8270	4 oz	Soil Jar	1	14 days/40 days
Base Neutral Extractables-TCL	8270	4 oz	Soil Jar	1	14 days/40 days
Polyaromatic Hydrocarbons	8270/8270SIM	4 oz	Soil Jar	1	14 days/40 days
Semivolatile Extractables-Priority Pollutants	8270	4 oz	Soil Jar	1	14 days/40 days
Semivolatile Extractables-TCL	8270	4 oz	Soil Jar	1	14 days/40 days
Volatile Organics – High Soil (>200 ug/kg)	5035/8260	Please refer to Table 6-2	Encore or similar sampler or VOA Vial or soil jar	14	Extruded w/in 48 hrs. Analyzed w/in 14 days
Volatile Organics – Low Soil (<200 ug/kg)	5035/8260	Please refer to Table 6-2	Encore or similar sampler or VOA Vial	14 or 15	Extruded w/in 48 hrs. Analyzed w/in 14 days
Volatile Organics-Priority Pollutants	8260	(2) 40 mL	VOA Vial	1	14 days
Volatile Organics-TCL	8260	(2) 40 mL	VOA Vial	1	14 days

TABLE 1 (cont.)

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER – SOLID MATRICES	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
RCRA - HAZARDOUS WASTE CHARAC.					
Corrosivity-pH	9045	4 oz	Soil Jar	1	24 hours (^)
Ignitability-Flash Point (closed cup)	1010	4 oz	Soil Jar	1	14 days (^)
Reactivity-Reactive Cyanide	7.3.3.2	4 oz	Soil Jar	1	14 days
Reactivity-Reactive Sulfide	7.3.4.1	4 oz	Soil Jar	1	7 days
TCLP					
TCLP Extraction-Volatile Organics	1311	100 g	Soil Jar	1	14 days
TCLP Extraction-Semivolatiles	1311	200 g	Soil Jar	1	14 days
TCLP Extraction-Pesticides & Herbicides	1311	400 g	Soil Jar	1	14 days
TCLP Extraction-Metals	1311	200 g	Soil Jar	1	28 days
TCLP Analysis-Volatile Organics	8260	see above	Soil Jar	1	14 days
TCLP Analysis-Metals	6010/6020	see above	Soil Jar	1	180 days
TCLP Analysis-Mercury	7470	see above	Soil Jar	1	28 days
TCLP Analysis-Semivolatiles	8270	see above	Soil Jar	1	7 days/40 days
TCLP Analysis-Pesticides	8081	see above	Soil Jar	1	7 days/40 days
TCLP Analysis-Herbicides	8151	see above	Soil Jar	1	7 days/40 days

METHODS OF PRESERVATION
1 = Cool at 4 Degrees Celsius
2 = Settled
3 = H2SO4 to pH<2
4 = HNO3 to pH<2
5 = NaOH to pH>12
6 = 1 mL 0.1M Na2S2O3 or 1 10 mg pellet
7 = 1 m/L 2NZnAc/L & NaOH
8 = 2 drops 1:1 HCl
9 = No headspace
10 = Na2S2O3, if chlorinated
11 = HCl to pH < 2
12 = 5 mL of HCL
13 = 15 mL of methanol
14 = methanol
15 = sodium bisulfate

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 1

EXAMPLE OF STANDARD KATAHDIN CHAIN-OF-CUSTODY FORM

Katahdin ANALYTICAL SERVICES
600 Technology Way
Scarborough, ME 04074
Tel: (207) 874-2400
Fax: (207) 775-4029

CHAIN of CUSTODY

PLEASE BEAR DOWN AND PRINT LEGIBLY IN PEN

Page ____ of ____

Client | Contact | Phone # ( ) | Fax # ( )

Address | City | State | Zip Code

Purchase Order # | Proj. Name / No. | Katahdin Quote #

Bill (if different than above) | Address

Sampler (Print / Sign) | Copies To:

LAB USE ONLY WORK ORDER #:

KATAHDIN PROJECT NUMBER _____

REMARKS: _____

SHIPPING INFO: ❒ FED EX ❒ UPS ❒ CLIENT

AIRBILL NO: _____

TEMP°C _____ ❒ TEMP BLANK ❒ INTACT ❒ NOT INTACT

ANALYSIS AND CONTAINER TYPE PRESERVATIVES

Sample Description	Date / Time coll'd	Matrix	No. of Cntrs.	Filt. ❒Y ❒N	Filt. ❒Y ❒N	Filt. ❒Y ❒N	Filt. ❒Y ❒N	Filt. ❒Y ❒N	Filt. ❒Y ❒N	Filt. ❒Y ❒N	Filt. ❒Y ❒N	Filt. ❒Y ❒N	Filt. ❒Y ❒N
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MMENTS

Relinquished By: (Signature)	Date / Time	Received By: (Signature)	Relinquished By: (Signature)	Date / Time	Received By: (Signature)
Relinquished By: (Signature)	Date / Time	Received By: (Signature)	Relinquished By: (Signature)	Date / Time	Received By: (Signature)

THE TERMS AND CONDITIONS ON THE REVERSE SIDE HEREOF SHALL GOVERN SERVICES, EXCEPT WHEN A SIGNED CONTRACTUAL AGREEMENT EXISTS

ORIGINAL

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 2

EXAMPLE OF HOMEOWNER KATAHDIN CHAIN-OF-CUSTODY FORM

Katahdin
ANALYTICAL SERVICES

600 Technology Way
P.O. Box 540
Scarborough, ME 04070
Tel: (207) 874-2400 Fax: (207) 775-4029

Homeowner Chain of Custody

Client: Contact: Phone: Fax:

Address: City: State: Zip:

Purchase Order #: Project Name/No.: E-mail:

Billing Address (if different):

Sampler (Print/Sign): Copies To:

***Test results are for compliance and will be reported to the state (see statement below). yes no Compliance samples must be received on ice.

Lab Use Only | Work Order #: KAS Project Manager:

Shipping: UPS Fed-Ex Mail Drop-Off

Sample(s) Received on Ice? Yes No Temperature if Iced:

Requested Services

Sample Description (Sample Identification and/or Lot #)	Date Collected	Time Collected	No. of Cntrs.	Standard Homeowner	Arsenic	Total Coliforms	Lead	Safety Test – coliform & N+N	FHA/MSH	Fluoride	Uranium		What's Included in the Standard Test and the FHA/MSH Test.
													Standard Homeowner Total Coliform/e-coli Nitrate, Nitrite Chloride, pH Hardness Copper, Iron Manganese Sodium
													FHA/MSH Standard plus Lead Turbidity Color Odor

Relinquished By:	Date/Time:	Received By:	Relinquished By:	Date/Time:	Received By:

Per the National Environmental Laboratory Accreditation Program (NELAP) Standards, Katahdin is required to accept samples that have been properly preserved. All sample containers provided to you have been properly preserved, but the proper preservation also requires samples to be received at <6 degrees celcius. The Safe Drinking Water Act regulations only require this for compliance samples (i.e., results that are submitted to the state). By circling no for compliance (above), you acknowledge that the samples described above are not for compliance purposes, and thus may not meet the temperature receipt requirements.

