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FINAL SAMPLING AND ANALYSIS PLAN FOR VAPOR INTRUSION INVESTIGATION
OPERABLE UNIT 1 (OU1) MCAS CHERRY POINT NC
8/1/2009
CH2M HILL

SAP Worksheet #1—Title and Approval Page

Final

**Sampling and Analysis Plan
Vapor Intrusion Investigation
Operable Unit 1**

**Marine Corps Air Station, Cherry Point
Cherry Point, North Carolina**

Contract Task Order 177

August 2009

Prepared for

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

Under the

**NAVFAC CLEAN III Program
Contract N62470-02-D-3052**

Prepared by

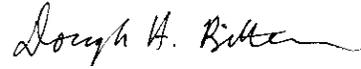


CH2MHILL

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Executive Summary

This Sampling and Analysis Plan (SAP) is prepared to support the proposed field activities at Operable Unit 1 (OU1) at Marine Corps Air Station (MCAS) Cherry Point, North Carolina. This United States Navy (Navy) specific SAP includes 37 worksheets that detail various aspects of the environmental investigation process and serves as a guideline for the field activities and data quality assessment. This SAP was developed in accordance with two guidance documents: 1) U.S. Environmental Protection Agency (USEPA), *EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS* (USEPA, 2002), and 2) USEPA, *Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP)* (USEPA, 2005). The Data Quality Objectives (DQOs) were prepared using USEPA's seven-step DQO process.

This SAP was prepared under the Navy Comprehensive Long-Term Environmental Action (CLEAN) III Contract N62470-02-D-3052, Contract Task Order 0177, for submittal to the Navy, specifically the Naval Facilities Engineering Command, Mid-Atlantic Division (NAVFAC Mid-Atlantic), MCAS Cherry Point Environmental Affairs Department (EAD), USEPA Region 4, and North Carolina Department of Environment and Natural Resources (NCDENR). NAVFAC Mid-Atlantic, EAD, USEPA, and NCDENR work jointly as the MCAS Cherry Point Tier I Partnering Team.

A vapor intrusion evaluation is being conducted by the Navy to assess potential vapor intrusion migration of chlorinated Volatile Organic Compounds (VOCs) from contaminated groundwater into overlying industrial buildings at OU1. Analytical data collected as part of this investigation will be used to understand if a complete exposure pathway exists and if there are current unacceptable risks to building occupants.

The vapor intrusion evaluation is being conducted in accordance with the following vapor intrusion guidance:

- *Vapor Intrusion Pathway: A Practical Guide* by Interstate Technology and Regulatory Council (ITRC), January 2007.
- *DoD Vapor Intrusion Handbook* by the Department of Defense (DoD), 2009.

The vapor intrusion evaluation approach consists of four primary steps: Step 1 - Identification of Buildings of Interest; Step 2 - Desktop Risk Evaluation; Step 3 - Sampling and Analysis; and Step 4 - Risk Evaluation. Steps 1 and 2 have been completed in the preparation of this SAP. The plan for Steps 3 and 4 are discussed in detail in this SAP. Each step is described below:

- **Step 1 - Identification of Buildings of Interest**
 - *Selection of Constituents of Potential Concern (COPCs)*. Groundwater data collected from the upper and lower portions of the surficial aquifer as part of the OU1 RI Addendum activities was screened against generic vapor intrusion screening levels from the 2002 USEPA Draft Vapor Intrusion Guidance target groundwater concentrations based on a 1×10^{-6} cancer risk and a non-cancer hazard quotient (HQ) of 1.0.

- *Selection of Buildings of Interest.* Buildings located above the VOC groundwater plume as mapped in the OU1 RI Addendum, or located within 100 feet of groundwater monitoring wells with COPC concentrations that exceeded the generic screening levels, were selected as buildings of interest for further vapor intrusion evaluation.
- *Building Survey.* A building survey (site reconnaissance) was conducted at each building of interest to describe building type, size, status, occupancy, and construction.
- **Step 2 - Desktop Risk Evaluation**
 - *Refinement of Buildings of Interest.* Site-specific modeling was conducted to determine site-specific screening values, which focuses sampling activities at buildings with the highest potential for vapor intrusion migration. The Johnson and Ettinger (J&E) model was used, with data collected as part of the OU1 RI Addendum and the building survey.
 - *Buildings Identified for Sampling.* Buildings located within 100 feet of upper surficial aquifer monitoring wells with groundwater concentrations above the site-specific screening values were selected as buildings that required further investigation.
- **Step 3 - Sampling and Analysis**
 - Shallow groundwater, near-slab soil vapor, and/or subslab soil vapor samples will be collected at buildings identified through Steps 1 and 2 to further characterize the potential vapor intrusion pathway. This SAP documents the appropriate number, type, location, and rationale of samples to be collected at buildings retained for sampling. During field activities, the presence of potential preferential pathways (e.g., utility corridors) will also be identified.
- **Step 4 - Risk Evaluation**
 - The sampling results will be evaluated to develop a conceptual site model for each building identified with a potential vapor intrusion pathway. Data will be evaluated using a “multiple lines of evidence” approach, as outlined in the vapor intrusion guidance document published by ITRC, the Interstate Technology & Regulatory Council (ITRC, 2007). The predictive modeling (using the J&E model) will be updated using the analytical results, and the data will be re-screened. Upon evaluation of the sampling results, identified preferential pathways will be evaluated to determine whether any additional buildings may require further investigation.
 - The results of this risk evaluation will be used to make decisions regarding further actions, or if appropriate, to evaluate mitigation and/or remediation measures for specific buildings.
 - The sampling results and risk evaluations will be documented in a summary report. The summary report will include the building inventory, analytical results and comparison to screening levels, and maps showing sampling and building locations.

This SAP will help ensure that environmental data collected or compiled are scientifically sound, of known and documented quality, and suitable for intended uses. The laboratory information cited in this SAP is for the contracted laboratories that provide analytical

services for this investigation. The analytical services for this investigation will be provided by Test America Laboratories in Knoxville, TN. Data validation services will be provided by Environmental Data Services.

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- 2 OU1 – Site Location Map
- 3 Operable Unit 1 Location Map
- 4 Simplified Conceptual Hydrogeology of OU1
- 5 Trichloroethene (TCE) Isoconcentration Map, Upper Surficial Aquifer
- 6 Trichloroethene (TCE) Isoconcentration Map, Lower Surficial Aquifer
- 7 Vapor Intrusion Conceptual Site Model for Building 133
- 8 Buildings of Interest
- 9 Buildings Retained for Sampling
- 10 Field Investigation Decision Logic
- 11 Proposed Sample Locations
- 12 Risk Evaluation Strategy

Tables

- 1 Building Inventory at OU1
- 2 Site-Specific Vapor Intrusion Screening Levels

Appendixes

- A Generic Screening Values
- B Johnson & Ettinger Model
- C Field SOPs
- D Laboratory SOPS
- E Data Management Plan

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Acronyms and Abbreviations

AM	Activity Manager
CA	Corrective Action
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CIH	Certified Industrial Hygienist
CLP	Contract Laboratory Program
COC	Contaminant of Concern
COPC	Constituents of Potential Concern
CTO	Contract Task Order
cVOC	Chlorinated Volatile Organic Compounds
DNAPL	Dense Non-Aqueous Phase Liquid
DoD	Department of Defense
DPT	Direct-Push Technology
DQI	Data Quality Indicator
DQO	Data Quality Objective
EAD	Environmental Affairs Department
EDS	Environmental Data Service
EIS	Environmental Information Specialist
FFS	Focused Feasibility Study
FRCE	Fleet Readiness Center - East
FS	Feasibility Study
FSP	Field Sampling Plan
FTL	Field Team Lead
GC	Gas Chromatograph
GC/MS	Gas Chromatograph/Mass Spectrometer
GW	Ground Water
H&S	Health and Safety
HHRA	Human Health Risk Assessment
HQ	Hazard Quotient
IDW	Investigation Derived Waste
IR	Installation Restoration
ITRC	Interstate Technology and Regulatory Council
IWTP	Industrial Wastewater Treatment Plant
J&E	Johnson and Ettinger
LCS	Laboratory Control Sample
LIMS	Laboratory Information Management Systems
MCAS	Marine Corps Air Station

MDL	Method Detection Limit
MS/MSD	Matrix Spike/Matrix Spike Duplicate
NA	Not Applicable
Navy	United States Navy
NCDENR	North Carolina Department of Environment and Natural Resources
OU1	Operable Unit 1
PAL	Project Action Limit
PID	Photo Ionization Detector
PM	Project Manager
PPE	Personal Protective Equipment
PQO	Project Quality Objective
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
QL	Quantitation Limit
RI	Remedial Investigation
RPD	Relative Percent Difference
RPM	Remedial Project Manager
RSD	Relative Standard Deviation
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SSC	Site Safety Coordinator
SNEDD	Supplemental Naval Installation Restoration Information Solution Electronic Data Deliverable
SOP	Standard Operating Procedure
TAL	Test America Laboratories
TBD	To Be Determined
UFP	Uniform Federal Policy
USEPA	U.S. Environmental Protection Agency
UST	Underground Storage Tank
VOA	Volatile Organic Analyte
VOC	Volatile Organic Compound

SAP Worksheet #2—SAP Identifying Information

Site Name/Number:OU1 Central Groundwater Plume
Operable Unit: OU1
Contractor Name: CH2M HILL
Contract Number: N62470-02-D-3052 CTO-177
Contract Title: Navy CLEAN III

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

2. Identify regulatory program: CERCLA

3. This SAP is a project-specific SAP.

4. List dates of scoping sessions that were held:

Scoping Session	Date
Partnering Meeting	May 7, 2008
Partnering Meeting	July 29-30, 2008
Partnering Meeting	November 5-6, 2008

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

N/A

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

Lead Organization: U.S. Navy (NAVFAC, Mid-Atlantic and MCAS Cherry Point Environmental Affairs Department [EAD]); Lead Regulatory Agency: USEPA Region 4; State Regulatory Agency: North Carolina Department of Environment and Natural Resources (NCDENR).

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

All required SAP elements are provided in this document. The crosswalk table is not applicable and is not included in this document.

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SAP Worksheet #3—Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address	Document Control Number
Janice Nielsen	Remedial Project Manager (RPM)	NAVFAC Mid-Atlantic	Phone: (757) 322-8339 Fax: (757) 322-8280	Email: janice.nielsen@navy.mil (Mailing and FedEx address): Commander NAVFAC MIDLANT Attn: Janice Nielsen LRA, Building C, NC IPT 6506 Hampton Blvd Norfolk, VA 23508-1278	(A PANTAGON number will be assigned when the final document is being prepared.)
Jeff Christopher	Installation Restoration (IR) Program Manager	MCAS Cherry Point Environmental Affairs Department	Phone: (252) 466-4421 Fax: (252) 466-2000	Email: jeffrey.christopher@usmc.mil (Mailing address): MCAS Cherry Point PSC Box 8006 Cherry Point, NC 28533-0006 (FedEx address): MCAS Cherry Point Building 4223, Access Road Cherry Point, NC 28533-0006	
Gena Townsend	RPM	USEPA Region 4	Phone: (404) 562-8538 Fax: (404) 562-8518	Email: townsend.gena@epa.gov (Mailing and FedEx address): USEPA Region 4 Atlanta Federal Center Superfund Division Federal Facilities Branch 61 Forsyth St. SW Atlanta, GA 30303-3104	
George Lane	RPM	NCDENR	Work Phone: (919) 508-8462 Fax: (919) 733-4811	Email: george.lane@ncdenr.gov (Mailing address): NC Department of Environmental and Natural Resources, Superfund Section PO Box 27687 Raleigh, NC 27699-1646 (FedEx address): NC Department of Environment and Natural Resources, Superfund Section 401 Oberlin Rd., Suite 150 Raleigh, NC 27605	
Bonnie Capito	Librarian	NAVFAC Atlantic	(757) 322-4785	bonnie.capito@navy.mil	
Doug Bitterman	Activity Manager (AM)	CH2M HILL	(757) 671-6209 (703) 627-3291 (cell)	Doug.bitterman@ch2m.com	