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 3

EXAMPLE OF FOOD/MICROBIOLOGY KATAHDIN CHAIN-OF-CUSTODY FORM

Katahdin
ANALYTICAL SERVICES

600 Technology Way
P.O. Box 540
Scarbrough, ME 04070
Tel: (207) 874-2400 Fax: (207) 775-4029

Chain of Custody

Client: Contact: Phone: Fax:
Address: City: State: Zip:
Purchase Order #: Project Name/No.: E-mail:
Billing Address (if different):
Sampler (Print/Sign): Copies To:

Lab Use Only | Work Order #: KAS Project Manager:

Food & Microbiological Services

Shipping: UPS Fed-Ex Airbill No.:
Temperature:

Sample Description (Sample Identification and/or Lot #)	Date/Time Collected	Matrix	No. of Cntrs.	Plate Count (A/H/S)	Listeria	Yeast and Mold	Salmonella	E-Coli	E-Coli 0157:H7	Staph	Vibrio	Total Coliforms	Campylobactor	Shelf Life	Challenge Study		

Relinquished By:	Date/Time:	Received By:	Relinquished By:	Date/Time:	Received By:

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 4

EXAMPLE OF KATAHDIN SAMPLE RECEIPT LOGBBOK

KATAHDIN ANALYTICAL SERVICES, INC.

SAMPLE LOG IN

Date Received	Time Received	Date Logged In	Time Logged In	Work Order	Client	Initials
				SA 0094		
				SA 0095		
				SA 0096		
				SA 0097		
				SA 0098		
				SA 0099		
				SA 0100		
				SA 0101		
				SA 0102		
				SA 0103		
				SA 0104		
				SA 0105		
				SA 0106		
				SA 0107		
				SA 0108		
				SA 0109		
				SA 0110		
				SA 0111		
				SA 0112		
				SA 0113		
				SA 0114		
				SA 0115		
				SA 0116		
				SA 0117		
				SA 0118		
				SA 0119		
				SA 0120		
				SA 0121		
				SA 0122		
				SA 0123		
				SA 0124		

Signed By:_____ Date :_____

Reviewed By:_____ Date:_____

0000004

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 5

EXAMPLE OF WET CHEMISTRY SHORTS AND RUSHES LOGBOOK

WET CHEMISTRY SHORTS & RUSHES **Receipt Date:**

HOLDING TIME					Immediate			24 Hr		48 Hr								
Work Order / Client	Matrix	Earliest Sampling Date	Earliest Sampling Time	Rush Parameters	pH	DO	Sulfite	Fe +2	Cr-6	Total BOD	Carbon. BOD	Color	Nitrate	Nitrite	OPO4	Set Solids	Turbidity	Comments (Quick TAT, MS/MSD, etc.)

0000004

FIGURE 6

EXAMPLE OF SAMPLE RECEIPT CONDITION REPORT FORM

Katahdin Analytical Services, Inc. **Sample Receipt Condition Report**

Client:	KAS PM:	Sampled By:
Project:	KIMS Entry By:	Delivered By:
KAS Work Order#:	KIMS Review By:	Received By:
SDG #:	Cooler: _____ of _____	Date/Time Rec.:

Receipt Criteria	Y	N	EX*	NA	Comments and/or Resolution
1. Custody seals present / intact?					
2. Chain of Custody present in cooler?					
3. Chain of Custody signed by client?					
4. Chain of Custody matches samples?					
5. Temperature Blanks present? If not, take temperature of any sample w/ IR gun.					Temp (°C):
Samples received at <6 °C w/o freezing?					Note: Not required for metals analysis.
Ice packs or ice present?					The lack of ice or ice packs (i.e. no attempt to begin cooling process) may not meet certain regulatory requirements and may invalidate certain data.
If not, has the cooling process begun (i.e. ice or packs present) and sample collection times <2hrs., but samples are not yet cool?					Note: No cooling process required for metals analysis.
6. Volatiles free of headspace: **Aqueous:** No bubble larger than a pea **Soil/Sediment:**					
Received in airtight container?					
Received in methanol?					
Methanol covering soil?					
7. Trip Blank present in cooler?					
8. Proper sample containers and volume?					
9. Samples within hold time upon receipt?					
10. Aqueous samples properly preserved? Metals, COD, NH3, TKN, O/G, phenol, TPO4, N+N, TOC, DRO, TPH – pH <2					
Sulfide - >9					
Cyanide – pH >12					

* Log-In Notes to Exceptions: document any problems with samples or discrepancies or pH adjustments

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 7

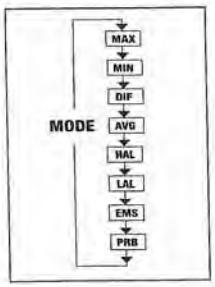
IR THERMOMETER MANUFACTURER'S INSTRUCTIONS FOR CHANGING EMISSIVITY

MODE Button Functions

Your infrared thermometer measures Maximum (MAX), Minimum (MIN), Differential (DIF)*, and Average (AVG)** temperatures each time you take a reading. This data is stored and can be recalled with the MODE button (3) until a new measurement is taken. (See "Hold and Recall" for information on how to recall stored data.) When the trigger is pulled again, the unit will begin measuring in the last mode selected. Pressing the MODE button also allows you to access the High Alarm (HAL), Low Alarm (LAL), Emissivity (EMS), Probe temperature (PRB—only available when the probe is connected), and Data logger (LOG). Each time you press MODE, you advance through the mode cycle. The diagram shows the sequence of functions in the Mode cycle.

Note: PRB (probe) is only available in the MODE loop when the contact probe is connected to the unit.

*DIF shows the difference between the maximum and minimum temperatures measured.
**AVG shows the average temperature reading for each time the trigger is pulled or the unit is locked on.



Selecting a Function

To Select the MAX, MIN, DIF, or AVG mode, pull the trigger. While holding the trigger, press the MODE button (3) until the appropriate code appears in the lower left corner of the display (E). Each time you press MODE, you advance through the MODE cycle. The MODE cycle is shown above.

Setting the High Alarm, Low Alarm, and Emissivity

To set values for the High Alarm (HAL), Low Alarm (LAL), and Emissivity, pull the trigger or press the MODE button (3) to activate the display. Press the MODE button until the appropriate code appears in the lower left corner of the display (E). Use the up and down keys (2) to adjust the desired values. To activate the alarms, press SET (1). To deactivate the alarms, press SET again.