SAP Worksheet #3—Distribution List (continued)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address	Document Control Number
Bill Hannah	Project Manager (PM)	CH2M HILL	(757) 671-6277	Bill.hannah@ch2m.com	(A PANTAGON number will be assigned when the final document is being prepared.)
Megan Morrison	Project Chemist	CH2M HILL	(401) 619-2657	Megan.Morrison@ch2m.com	
Loren Lund	Senior Technical Vapor Intrusion Technologist	CH2M HILL	(208) 357-5351	loren.lund@ch2m.com	
Kyle Block	Project Environmental Information Specialist (EIS)	CH2M HILL	(617)-626-7013	Kyle.block@ch2m.com	
TBD	Field Team Leader (FTL)	CH2M HILL	TBD		
TBD	Field Crew Members	CH2M HILL	TBD		
Mark Orman	Health and Safety (H&S) Officer	CH2M HILL	(414) 847-0597	mark.orman@ch2m.com	
Roni Warren	Human Health Risk Assessor	CH2M HILL	(814) 364-2454	Roni.warren@ch2m.com	
Dan Lavoie	Ecological Risk Assessor	CH2M HILL	(202) 290-1455	daniel.lavoie@ch2m.com	
Jamie McKinney	PM	Test America Laboratories- Knoxville Branch (TAL-Knoxville)	(865) 291-3000	Jamie.Mckinney@TestAmericaInc.com	
Chris Rigell	Quality Assurance (QA) Officer	TAL- Knoxville	(865) 291-3011	Chris.Rigell@TestAmericaInc.com	
Nancy Weaver	PM	Environmental Data Services (EDS)	(757) 564-0090	nweaver@env-data.com	
TBD- Drilling Subcontractor TBD- Utility Locating Subcontractor TBD- Surveyor TBD- IDW Disposal Subcontractor					

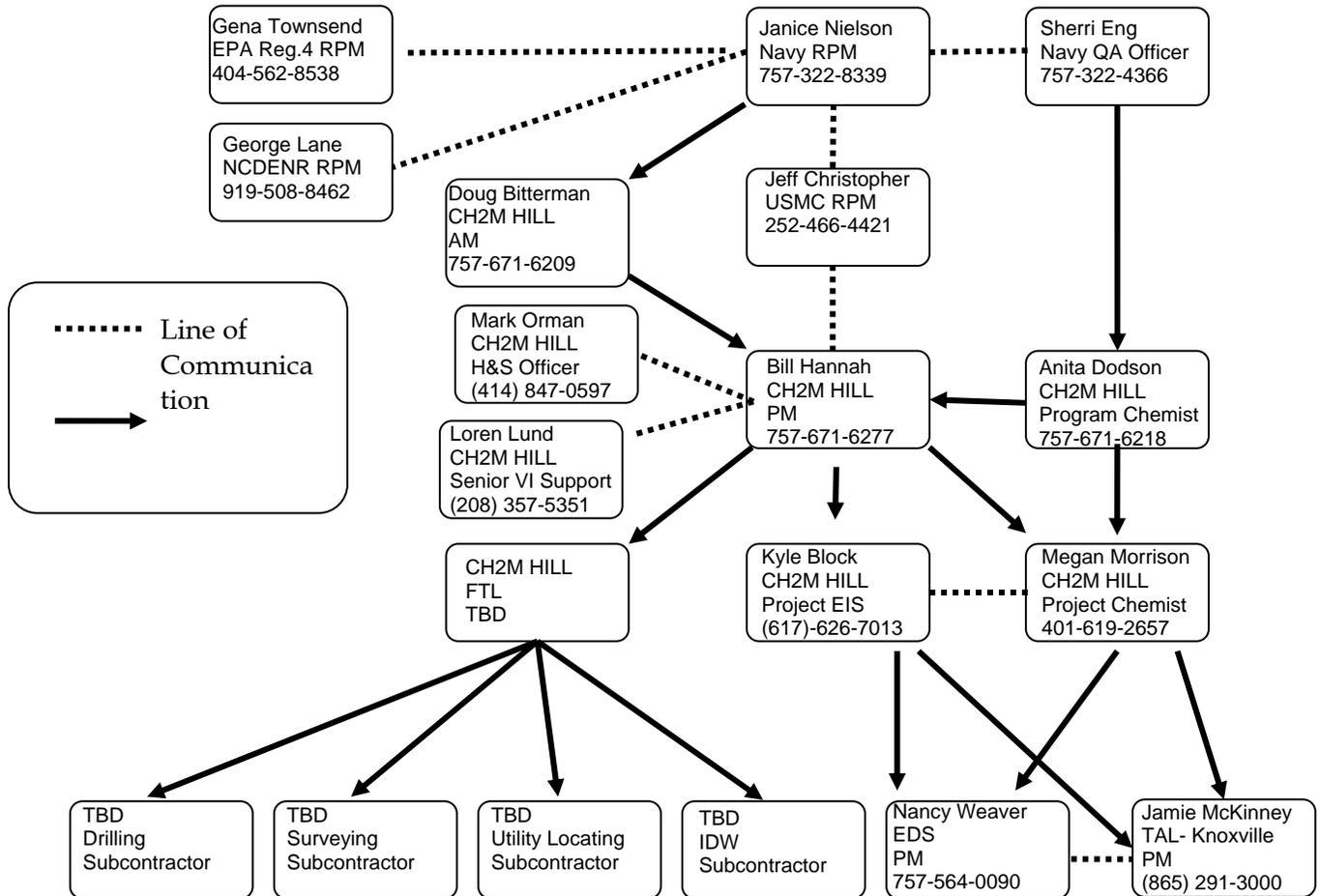
SAP Worksheet #4—Project Personnel Sign-Off Sheet

Name	Organization/Title/Role	Telephone Number	Signature/email Receipt	SAP Section Reviewed	Date SAP Read
Janice Nielsen	U.S. Navy/ RPM	(757) 322-8339 (757) 617-0987 (cell)			
Doug Bitterman	CH2M HILL/ AM and Activity Quality Manager	(757) 671-6209 (703) 627-3291 (cell)			
Jeff Christopher	MCAS EAD/ IR Program Manager	(252) 466-4421			
Gena Townsend	USEPA Region 4/ RPM	(404) 562-8538			
George Lane	NCDENR/ RPM	(919) 508-8462			
Bill Hannah	CH2M HILL/ PM	(757) 671-6277			
Anita Dodson	CH2M HILL/ Navy CLEAN Program Chemist	(757) 671-6218			
Brett Doerr	CH2M HILL/ Navy CLEAN Program UFP SAP Reviewer	(757) 671-6219			
Megan Morrison	CH2M HILL/ Project Chemist	(401) 619-2657			
Kyle Block	CH2M HILL/ Project EIS	(617)-626-7013			
Mark Orman	CH2M HILL/ Health and Safety Officer	(414) 847-0597			
TBD	CH2M HILL/ FTL	TBD			
TBD	CH2M HILL / Field Crew Members	TBD			
Roni Warren	CH2M HILL/ Human Health Risk Assessor	(814) 364-2454			
Linda McWhirter	TAL- Knoxville/ PM	(865) 291-3006			
Chris Rigell	TAL- Knoxville/ QA Officer	(865) 291-3011			
Bryan Dameron	TAL- Knoxville/ Sample Login, Receipt, Custody	(865) 291-3000			
Ryan Henry	TAL- Knoxville/ Sample Disposal	(865) 291-3000			

SAP Worksheet #4—Project Personnel Sign-Off Sheet (continued)

Name	Organization/Title/Role	Telephone Number	Signature/email Receipt	SAP Section Reviewed	Date SAP Read
David Flores	TAL- Knoxville/ Sample Prep (TO 15)	(865) 291-3000			
Anna Barlozhetskaya	TAL- Knoxville/ Sample Prep (8260B)	(865) 291-3000			
Holly Taj	TAL- Knoxville/ Sample Analysis/ Dept Manager (TO 15)	(865) 291-3000			
David Wiles	TAL- Knoxville/ Volatiles Department Manager	(865) 291-3000			
Scot Goss	TAL- Knoxville/ Sample Analysis (8260B)	(865) 291-3000			
Nancy Weaver	EDS/ PM	(757) 564-0090			
TBD- Drilling Subcontractor					
TBD- Utility Locating Subcontractor					
TBD- Surveyor Subcontractor					
TBD- IDW Disposal Subcontractor					

SAP Worksheet #5—Project Organizational Chart



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SAP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or e-mail	Procedure
Point of Contact with Partnering Team	Navy RPM for MCAS Cherry Point	Janice Nielsen	(757) 322-8339	Primary point of contact for Navy; all materials and information pertaining to the project will be forwarded to the Partnering Team as soon as possible following review.
Environmental Manager	MCAS Cherry Point IR Program Manager	Jeff Christopher	(252) 466-4421	Oversees all remedial activities at USMC Cherry Point. Any issues that may impact the Cherry Point operations are to be reported to him immediately. Point of contact for access to FRCE areas.
Primary contact for CH2M HILL activities	CH2M HILL AM for MCAS Cherry Point	Doug Bitterman	(757) 671-6209	Primary point of contact for Navy and MCAS Cherry Point RPMs; oversees CH2M HILL project delivery for this project.
Manage all Project Phases	CH2M HILL PM	Bill Hannah	(757) 671-6277	Issues reported to the Navy RPM immediately and followed up in writing within 2 business days. Implement modifications to the SAP.
Technical Vapor Intrusion Support	CH2M HILL Principal Technologist	Loren Lund	(208) 357-5351	Technical oversight of the project.
SAP changes in the field	CH2M HILL FTL			Notify the PM by phone and email of changes to the SAP made in the field and the reasons within 24 hours. Changes will be documented.
Daily Field Progress Reports	CH2M HILL FTL			Field Team Leader will email or fax daily field progress reports to PM; telephone communication with project managers on as-needed basis.
Data tracking from collection through upload to database	CH2M HILL EIS	Kyle Block	(617)-626-7013	EIS will track data from sample collection through upload to database, ensuring SAP requirements are met by laboratory and field staff. Issues will be communicated to the project chemist and PM as soon as possible.
Reporting Lab Data Quality Issues	Laboratory PM	Linda McWhirter, TAL- Knoxville	(865) 291-3006	All QA/QC issues with project filed samples will be reported by the lab to the EIS, Project Chemist, and Contractor Quality Assurance Officer within 2 business days. Contact for TAL staff.
Reporting Validated Data	Data Validation PM	Nancy Weaver, EDS	(757) 564-0090	The data validator will validate all environmental results within a turnaround time of 14 calendar days. The validator will contact the laboratory PM as soon as possible if issues are found with the data.
Field and Analytical Corrective Actions	CH2M HILL Program Chemist	Anita Dodson	(757) 671-6218	The need for corrective action for field and analytical issues will be determined by the Field Team Leader and/or Contractor Quality Assurance Officer.
Evaluation of Human Health Risks	Human Health Risk Assessor	Roni Warren	(814) 364-2454	Communication with project manager.
Field Subcontractor	Utility Clearance, Driller, and Waste Hauler staff	TBD		Communication with FTL and project manager.