Using a Probe (PRB)

Connect the probe to the input on the side of the unit (as shown).
PRB automatically appears in the lower left corner of the display (E, below). The probe temperature is shown in the lower right part of the display. The current infrared temperature continues to show in the center of the display (F). While the probe is connected, you may still cycle through the mode functions by pressing MODE (3).

Note: PRB is only available in the MODE loop when a probe is connected to the unit; the probe temperature will not activate the high alarm or low alarm.

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 8

EXAMPLE OF KATAHDIN SAMPLE FILTRATION LOGBOOK

KATAHDIN ANALYTICAL SERVICES, INC.

Sample Filtration Logbook

Katahdin Sample No. List Individually	Site ID (Optional)	Filtration Requested By:		Filtered and Preserved By:		
		Initials	Date	Initials	Date	Time

Reviewed and Approved by: _____ **Date:** _____

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TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 9

MEASURED TURBIDITY AND PRESERVATION OF INCOMING SAMPLES LOGBOOK

KATAHDIN ANALYTICAL SERVICES

Measured Turbidity and Preservation of Incoming Samples

KAS Lab Sample ID	Measured Turbidity (NTU)	Turbidity Date	Turbidity Analyst	Preservation Date	Preservation Time	Preservation Analyst
WW6757-9A	0.22	12-19-06		12/14/06	~~1430~~ 1400	DM
↓ -10A	0.18	↓		↓	↓	↓
WW6758-1A	4.80	↓	↓	↓	↓	↓
WW6776-1A	0.68	12-20-06		12/20/06	1000	DM
WW6855-1A	0.92	12-26-06		12/26/06	1600	DM
WW6860-1A	2.40	↓	↓	↓	↓	↓
SA0027-1A	0.52	1-3-07		01/03/07	1445	DM
SA0028-1A	0.72	1-3-07		↓	↓	↓
SA0087-1A	0.26	1-5-07		01/05/07	1645	DM
SA0088-1A	10.4	1-5-07		↓	↓	↓
SA0110-1A	0.47	1-8-07		01/08/07	1430	DM
SA0109-1A	0.32	1-8-07		↓	↓	↓
SA0138-1A	0.12	1-09-07		01/09/07	1700	DM
SA0262-1A	0.14	1-18-07		01/18/07	0930	DM
SA0263-1A	0.33	1-18-07		↓	↓	↓
SA0267-1A	0.30	1-18-07		01/18/07	0950	DM
SA0313-1A	0.58	1-22-07		01/22/07	1030	↓
SA0316-1A	1.70	1-22-07		01/22/07	1345	DM

REVIEWED BY: DATE:

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TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 10

EXAMPLE OF LABORATORY INCOMING SAMPLE INFORMATION SHEET (ISIS)

KATAHDIN ANALYTICAL SERVICES, INC. – INCOMING SAMPLE INFORMATION SHEET

CLIENT:	ATTENTION:
ADDRESS:	
TELEPHONE:	FAX:
OTHER CLIENT CONTACTS:	
REPORT CC:	PM/SALES CONTACT:
PO #:	CLIENT ACCOUNT:
KAS QUOTE #:	KIMS QUOTE #:
PROJECT NAME:	KIMS PROJECT REF.:
SDG:	APPLICABLE CERTIFICATION:
RECEIPT DATE:	MEANS OF DELIVERY:

METHOD OR KIMS PRODUCT	MATRIX	# OF SAMPLES	SPECIAL INSTRUCTIONS (I.E LIMITS, PREPS)

SUBCONTRACT PARAMETER	SUBCONTRACT LABORATORY

QC LEVEL:	EDD:
RUSH/VERBAL TAT:	HARDCOPY TAT:
HISTORY:	
OTHER:	

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 11

EXAMPLE OF KATAHDIN WORK ORDER/LOGIN COC REPORT

Katahdin
ANALYTICAL SERVICES

Katahdin Analytical Services
Login Chain of Custody Report (lno1)
Jan. 26, 2007
03:51 PM

Page: 1 of 1

Login Number: SA0395
Account:KATAHD001 Web
Katahdin Analytical Services
Project:

Primary Report Address:
Leslie Dimond
Katahdin Analytical Services
600 Technology Way
P.O. Box 540
Scarborough,ME 04070

Primary Invoice Address:
Accounts Payable
Katahdin Analytical Services
600 Technology Way
P.O. Box 540
Scarborough,ME 04070

Report CC Addresses:
Invoice CC Addresses:

Login Information

ANALYSIS INSTRUCTIONS	:
CHECK NO.	:
CLIENT PO#	:
COOLER TEMPERATURE	: n/a
DELIVERY SERVICES	: In House
EDD FORMAT	:
MAIL DATE	:
PM	: LAD
PROJECT NAME	: QC Holding Blanks
QC LEVEL	: I
REGULATORY LIST	:
REPORT INSTRUCTIONS	:
SDG ID	:
SDG STATUS	:

Laboratory Sample ID	Client Sample Number	Collect Date/Time	Receive Date	PR	Verbal Date	Due Date	Comments
SA0395-1	WHITE FRIDGE	26-JAN-07 15:50	26-JAN-07			08-FEB-07	
Matrix	***Product***	***Hold Date (shortest)***	***Bottle Type***		***Bottle Count***		
Aqueous S	SW8260FULL5ML	09-FEB-07			2		
SA0395-2	BLUE FRIDGE	26-JAN-07 15:50	26-JAN-07			08-FEB-07	
Matrix	***Product***	***Hold Date (shortest)***	***Bottle Type***		***Bottle Count***		
Aqueous S	SW8260FULL5ML	09-FEB-07			2		

Total Samples: **2** ***Total Analyses:*** **2**

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 12

EXAMPLE OF LABORATORY INTERNAL CHAIN-OF-CUSTODY FORM

Katahdin Analytical Services, Inc.
Internal Custody Record

EXTRACTIONS (AQ) Work Order #:_____

Sample Numbers Involved	Placed in refrigeration by: Initials
	Date
	Time

Sample Numbers	Analysis	Removed			Returned			Consumed?	
		Initials	Date	Time	Initials	Date	Time	Yes	No

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 13

EXAMPLE OF REFRIGERATOR TEMPERATURE LOGBOOK

KATAHDIN ANALYTICAL SERVICES, INC.

SAMPLE RECEIPT WALK-IN TEMPERATURE LOG

Corrective Action: Note in the "comments" column and notify the QAO or supervisor; document corrective actions taken and return to control.

Thermometer Location		Sample Receipt Walk-in 1	Comments
Acceptance Criteria		2 to 6 °C	
Date	Initials	Temp (°C)	
02/2/07	ND4	3.7	
02/05/07	DWM	5.8	
02/06/07	DWM	5.8	
02/07/07	DWM	5.8	
02/08/07	DWM	3.8	
02/09/07	DWM	3.5	
02/12/07	DWM	3.5	
02/13/07	DWM	3.5	

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TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 14

EXAMPLE OF IMMEDIATE INTERNAL COC LOGBOOK

KATAHDIN ANALYTICAL SERVICES, INC.
INTERNAL CUSTODY RECORD FOR IMMEDIATES

CLIENT	PROJECT	CLIENT ID &/or WORK ORDER #	ANALYSIS	OUT date/time	IN date/time	INIT	Consumed?
Jacobs		WW4813-1A, -2A	ICP	9/13/06 0930	→ 0935	DJJ	yes no
Jacobs		WW4883-1A	ICP	9/16/06 0900	→ 1000	DJJ	yes no
CES		WW4965	BOD	9/20/06 0920	9/20/06 1000	CP	yes no
CCAR		WW4969	BOD	9/20/06 1000	↓	CP	yes no
GEMF		WW4970	BOD	↓	↓	CP	yes no
Jacobs		WW4962-1A, -2A	ICP	9/20/06 0900	→ 1000	DJJ	yes no
Irving		WW4994	BOD	9/21/06 1000	9/21/06 1015	CP	yes no
Highlimer		WW4992	BOD	9/21/06 1015		CP	yes no
NATIONAL		WW5000	TS, PERCHLORIDE PH, SP.CONDUCT	9/21/06 1100	9/21/06 1217	↓	yes no
W+C		WW5001	BOD	9/22/06 1300		CP	yes no
Allens		WW5016	NO3	9/22/06 1300 NO3	09/22/06 1100	[illegible]	yes no
RANSOM		WW5010	↓	↓	↓	↓	yes no
EcoMaine		WW5029	BOD	9/22/06 1100		CP	yes no

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TITLE: **SAMPLE DISPOSAL**

Prepared By: _____ Date: 2/01

Approved By:

Group Supervisor: _____ Date: _____

Operations Manager: _____ Date: 2/01

QA Officer: Deborah J. Nadeau Date: 2.01

General Manager: _____ Date: 2/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01	Format changes, ~~added pollution prevention~~, added updated log-book and greater detail on dis-posal.	DN	2.01	2/01
02	Major rewrite to include more detail on hazardous waste regu-lations + to reflect current practices.	DN	02/05	02/05
03	Rewrite of section 7 to comply with current practices in new facility. Updated Figures 1 to 3.	DN	02.08	02.08
04	Added elementary neutralization to section 7.0. Other minor edits.	DN	05.09	0509

TITLE: SAMPLE DISPOSAL

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SD-903-04**, titled **SAMPLE DISPOSAL**.

Recipient: _____Date:_____

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SD-903-04**, titled **SAMPLE DISPOSAL**.

Recipient: _____Date:_____

TITLE: SAMPLE DISPOSAL

1.0 SCOPE AND APPLICATION

Katahdin Analytical Services, Inc. requires strict adherence to specific procedures for the disposal of samples. The procedures are designed to categorize waste materials, provide for their safe and timely disposal and to ensure compliance with local and federal regulations pertaining to disposal of chemicals and environmental samples. Any other means of disposal not described in this SOP is prohibited without consent from the Katahdin Environmental Health & Safety Officer and/or the Katahdin Environmental Compliance Officer.

The purpose of this SOP is to describe the procedures utilized by Katahdin Analytical personnel for the disposal of samples. These procedures apply to the disposal of all samples received or processed by Katahdin. Refer to the current revision of Katahdin SOP CA-107 regarding the disposal of spent preparation and analysis reagents, standards, sample extracts, distillates, or digestates.

1.1 Definitions

Hazardous Waste – A “Solid Waste” which displays a hazardous characteristic or is specifically listed as hazardous waste.

Solid Waste – Any discarded material that is not excluded from the definition of hazardous waste.

Discarded Material – Material that is abandoned, recycled or inherently waste-like.

Waste (State of Maine) –

- Any useless, unwanted, or discarded substance or material, whether or not such substance or material has any other future use.
- Any substance or material that is spilled, leaked, pumped, poured, emptied or dumped onto the land or into the water or ambient air.
- Materials which are used in a matter constituting disposal, burned for energy recovery, reclaimed, or accumulated speculatively.

Ignitable Hazardous Waste – EPA Waste Code D001

- Liquids with a flash point less than 140°F or 60°C.
- Solids capable of spontaneous combustion under normal temperature and pressure.
- Ignitable compressed gas.
- Oxidizers.

Corrosive Hazardous Waste - Liquids with a pH less than or equal to 2.0 or greater than or equal to 12.5. EPA waste code D002.

Reactive Hazardous Waste – EPA waste code D003.

- A material that reacts violently with water.
- A material that generates toxic gases or fumes.
- Explosives.

Toxic Hazardous Waste – A material that exceeds certain concentration levels based on the toxicity characteristic leaching procedure (TCLP). See Figure 3 for the chemicals and concentration levels covered under this definition.

Listed Wastes – Lists of chemicals that are considered hazardous based on the following criteria

- Virgin chemical or unused product.
- Sole active ingredient.
- Single substance spill debris.

Listed wastes are divided into 5 subcategories

- F-wastes – Describe hazardous waste from non-specific sources usually containing halogenated and non-halogenated solvents.
- K-wastes – Describe hazardous wastes created by specific processes.
- U-wastes – Describe toxic or non-acute hazardous wastes.
- P-wastes – Describe acute hazardous wastes. (Note: Maine considers a material to be a P-listed waste if it contains 10% or more of any P-listed chemical.
- State listed wastes – Maine lists any material with a concentration of greater than 50 ppm Polychlorinated Biphenyls (PCB) as a hazardous waste.

Organics hit – A liquid sample containing greater than 1 mg/L of organic contaminants or a soil sample containing greater than 20 mg/kg of organic contaminants.

1.2 Responsibilities

Only designated analysts/technicians trained in these procedures may dispose of samples or analytical by-products. Each analyst or technician must be familiar with Katahdin Analytical safety procedures. Gloves, safety glasses, lab coats and/or other protective clothing must be worn at all times.

It is the responsibility of the designated Katahdin personnel involved in the disposal of samples to read and understand this SOP, to adhere to the procedures outlined, to properly document their activities in the appropriate lab notebook and file the necessary manifests and reports to outside agencies in the required manner. Refer to

Katahdin SOP QA-805, "Personnel Training & Documentation of Capability," current revision.

It is the responsibility of the Department Managers to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to initiate periodic review of the associated logbooks.

It is the responsibility of the Katahdin Environmental Health & Safety Officer (EHSO) to manage the proper classification and disposal of samples. Katahdin is responsible for regulatory compliance of Katahdin's waste storage areas (less than 90 day storage). The EHSO ensures compliance of the waste storage areas with applicable state and federal regulations. The EHSO is responsible for providing the appropriate training to all individuals involved in the proper classification and/or disposal of samples. The EHSO is responsible for working with the Laboratory Operations Manager/Environmental Compliance Officer to help identify problems and assure resolution, to facilitate corrective action where needed, and to communicate unresolved problems and concerns to the Laboratory Vice President.