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SAP Worksheet #7—Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organizational Affiliation	Responsibilities
Janice Nielsen	RPM	NAVFAC	Coordinates Environmental Restoration (CERCLA/ MRP) activities at MCAS Cherry Point.
Jeff Christopher	IR Program Manager	USMC Cherry Point	Oversight of remedial activities at MCAS Cherry Point.
Doug Bitterman	AM / Activity Quality Manager	CH2M HILL	Responsible for ERP at MCAS Cherry Point; Provides senior technical oversight and review.
Bill Hannah	PM	CH2M HILL	Directs and oversees staff and subcontractors. Develops SAP for Partnering Team and Navy review. Presents the findings of the investigation in a report for the Partnering Team for future site status decisions. Responsible for data usability evaluation and final decision-making.
Anita Dodson	Navy CLEAN Program Chemist	CH2M HILL	Provides program level review of UFP-SAP and provides support during UFP-SAP development
Brett Doerr	Navy CLEAN UFP-SAP Reviewer	CH2M HILL	Provides program level review of UFP-SAP
Loren Lund	Vapor Intrusion Technical Lead	CH2M HILL	Technical oversight of the project.
Megan Morrison	Project Chemist	CH2M HILL	Performs oversight of laboratory and data validators, releases analytical data, data usability evaluation.
TBD	FTL	CH2M HILL	Supervises field sampling and coordinates all field activities
Mark Orman	H&S Officer	CH2M HILL	Oversees health and safety for field activities
Kyle Block	EIS	CH2M HILL	Manages sample tracking, coordinates with laboratory and data-validator, data management
Linda McWhirter	Laboratory PM	TAL- Knoxville	Manages analytical projects from initiation to completion.
Nancy Weaver	Data Validation PM	EDS	Responsible for data validation.
TBD	Driller	TBD	Operates equipment used to collect soil and groundwater samples.
TBD	Utility Clearance	TBD	Clearance of underground utilities.
TBD	Waste Hauler	TBD	Disposal of IDW-generated materials

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SAP Worksheet #8—Special Personnel Training Requirements Table

Project Function	Specialized Training By Title or Description of Course	Training Provider	Training Date	Personnel / Groups Receiving Training	Personnel Titles / Organizational Affiliation	Location of Training Records / Certificates
Environmental Field Work	HAZWOPER 40 hour training and 8 hour refreshers	Various registered organizations	Annually	All field crew members	TBD/ CH2M HILL	CH2M HILL Human Resources Department
Environmental Field Work	3R Training (Recognize, Retreat, Report)	Internal, CH2M HILL	Project-specific	All field crew members	TBD/CH2M HILL	Document in personal HASP file
Site Safety Coordinator (SSC)	Site Safety Coordinator-Hazardous Waste Training	Internal to CH2M HILL	Every 3 years	At least one field crew member must be designated as the SSC	SSC/ CH2M HILL	CH2M HILL Human Resources Department

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

Project Name: Soil Vapor Investigation at OU1			Site Name: OU1		
Projected Date(s) of Sampling: Spring/Summer 2009			Site Location: MCAS Cherry Point, North Carolina		
Project Manager: Bill Hannah					
Date of Session: May 6-8, 2008					
Scoping Session Purpose: Partnering Team Meeting					
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Janice Nielsen	Remedial Project Manager	NAVFAC Mid-Atlantic	(757) 322-8339	janice.nielsen@navy.mil	Coordinates Navy Environmental Restoration (CERCLA/MRP) activities; Partnering Team member
Jeff Christopher	Installation Restoration Project Manager	MCAS Environmental Affairs Department	Phone: (252) 466-4421	jeffrey.christopher@usmc.mil	Coordinates MCASCP Environmental Restoration Activities; Partnering Team member
Gena Townsend	Remedial Project Manager	USEPA Region 4	Phone: (404) 562-8538	townsend.gena@epa.gov	EPA regulator; Partnering Team member
George Lane	Remedial Project Manager	NCDENR	(919) 508-8462	george.lane@ncdenr.gov	State regulator; Partnering Team member
Doug Bitterman	Activity Manager, MCAS Cherry Point	CH2M HILL	(757)-671-6209	Doug.Bitterman@CH2M.com	Overseeing UFP-SAP production, Work Plan production, and project support; Partnering Team member
Erica DeLattre	Project Manager	Rhea	(724)-443-4111	erica@rhea.us	Partnering Team member
Tim Wenk	Staff Consultant	CH2M HILL	(757)-671-6265	Tim.Wenk@CH2M.com	Drafted meeting minutes; Partnering Team member
Bill Hannah	Hydrogeologist	CH2M HILL	(757)-671-6277	Bill.Hannah@CH2M.com	Work Plan production
Barry Valicek	Environmental Protection Specialist	FRCE Environmental	(252) 464-5315	barry.valicek@navy.mil	FRCE Representative
Cliff Game	Lead Environmental Engineer	FRCE Environmental	(252) 464-7690	clifton.game@navy.mil	FRCE Representative

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

Comments/Decisions:

For OU1, the screening based on groundwater concentrations needs to be conducted to determine the potential exposure risks. Since dense non-aqueous phase liquid (DNAPL) is present, the normal screening procedure utilizing common modeling cannot apply and samples will need to be collected. However, based on past experience, it is anticipated that there will be potential risks to future residents from vapor intrusion at OU1.

In order for the true current risk to be assessed, there needs to be a field recon/building survey at OU1. Once this is complete, the screening from the respective remedial investigations (RIs) will be modified to reflect actual conditions. Moving forward with the study, CH2M HILL will prepare a UFP-SAP work plan (i.e., the team will scope the UFP-SAP sampling objectives and rationale) for vapor intrusion, collect samples (soil gas), run risk assessments, and add to the feasibility study (FS) or write a focused feasibility study (FFS) for vapor intrusion. The team agreed with the building survey and determined that a work plan is not required to conduct a building assessment using established audit forms.

Amy Morgan/FRCE said that a certified industrial hygienist (CIH) currently monitors the indoor air at FRCE and may be able to segregate out vapor intrusion contamination. However, the samples are operation-specific and only scan for task-specific compounds, so the data may not be of any value to the team. The group discussed having a CIH accompany the field team when conducting the building survey and decided that it would be worthwhile to invite a CIH to accompany the team.

The goal is to have the survey done within the next couple months.