It is the responsibility of the Operations Manager/Environmental Compliance Officer to oversee adherence to Katahdin sample disposal and hazardous waste practices by all laboratory groups under his/her authority, to help identify problems and assure resolution, to facilitate corrective action where needed, and to communicate problems and concerns to the EHSO and/or the Laboratory Vice President.

It is the responsibility of the Laboratory Vice President to provide the necessary resources to meet the regulatory requirements of proper classification and disposal of samples.

2.0 SUMMARY OF METHOD

Not applicable.

3.0 INTERFERENCES

Not applicable.

4.0 APPARATUS AND MATERIALS

Not applicable.

TITLE: SAMPLE DISPOSAL

5.0 REAGENTS

Not applicable.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Not applicable.

7.0 PROCEDURES

7.1 Sample purging is the removal of samples from laboratory refrigerated storage. Sample storage areas where samples are removed (purged) from include wet chemistry, organic extractables, metals, volatiles, total organic carbon and soils. Wet chemistry, aqueous metals, organic extractables, total organic carbon, and soils can all be found in the walk-in refrigerator. Aqueous and soil volatiles can be found in the volatiles laboratory refrigerators/freezer.

7.2 Samples are purged from storage, after analysis and reporting, on a routine basis to make room for incoming samples. Samples are to be kept in storage for a duration of 30 days past the report mailed date. Some samples must be kept for 60 or 90 days beyond the report mailed date, depending on specific client requests and contracts.

7.3 The first step in disposing of samples is to generate a disposal list. The disposal list contains sample analysis information stored in the Katahdin Information Management System (KIMS). The analytical data for the samples is compared to the hazardous waste criteria specified in 40CFR Part 261 and to local wastewater discharge criteria. Refer to Figure 4 for 40 CFR Part 261 Characteristic Hazardous Waste Criteria. Based on this comparison, the report displays information on the classification/category for disposal of each sample. The disposal report should be reviewed against the data reports for accuracy. Refer to Figure 2 for an example of a KIMS generated disposal list. The primary disposal categories listed in the report are: non-hazardous, high organics, high metals, flashpoint, high mercury, high PCBs, and high cyanide. Katahdin has established 14 waste stream profiles with a 3rd party waste transporter/waste disposal firm for sample disposal based on these categories. As required, new or special temporary waste profiles are established based on the characteristics of samples.

7.4 Sorting through samples and preparing them for disposal is a crucial quality checkpoint. Samples put into the incorrect waste stream could not only produce adverse environmental effects, but, could also interrupt the 3rd party's waste treatment efficiency, or endanger an individual handling the waste stream. Therefore, when sorting through samples pay close attention to which waste stream each sample falls into.

7.5 Once you are ready to dispose of the samples of interest (the oldest samples that have been purged), these samples must be sorted, logged, and the classification/category (sample knowledge) information recorded.

Sample storage times (as listed in section 7.2) and space should be taken into consideration when purging samples. It is important to make room for future samples, but to make sure that samples are not purged too early. Samples should be pulled from the walk-in or the volatiles refrigerators to make room for new samples. When purging, chose a section that needs extra space the most and remove the oldest samples.

Safety glasses, nitrile gloves, lab coat, and a splash apron must be worn when handing samples during disposal

7.6 Remove the designated purge samples from the shelf one by one and line them up on the countertop in the log-in area. Generally, removing two cartloads at a time is a good amount to purge at one time. For volatile samples in 40mL vials, 5 or 6 vial trays should be purged at a time. Samples should be lined up across the counter with the earliest sample to the left and building up to the right, organizing the samples according to work order and sample number. After the samples are lined up, they should be recorded in the Sample Disposal Logbook (SDL). Refer to Figure 1 for an example SDL page. The location the samples were removed from should also be recorded. Sample storage areas are recorded with the following designations:

VOA (Aq)	Aqueous Volatiles(VOA)
VOA (SL)	Solid Volatiles(VOA)
M	Metals
EXT	Extractables (Organic)
TOC	Total Organic Carbon
WC	Wet Chemistry
S	Soils

7.7 The next step is to use the sample disposal list to determine the earliest release date of the reports and to determine each samples appropriate waste classification/characterization. As stated in section 7.3, the primary disposal categories listed in the report are: non-hazardous, high organics, high metals, flashpoint, high mercury, high PCBs, and high cyanide.

Using the information from the KIMS disposal list, record the appropriate classification for each sample in the SDL. If multiple categories are identified as being present then a single category is selected as controlling. The order of precedence is PCB's, metals and then organics. If another scenario is found, the individual should bring it to the EHSO for a determination of the acceptable waste stream designation or a determination that it should be lab packed separately.

If samples have been sorted that have not been in storage for the 30 days beyond the release date (60 or 90 for certain clients), then these samples need to be placed back in storage and it should be noted in the SDL.

7.8 As stated above, a sample may be categorized into a waste stream based upon the analytes it contains as determined by laboratory testing. In addition, many samples are also categorized as hazardous waste based upon the preservative that they contain. Since many samples contain preservatives, caution must be used when dumping samples. It is also important to ensure that the sample container is empty. This can be accomplished by holding the container upside down and shaking gently until liquid is no longer observed coming out of the container.

7.9 Once waste categories have been determined and entered into the SDL, The following waste categories are disposed of as follows:

7.9.1 Dumping non-hazardous samples (as determined by laboratory testing)

Non-hazardous samples (non-preserved) are poured directly into the sink in the warehouse.

Non-hazardous solid samples are disposed of with the general trash, which is picked up by commercial trash collectors and ultimately disposed of in a waste-to-energy incinerator.

Sample containers from non-hazardous samples are disposed of with the general trash.

7.9.2 Dumping Samples with high Organics (as determined by laboratory testing)

Aqueous samples get dumped into waste stream “K”. Containers are disposed of with general trash. Solid samples are placed into waste stream “I” with their containers. The disposal date is recorded in the SDL.

7.9.3 Dumping samples high in metals, including mercury (as determined by the by laboratory testing)

Aqueous samples get disposed of in waste stream “A”. Containers are disposed of with general trash. Solid samples are placed in waste stream “L” with their containers. The disposal date is recorded in the SDL.

7.9.4 Dumping Acidic Samples that do not contain any other hazardous waste constituents (as determined by the acidic preservative or by laboratory testing)

Refer to section 7.10 below.

7.9.5 Dumping Basic samples (as determined by the basic preservative or by laboratory testing)

Aqueous samples get disposed of in waste stream “NHi”. Containers are disposed of with general trash. The disposal date is recorded in the SDL.

7.9.6 Dumping samples with high PCBs (as determined by laboratory testing)

Aqueous samples are disposed of in waste stream “Q”. Containers are disposed of with general trash. Solid samples get disposed of in waste stream “F” with their containers. The disposal date is recorded in the SDL.

7.9.7 Dumping samples with low flashpoints (as determined by laboratory testing)

Aqueous samples are disposed of in waste stream “O”. Containers are disposed of with general trash. Solid samples get disposed of in waste stream “I” with their containers. The disposal date is recorded in the SDL.

7.9.8 Dumping samples with high cyanide (as determined by laboratory testing)

Aqueous samples are disposed of in waste stream “NHi”. Containers are disposed of with general trash. Solid samples should be set aside for labpack. The disposal date is recorded in the SDL.

7.9.9 Miscellaneous Disposal (as determined by the preservative)

Sodium Bisulfate: Sodium Bisulfate often comes in vials, but may also come in the 2-4oz glass jars. Dump the Sodium Bisulfate out of the container into waste stream “A”. There may be remaining soil left in the sample container. The soil’s waste stream and dump date will be dictated by the SDL. The disposal date is recorded in the SDL.

Methanol / Free Products: This often comes in vials, but may also come in the 2-4oz glass jars. Dump the methanol out of the container into the mix-flammables accumulation. When this satellite accumulation container gets full it can be dumped into the “O” waste stream. There may be remaining soil left in the sample container. The soil’s waste stream and dump date will be dictated by the SDL. Lastly, samples marked “free product” on the Katahdin sample ID label can be dumped into the mixed flammables stream. The disposal date is recorded in the SDL.

7.10 Pursuant to Maine DEP regulations, Katahdin has the necessary agreements, processes and documentation in place to neutralize samples without a license. Refer to the current revision of the Katahdin Environmental Health & Safety Manual for additional information. Generally, the following procedures are followed.

7.10.1 Samples that have been determined to be hazardous due **solely** to the corrosivity characteristic are neutralized using sodium hydroxide pellets. In the warehouse, samples are emptied into a five gallon heavy duty carboy to about 60% capacity. The carboy is kept in a secondary container. Sodium hydroxide pellets are added slowly to the carboy (about 5 grams at a time) and stirred with a long glass stirring rod. The pH is checked with pH paper.

7.10.2 This process is continued until the pH is between 7 and 8. This normally takes about 30-40 grams of sodium hydroxide pellets, but may vary depending on the buffering capacity of the individual samples.

7.10.3 The carboy is emptied into the sink in the warehouse. The tap water is run at the same time as the neutralized material is disposed of. An eyewash station and spill material is located at this sink.

7.10.4 All neutralization activities are documented, including the date and time of neutralization, the name of the person doing the neutralizing, the amount of neutralized liquid discharged, details on the inspection of the drain area and the date and nature of any significant repairs or corrective actions. This documentation is maintained by the EHSO. Refer to Figure 5 for an example logbook page of neutralization documentation.

7.11 Every 3 to 5 weeks a pickup of hazardous waste is scheduled with the 3rd party waste transporter/waste disposal firm. An inventory is faxed to the transporter summarizing the number of drums and waste streams/profiles. As required, a “lab pack” of expired chemicals or orphan samples is organized as necessary. A designated individual, with applicable Hazardous Waste (RCRA) and Department of Transportation (DOT) training, oversees the waste pickup and signs the hazardous manifests and land ban documentation. Within 7 days a copy is forwarded to the Maine Department of Environmental Protection (MEDEP) and the environmental agency in the designation state (if required by that state). Once the report is received at the disposal facility a copy is returned to KATAHDIN and the MEDEP.

7.12 Prior to March 31 of each year, the laboratory prepares the Annual Hazardous Waste Report (i.e., MEDEP modified EPA Form 8700-13A) as required by MEDEP Hazardous Waste Management Rules. The complete report is reviewed by the Katahdin Environmental Compliance Officer and then forwarded to the following address:

Maine Department of Environmental Protection
Bureau of Remediation & Waste Management
State House Station #17
Augusta, ME. 04333
Attn: Annual Hazardous Waste Report

TITLE: SAMPLE DISPOSAL

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

On a daily basis, a designated individual performs quality checks in all hazardous waste storage areas. The daily check documentation is located in login. Any discrepancy is copied to the Operations Manager and the Katahdin Vice President for corrective action. Refer to the current revision of Katahdin SOP CA-107, *The Management of Hazardous Waste as it Relates to the Disposal of Laboratory Process Waste, Reagents, Solvents & Standards*, for more information. Refer to Figure 3 for a copy of the daily check documentation.

9.0 METHOD PERFORMANCE

Not applicable.

10.0 APPLICABLE DOCUMENTS/REFERENCES

USEPA Code of Federal Regulations, 40 CFR Part 261.

Maine Department of Environmental Protection (ME DEP) Hazardous Waste Management Rules

ME DEP modified EPA Form 8700-13A

LIST OF TABLES AND FIGURES

Figure 1 Example of Sample Disposal Logbook
Figure 2 Example of KIMS Generated Waste Disposal Report
Figure 3 Example Of Hazardous Waste Area Daily Check Documentation
Figure 4 Characteristic Toxic Hazardous Waste and TCLP concentrations
Figure 5 Example of Elementary Neutralization Logbook

TITLE: SAMPLE DISPOSAL

FIGURE 1

EXAMPLE OF SAMPLE DISPOSAL LOGBOOK (SDL)

KATAHDIN ANALYTICAL SERVICES, INC. –SAMPLE STORAGE/DISPOSAL LOGBOOK

WORK ORDER/ SAMPLE NUMBERS	DEPARTMENT	EARLIEST RELEASE DATE	< CRITERIA	SAMPLE KNOWLEDGE									DATE DISPOSED	INITIALS
			CLEAN	WL	ORG	METS	CN	FP	HG	PCBS				
SAS783-1	WC	10-17-07	✓										1-22-08	GN
SAS786-1		10-17-07	✓											
SAS787-1,2,4		10-17-07	✓											
SAS790-1		10-14-07		✓										
SAS793-1		10-17-07	✓											
SAS795-1-9		10-23-07	✓											
SAS797-1		10-23-07	✓											
SAS798-1,2		10-25-07			✓									
SAS799-1-5		10-31-07	✓											
SAS804-1,2		10-25-07	✓											
SAS809-1,2		10-23-07	1			2				2				
SAS810-1-4		10-23-07	✓											