Action Items:

N/A

Consensus Decisions:

N/A

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

Project Name: Soil Vapor Investigation at OU1 Projected Date(s) of Sampling: Spring/Summer 2009 Project Manager: Bill Hannah			Site Name: OU1 Site Location: MCAS Cherry Point, North Carolina		
Date of Session: July 29-30, 2008 Scoping Session Purpose: Partnering Team Meeting					
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Janice Nielsen	Remedial Project Manager	NAVFAC Mid-Atlantic	(757) 322-8339	janice.nielsen@navy.mil	Coordinates Navy Environmental Restoration (CERCLA/MRP) activities; Partnering Team member
Jeff Christopher	Installation Restoration Project Manager	MCAS Environmental Affairs Department	Phone: (252) 466-4421	jeffrey.christopher@usmc.mil	Coordinates MCASCP Environmental Restoration Activities; Partnering Team member
Gena Townsend	Remedial Project Manager	USEPA Region 4	Phone: (404) 562-8538	townsend.gena@epa.gov	EPA regulator; Partnering Team member
George Lane	Remedial Project Manager	NCDENR	(919) 508-8462	george.lane@ncdenr.gov	State regulator; Partnering Team member
Doug Bitterman	Activity Manager, MCAS Cherry Point	CH2M HILL	(757)-671-6209	Doug.Bitterman@CH2M.com	Overseeing UFP-SAP production, Work Plan production, and project support; Partnering Team member
Erica DeLattre	Project Manager	Rhea	(724)-443-4111	erica@rhea.us	Partnering Team member
Tim Wenk	Staff Consultant	CH2M HILL	(757)-671-6265	Tim.Wenk@CH2M.com	Drafted meeting minutes; Partnering Team member
Bill Hannah	Hydrogeologist	CH2M HILL	(757)-671-6277	Bill.Hannah@CH2M.com	Work Plan production
Vicki Lewis	Environmental Protection Specialist	FRCE Environmental	(252) 464-9070	vicki.lewis@navy.mil	FRCE Representative
Kirk Stevens	Supervisor	NAVFAC MIDLANT	(757)-322-4589	Kirk.a.stevens@navy.mil	Guest

SAP Worksheet #9-2—Project Scoping Session Participants Sheet (continued)

Comments/Decisions:

Bill Hannah/CH2M HILL provided a general update on OU1 vapor intrusion activities:

The screening process for vapor intrusion at OU1 has been completed. The results will be presented during the September 2008 partnering meeting. During this process, CH2M HILL compared groundwater samples to screening values/ rules, identified 80 potentially impacted buildings, conducted a building survey at 35 buildings, and modeled data and building survey information. As a result of the screening process, 17 buildings were identified for further analysis.

Action Items: N/A

Consensus Decisions: N/A

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

Project Name: Soil Vapor Investigation at OU1 Projected Date(s) of Sampling: Spring/Summer 2009 Project Manager: Bill Hannah			Site Name: OU1 Site Location: MCAS Cherry Point, North Carolina		
Date of Session: November 5-6, 2008 Scoping Session Purpose: Partnering Team Meeting					
Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Janice Nielsen	Remedial Project Manager	NAVFAC Mid-Atlantic	(757) 322-8339	janice.nielsen@navy.mil	Coordinates Navy Environmental Restoration (CERCLA/MRP) activities; Partnering Team member
Jeff Christopher	Installation Restoration Project Manager	MCAS Environmental Affairs Department	Phone: (252) 466-4421	jeffrey.christopher@usmc.mil	Coordinates MCASCP Environmental Restoration Activities; Partnering Team member
Gena Townsend	Remedial Project Manager	USEPA Region 4	Phone: (404) 562-8538	townsend.gena@epa.gov	EPA regulator; Partnering Team member
George Lane	Remedial Project Manager	NCDENR	(919) 508-8462	george.lane@ncdenr.gov	State regulator; Partnering Team member
Doug Bitterman	Activity Manager, MCAS Cherry Point	CH2M HILL	(757)-671-6209	Doug.Bitterman@CH2M.com	Overseeing UFP-SAP production, Work Plan production, and project support; Partnering Team member
Erica DeLattre	Project Manager	Rhea	(724)-443-4111	erica@rhea.us	Partnering Team member
Tim Wenk	Staff Consultant	CH2M HILL	(757)-671-6265	Tim.Wenk@CH2M.com	Drafted meeting minutes; Partnering Team member
Bill Hannah	Hydrogeologist	CH2M HILL	(757)-671-6277	Bill.Hannah@CH2M.com	Work Plan production
Cliff Game	Lead Environmental Engineer	FRCE Environmental	(252) 464-7690	Clifton.game@navy.mil	FRCE Representative

Comments/Decisions:

Bill Hannah/CH2M HILL informed the team that a UFP-SAP needed to be prepared, and that the team would conduct a scoping session for an investigation at the site. For this investigation, the goals will be to:

- Evaluate the potential for the migration of the chlorinated volatile organic compounds (cVOCs) from groundwater and soil gas to overlying buildings
- Assess current potential risk to industrial workers from potential vapor intrusion

SAP Worksheet #9-3—Project Scoping Session Participants Sheet (continued)

For vapor intrusion, a screening process was conducted in accordance with DoD and ITRC guidance using a tiered approach:

- CH2M HILL has already conducted the generic screening process. The groundwater data from the OU1 RI Addendum were compared to generic vapor intrusion screening values for groundwater from EPA's 2002 draft subsurface vapor intrusion guidance. The results of this screening identified 80 buildings of interest for vapor intrusion (Figure 8).
- The list of 80 buildings of interest was further reduced by looking at the buildings above upper surficial aquifer contamination. The buildings in areas where contamination was present only in the lower surficial aquifer were screened out because volatilization is less likely from the lower surficial aquifer if there is a layer of clean groundwater above. Gena asked if screening out the areas with only deeper contamination was in the guidance. Bill said he thought not; the guidance says to look at buildings that are within 100 ft both vertically and laterally of the contamination, but there are studies and experts that indicate that vapor intrusion is only a concern if the VOC contamination is within 1 meter of the water table. Gena said that this screening step will raise questions without adequate justification, so we need to be able to justify what has been done. She said that we should say that the buildings were removed due to a list of factors, not just because the contamination was only present in the lower surficial aquifer.
- CH2M HILL conducted a building survey on 34 buildings within the OU1 plume to look at the condition of the buildings and various features that could increase or reduce the potential for vapor intrusion.