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TITLE: SAMPLE DISPOSAL

FIGURE 2

EXAMPLE OF KIMS GENERATED WASTE DISPOSAL REPORT

SAMPLE DISPOSAL REPORT

Query by: Login SA6501 to SA7000
Date : 15-JAN-08

Sample	SDG	Status	Mail Date	Parameter	Value		
SA6605-1		NEED	12/02/07				
SA6606-1		NEED	12/02/07				
SA6607-1		NEED	11/15/07				
SA6608-1		NEED	12/06/07				
				ORG	1.17	MG/L	(HIGH)
SA6608-1		NEED	12/06/07				
SA6608-2		NEED	12/06/07				
				AA	13	MG/KG	(HIGH)
SA6609-1		NEED	11/26/07				
SA6609-1		NEED	11/26/07				
SA6610-1		NEED	11/30/07				
SA6611-1	FCS-020	NEED	12/07/07				
SA6611-2	FCS-020	NEED	12/07/07				
SA6611-3	FCS-020	NEED	12/07/07				
SA6611-4	FCS-020	NEED	12/07/07				
SA6611-5	FCS-020	NEED	12/07/07				
SA6611-6	FCS-020	NEED	12/07/07				
SA6611-7	FCS-020	NEED	12/07/07				
SA6611-8	FCS-020	NEED	12/07/07				
SA6612-1	NSA-030	NEED	12/07/07				
SA6612-2	NSA-030	NEED	12/07/07				
SA6612-3	NSA-030	NEED	12/07/07				
SA6612-4	NSA-030	NEED	12/07/07				
				ORG	1.70735	MG/L	(HIGH)
SA6612-5	NSA-030	NEED	12/07/07				
				ORG	1.0481	MG/L	(HIGH)

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TITLE: SAMPLE DISPOSAL

FIGURE 3

EXAMPLE OF HAZARDOUS WASTE STORAGE AREA DAILY CHECK

Daily Checklist for
HAZARDOUS WASTE STORAGE AREA

Week of: 1-28, 20 03

Item/Day:	Monday	Tuesday	Wednesday	Thursday	Friday
1. Are containers closed? (Except when waste is being added)	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
2. Are containers properly labeled with a hazardous waste label?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
3. Do you have access to each container and can you read the label? (36" aisle?)	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
4. Is each container marked with the date storage began?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
5. Are the dates on the containers less than 90 days old?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
6. Is container free of dents, bulges, rust, spills or leaks?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
7. Are all containers on a firm working surface?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
8. Inspection by: Name (No Initials)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
9. Time of Inspection	16:35	15:00	14:45	14:15	16:25
10. Verification of Inspection (Name/Date)	[illegible] 1-25-03	[illegible] 1-29-03	[illegible] 1-30-03	[illegible] 1-31-03 14:15	[illegible] 1-02 1700

Deficiency noted:					
Corrective action:					
By (Name/Date):					

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TITLE: SAMPLE DISPOSAL

FIGURE 4

CHARACTERISTIC TOXIC HAZARDOUS WASTE AND TCLP CONCENTRATIONS

Chemical Name	CAS Number	Waste Code	TCLP conc. liquid	Equivalent conc. In Soil
Arsenic	7440-38-2	D004	5.0 mg/L	100 mg/kg
Barium	7440-39-3	D005	100 mg/L	2000 mg/kg
Cadmium	7440-43-9	D006	1.0 mg/L	20 mg/kg
Chromium	7440-47-3	D007	5.0 mg/L	100 mg/kg
Lead	7439-92-1	D008	5.0 mg/L	100 mg/kg
Mercury	7439-97-6	D009	0.2 mg/L	4 mg/kg
Selenium	7782-49-2	D010	1.0 mg/L	100 mg/kg
Silver	7440-22-4	D011	5.0 mg/L	20 mg/kg
Endrin	72-20-8	D012	0.02 mg/L	0.4 mg/kg
Lindane	58-89-9	D013	0.4 mg/L	8 mg/kg
Methoxychlor	72-43-5	D014	10 mg/L	200 mg/kg
Toxaphene	8001-35-2	D015	0.5 mg/L	10 mg/kg
2,4-D	94-75-7	D016	10 mg/L	200 mg/kg
2,4,5-TP (Silvex)	93-72-1	D017	1.0 mg/L	20 mg/kg
Benzene	71-43-2	D018	0.5 mg/L	10 mg/kg
Carbon Tetrachloride	56-23-5	D019	0.5 mg/L	10 mg/kg
Chlordane	57-74-9	D020	0.03 mg/L	0.6 mg/kg
Chlorobenzene	108-90-7	D021	100 mg/L	2000 mg/kg
Chloroform	67-66-3	D022	6.0 mg/L	120 mg/kg
o-Cresol	95-48-7	D023	200 mg/L	4000 mg/kg
m-Cresol	108-39-4	D024	200 mg/L	4000 mg/kg
p-Cresol	106-44-5	D025	200 mg/L	4000 mg/kg
Cresol	1319-77-3	D026	200 mg/L	4000 mg/kg
1,4-Dichlorobenzene	106-46-7	D027	7.5 mg/L	150 mg/kg
1,2-Dichloroethane	107-06-2	D028	0.5 mg/L	10 mg/kg
1,1-Dichloroethylene	75-35-4	D029	0.7 mg/L	14 mg/kg
2,4-Dinitrotoluene	121-14-2	D030	0.13 mg/L	2.6 mg/kg
Heptachlor	76-44-8	D031	0.008 mg/L	0.16 mg/kg
Hexachlorobenzene	118-74-1	D032	0.13 mg/L	2.6 mg/kg
Hexachlorobutadiene	87-68-3	D033	0.5 mg/L	10 mg/kg
Hexachloroethane	67-72-1	D034	3.0 mg/L	60 mg/kg
Methyl Ethyl Ketone	78-93-3	D035	200 mg/L	4000 mg/kg
Nitrobenzene	98-95-3	D036	2.0 mg/L	40 mg/kg
Pentachlorophenol	87-86-5	D037	100 mg/L	2000 mg/kg
Pyridine	110-86-1	D038	5.0 mg/L	100 mg/kg
Tetrachloroethylene	127-18-4	D039	0.7 mg/L	14 mg/kg
Trichloroethylene	79-01-6	D040	0.5 mg/L	10 mg/kg

FIGURE 4, cont'd

CHARACTERISTIC TOXIC HAZARDOUS WASTE AND TCLP CONCENTRATIONS

Chemical Name	CAS Number	Waste Code	TCLP conc. liquid	Equivalent conc. In Soil
2,4,5-Trichlorophenol	95-95-4	D041	400 mg/L	8000 mg/kg
2,4,6-Trichlorophenol	88-06-2	D042	2.0 mg/L	40 mg/kg
Vinyl Chloride	75-01-4	D043	0.2 mg/L	4.0 mg/kg

TITLE: SAMPLE DISPOSAL

FIGURE 5

EXAMPLE OF ELEMENTARY NEUTRALIZATION LOGBOOK

Katahdin Analytical Services, Inc. – Elementary Neutralization Logbook

Date: 3-4-09		Time: 12:00	Analyst: GN
# of gallons neutralized	Final pH	Condition of drain and sink area before and after neutralization.	Significant Repairs or Corrective Actions
5	5	good	
6	7	good	
6	5	good	
6	6	good	
2	8	good	

25
240

Date: 3-10-09		Time: 13:45	Analyst: GN
# of gallons neutralized	Final pH	Condition of drain and sink area before and after neutralization.	Significant Repairs or Corrective Actions
6	7	good	
6	6	good	
5	6	good	
6	8	good	
6	5	good	
6	8	good	
5	5	good	
6	7	good	
3	5	good	

49
289

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Parameter	CAS Number	Units	USEPA Maximum Conatminant Level (1)	USEPA Regional Screening Level for Tapwater (2)	USEPA Regional Screening Level for Tapwater Risk Basis (3)	USEPA Regional Screening Level for Tapwater 1/10 PAL for Non-Carc.	Final Screening Level (4)	Source of Final Screening Level
1,1,1-TRICHLOROETHANE	71-55-6	UG/L	200	9100	N	910	66.7	GWPS
1,1,2,2-TETRACHLOROETHANE	79-34-5	UG/L		0.067			0.0223	RSL-Tapwater
1,1,2-TRICHLOROETHANE	79-00-5	UG/L	5	0.24			1.67	GWPS
1,1,2-TRICHLOROTRIFLUOROETHANE	76-13-1	UG/L		59000	N	5900	1970	RSL-Tapwater
1,1-DICHLOROETHANE	75-34-3	UG/L		2.4			0.8	RSL-Tapwater
1,1-DICHLOROETHENE	75-35-4	UG/L	7	340	N	34	2.33	GWPS
1,2,3-TRICHLOROBENZENE	87-61-6	UG/L		29	N	2.9	0.967	RSL-Tapwater
1,2,4-TRICHLOROBENZENE	120-82-1	UG/L	70	2.3			23.3	GWPS
1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	UG/L	0.2	0.00032			0.0667	MCL
1,2-DIBROMOETHANE	106-93-4	UG/L	0.05	0.0065			0.0167	MCL
1,2-DICHLOROBENZENE	95-50-1	UG/L	600	370	N	37	200	GWPS
1,2-DICHLOROETHANE	107-06-2	UG/L	5	0.15			1.67	GWPS
1,2-DICHLOROPROPANE	78-87-5	UG/L	5	0.39			1.67	GWPS
1,3-DICHLOROBENZENE	541-73-1	UG/L					NC	GWPS
1,4-DICHLOROBENZENE	106-46-7	UG/L	75	0.43			25	GWPS
1,4-DIOXANE	123-91-1	UG/L		6.1			2.03	RSL-Tapwater
2-BUTANONE	78-93-3	UG/L		7100	N	710	237	RSL-Tapwater
2-HEXANONE	591-78-6	UG/L		47	N	4.7	1.57	RSL-Tapwater
4-METHYL-2-PENTANONE	108-10-1	UG/L		2000	N	200	66.7	RSL-Tapwater
ACETONE	67-64-1	UG/L		22000	N	2200	733	RSL-Tapwater
BENZENE	71-43-2	UG/L	5	0.41			1.67	GWPS
BROMOCHLOROMETHANE	74-97-5	UG/L					NC	GWPS
BROMODICHLOROMETHANE	75-27-4	UG/L	80	0.12			26.7	MCL
BROMOFORM	75-25-2	UG/L	80	8.5			2.83	MCL
BROMOMETHANE	74-83-9	UG/L		8.7	N	0.87	0.29	RSL-Tapwater
CARBON DISULFIDE	75-15-0	UG/L		1000	N	100	33.3	RSL-Tapwater
CARBON TETRACHLORIDE	56-23-5	UG/L	5	0.44			1.67	GWPS
CHLOROBENZENE	108-90-7	UG/L	100	91	N	9.1	33.3	GWPS
CHLORODIBROMOMETHANE	124-48-1	UG/L	80	0.15			26.7	MCL
CHLOROETHANE	75-00-3	UG/L		21000	N	2100	700	RSL-Tapwater
CHLOROFORM	67-66-3	UG/L	80	0.19			26.7	MCL
CHLOROMETHANE	74-87-3	UG/L		190	N	19	6.33	RSL-Tapwater
CIS-1,2-DICHLOROETHENE	156-59-2	UG/L	70	370	N	37	23.3	GWPS
CIS-1,3-DICHLOROPROPENE	10061-01-5	UG/L		0.43			0.143	RSL-Tapwater
CYCLOHEXANE	110-82-7	UG/L		13000	N	1300	433	RSL-Tapwater
DICHLORODIFLUOROMETHANE	75-71-8	UG/L		390	N	39	13	RSL-Tapwater
ETHYLBENZENE	100-41-4	UG/L	700	1.5			233	GWPS
ISOPROPYLBENZENE	98-82-8	UG/L		680	N	68	22.7	RSL-Tapwater
M+P-XYLENES	TTNUS054	UG/L	10000				3330	GWPS

Parameter	CAS Number	Units	USEPA Maximum Conatminant Level (1)	USEPA Regional Screening Level for Tapwater (2)	USEPA Regional Screening Level for Tapwater Risk Basis (3)	USEPA Regional Screening Level for Tapwater 1/10 PAL for Non-Carc.	Final Screening Level (4)	Source of Final Screening Level
METHYL ACETATE	79-20-9	UG/L		37000	N	3700	1230	RSL-Tapwater
METHYL CYCLOHEXANE	108-87-2	UG/L					NC	GWPS
METHYL TERT-BUTYL ETHER	1634-04-4	UG/L		12			4	RSL-Tapwater
METHYLENE CHLORIDE	75-09-2	UG/L	5	4.8			1.67	GWPS
O-XYLENE	95-47-6	UG/L	10000	1200	N	120	40	GWPS
STYRENE	100-42-5	UG/L	100	1600	N	160	33.3	GWPS
TETRACHLOROETHENE	127-18-4	UG/L	5	0.11			1.67	GWPS
TOLUENE	108-88-3	UG/L	1000	2300	N	230	5	GWPS
TRANS-1,2-DICHLOROETHENE	156-60-5	UG/L	100	110	N	11	33.3	GWPS
TRANS-1,3-DICHLOROPROPENE	10061-02-6	UG/L					NC	GWPS
TRICHLOROETHENE	79-01-6	UG/L	5	2			1.67	GWPS
TRICHLOROFLUOROMETHANE	75-69-4	UG/L		1300	N	130	0.6	RSL-Tapwater
VINYL CHLORIDE	75-01-4	UG/L	2	0.016			0.667	GWPS

1 - USEPA Maximum Contaminant Level
2 - USEPA Regional Screening Level for Tapwater
3 - Georgia Groundwater Protection Standard
4 - Final Screening Levels were selected in the following order of preference:
  a. Georgia Groundwater Protection Standard
  b. USEPA Maximum Contaminant Level
  c. USEPA Regional Screening Level for Tapwater

Source of Screening Level
GWPS - Georgia Groundwater Protection Standard
RSL-Tapwater - USEPA Regional Screening Level for Tapwater
MCL - USEPA Maximum Contaminant Level
NC - No criteria available