Bill said the next step in the process will be to conduct investigations on buildings that were identified to have the highest potential for vapor intrusion. These buildings were identified using the Johnson-Ettinger model and site-specific characteristics. A figure was handed out to the team showing all of the buildings that will be included in the investigation (Figure 9).

Bill said that the recommended approach is to:

- Collect co-located groundwater and soil gas (near-slab soil vapor) samples adjacent to the buildings with the highest chances of having vapor intrusion concentrations that exceed site-specific screening levels. Samples will be collected within 5 to 15 feet (laterally) of the buildings and will consist of a groundwater sample collected within the top 5 ft below the water table and a near-slab soil vapor sample collected 1 to 2 feet above the water table.
- Collect subslab soil gas samples at buildings where:
 - DNAPL is present
 - The shallow groundwater plume exists only within the building footprint
 - An AS/SVE system is within 100 feet of the building
 - The groundwater table is less than 5 feet below ground surface
- Conduct pressure differential monitoring at 20 buildings.

SAP Worksheet #9-3—Project Scoping Session Participants Sheet (continued)

Cliff Game/FRCE said to coordinate the pressure differential monitoring with him so that he can identify the right people to talk to about the investigation. He said that the FRCE engineering building is most likely to be the best resource for support on this effort. He also added that it will be good to coordinate with him in the event there is an anomaly during the time of the sampling. Cliff took an action item to take the list of buildings to determine if those identified for additional investigation have positive or negative pressure.

Cliff said that he would try to have the FRCE safety group collect indoor air samples in conjunction with our investigation and have them analyzed for the COCs. Jeff Christopher/MCAS Cherry Point said he will coordinate with FRCE to ensure they are involved in the decision process and are kept aware of what will be done at the site.

After looking at the plume maps, Gena noticed that there is high vinyl chloride underneath a corner of Building 159 and asked why that building is not being evaluated. Bill and Doug Bitterman/CH2M HILL took an action item to determine the reason why Building 159 was not included in the proposed building evaluation. She said that since there is a high level of vinyl chloride below a corner of the building, we need to have a solid justification as to why this building and other similar buildings are not included.

Jeff asked if the UST plume should be avoided when conducting the subslab sampling. Doug replied that since the AS/SVE system has the potential to enhance the migration of the soil vapor contamination, we will likely want to include the areas.

Bill asked the team how to define risk for this investigation and whether the 10^{-4} level and lower is considered acceptable. Gena said that she thinks if we identify a risk for a building, the fix will just involve a mechanical design for the building; we are not cleaning up the indoor air, rather we are mitigating the problem. Regardless, Gena said that she believes North Carolina will be more conservative on this issue so 10^{-6} should be the level we use. Jeff clarified that if a risk is calculated to be greater than 10^{-6} we need to do something to mitigate the risk. Doug agreed and said that the concentrations from the investigation will be run through a risk assessment and the level of risk will be determined.

Bill said the results of the vapor intrusion risk assessment will be in a risk assessment separate from the OU1 RI Addendum. Gena suggested that depending on the timing, it could be included in the RI Addendum. Doug said that since the investigation really is not part of the RI or FS, it should be presented in a stand alone document and will still be discussed in the FS. Gena agreed and said it can be a stand alone document; the FS just needs a few sentences to draw that data into the FS.

Doug asked the team if it was okay to proceed with preparing the UFP-SAP for the vapor intrusion investigation based on the sampling scheme presented and discussed during the scoping session. The team came to a consensus that CH2M HILL could move forward with the UFP-SAP for the sampling as proposed. Jan Nielsen/NAVFAC MIDLANT said that we want to make sure that the locations of the samples are appropriate and asked if it was necessary to walk the building to make sure the locations are appropriate. Bill replied that as long as we target the plume, exact locations can be adjusted. Doug added that we need to say that the proposed sample locations are rough and will ultimately be based upon the building structure (walls and other features that could interfere with the work).

SAP Worksheet #9-3—Project Scoping Session Participants Sheet (continued)

George said he thought that there was a floor and subfloor in Building 133 and that there is airspace between the two. He said that he did not remember there being anything between the two floors (dirt or sand) and it could be easy to collect a vapor sample from that void. Doug said he thought that these void spaces had been filled with dirt or sand, but said the boring logs from past investigations will be reviewed to see what was observed.

Action Items:

Bill will be in charge of determining if there is airspace between the foundation and the subslab in Buildings 133 and 137 using old boring logs. If there is a space, then he will determine if an air sample can be taken from the void. Bill will also check with Jeff to locate an as-built drawing, if one exists. Bill or Doug will determine if Building 159 will be included in the vapor intrusion building evaluation, since there is an elevated concentration of vinyl chloride below a corner of the building. They will also determine the justification to not include this building and other similar buildings.

Cliff will determine if the buildings identified for the vapor intrusion investigation have positive or negative pressure.

Consensus Decisions:

CH2M HILL should move forward with the preparation of a UFP-SAP for the vapor intrusion investigation at OU1.

SAP Worksheet #10—Problem Definition

Site Background

OU1 is an industrial area within the southern portion of MCAS Cherry Point that covers approximately 565 acres (Figures 1 and 2). OU1 comprises more than 70 sites, solid waste management units, and other potential sources of contamination. OU1 is bounded by C Street and Sandy Branch to the northwest, portions of the MCAS Cherry Point flightline and runway to the northeast and southeast, and East Prong Slocum Creek to the southwest (Figure 3). OU1 includes the Fleet Readiness Center East (FRCE), Sandy Branch Landfill, the Industrial Wastewater Treatment Plant (IWTP), the Defense Reutilization Marketing Office and several support facilities.

OU1 is currently being investigated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) procedures. MCAS Cherry Point has been actively involved with environmental investigations and remediation programs since 1983. Most recently, from 2000 to 2008, additional activities were conducted as part of a Remedial Investigation Addendum (CH2M HILL, 2008) to further characterize the nature and extent of VOC groundwater contamination at OU1.

Hydrogeology

Figure 4 presents the simplified conceptual site model of OU1. The surficial aquifer is the first-encountered groundwater beneath OU1, and is generally underlain by the Yorktown confining unit which separates the aquifer from the Yorktown aquifer. However, in some areas of OU1, the surficial and Yorktown aquifer sediments are in direct hydraulic communication where a paleochannel has eroded and replaced the Yorktown confining unit.

The surficial aquifer consists of unconsolidated, interfingering beds of fine-grained sand, silt, clay, shell, and peat beds, and scattered deposits of coarse-grained material. The surficial aquifer has been evaluated as two different groundwater zones that are in direct connection hydraulically, with the upper surficial aquifer defined as the upper 10 to 15 ft of saturated thickness and the lower surficial aquifer defined as the lower 20 to the 30 ft of the aquifer.

Groundwater depths generally range from 5 to 15 feet below ground surface within OU1. Groundwater flows generally westward in the upper and lower surficial aquifers towards East Prong Slocum Creek and Sandy Branch. Vertical gradients are directed downward within the eastern portion of OU1, and upward in the paleochannel area of western OU1.

Release History

Chlorinated VOC groundwater contamination consisting primarily of TCE, 1,2-DCE, and vinyl chloride was detected within the upper and lower surficial aquifers at OU1. The extent of TCE contamination within the upper and lower surficial aquifers, respectively, is shown in Figures 5 and 6. The extent of 1,2-DCE and vinyl chloride is generally similar to TCE. Potential sources of the chlorinated VOC groundwater contamination, from the most upgradient site to the most downgradient site, include Site 51 (Building 137), Site 42 (Industrial Wastewater Treatment Plant), and Site 52 (Building 133).

SAP Worksheet #10—Problem Definition (continued)

A former Plating Shop was located within Building 133 that operated from 1943 to 1990 and discharged industrial wastewater to an adjacent drainage ditch. In the 1970s, the former ditch was covered by an addition to Building 133. The highest concentrations of TCE and 1,2-DCE occur beneath Building 133, with maximum detected concentrations of 62,000 and 33,000 µg/L, respectively. At two separate areas within the eastern and southeastern portions of the building, the TCE concentrations suggest the presence of TCE as a DNAPL within the lower portion of the upper surficial aquifer (20 to 30 feet bgs). A TCE, 1,2-DCE, and vinyl chloride plume extends approximately 3,800 feet westward from beneath Building 133 to East Prong Slocum Creek.

At Building 137, TCE in the upper surficial aquifer extends approximately 420 feet in the southwestern direction, and beneath the footprint of Building 137. Northwest of the building, the plume extends into the lower surficial aquifer, and is believed to migrate beneath the IWTP. The highest detected concentration of vinyl chloride (8,000 µg/L) was detected beneath the IWTP within the upper surficial aquifer. The plume is believed to mix with the larger groundwater plume emanating from Building 133, and also discharges at Sandy Branch.

Receptors

As part of the OU1 RI Addendum, a Human Health Risk Assessment (HHRA) was conducted. Potential risks to human health were identified due to industrial worker inhalation of vapors that could potentially migrate from the upper surficial aquifer to indoor air within the overlying buildings. A simplified conceptual site model of the potential vapor migration pathways (i.e., at Building 133) is shown in Figure 7.

Potential exposure at OU1 may occur under current and future land use scenarios. Receptors that may be exposed to OU1 vapor intrusion include current and future industrial workers and future unrestricted use receptors (e.g., residents, etc.). However, the current industrial land use is not expected to change in the near future and as a result this investigation focuses on current scenarios.

Selection of Constituents of Potential Concern

VOC groundwater data collected from 2000 to 2008 within the upper and lower surficial aquifers as part of the OU1 RI Addendum were screened against the 2002 USEPA Draft Vapor Intrusion Guidance target groundwater concentrations, based on a 1×10^{-6} cancer risk and a non-cancer hazard quotient (HQ) of 1.0 (Appendix A, Tables A-1 through A-7). VOCs detected above the screening levels were selected as the COPCs. Petroleum-related VOCs (i.e., benzene, chlorobenzene, ethylbenzene, isopropylbenzene, and xylenes) are being addressed under the Air Station Underground Storage Tank (UST) Program and are not evaluated as part of this investigation.

SAP Worksheet #10—Problem Definition (continued)

The following VOCs were selected as COPCs:

- 1,1,1-Trichloroethane (1,1,1-TCA)
- 1,1,2,2-Tetrachloroethane (1,1,2,2-PCA)
- 1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-11)
- 1,1,2-Trichloroethane (1,1,2-TCA)
- 1,1-Dichloroethane (1,1-DCA)
- 1,1-Dichloroethene (1,1-DCE)
- 1,2-Dichloroethane (1,2-DCA)
- 1,2-Dichloroethene (1,2-DCE)
- cis-1,2-Dichloroethene (cis-1,2-DCE)
- trans-1,2-Dichloroethene (trans-1,2-DCE)
- Bromodichloromethane
- Bromoform
- Chloromethane
- Dichlorodifluoromethane (Freon-12)
- Methylene Chloride
- Tetrachloroethene (PCE)
- Trichloroethene (TCE)
- Vinyl chloride

Identification of Buildings of Interest

Buildings located above the VOC groundwater plume (as mapped as part of the OU1 RI Addendum) or located within 100 feet of monitoring wells with exceedances of the generic screening levels were identified as building of interest. Eighty buildings were retained as buildings of interest and are summarized in Table 1 and shown in Figure 8.

Buildings located in areas where no contamination occurred in the upper surficial aquifer were removed from the buildings of interest list. Volatilization is less likely to occur from the lower surficial aquifer. The 2007 ITRC guidance document (“Vapor Intrusion Pathway: A Practical Guideline”) states that “in the event that sampling shows no contamination at the groundwater-vadose interface, the project manager may correctly interpret this as indicating no vapor intrusion risk to overlying buildings.” Similarly, the DoD (2009) VI Handbook states that, “It is an accepted component of the CSM for vapor intrusion from groundwater that a clean water lens above VOC contamination can act as a barrier to volatilization of VOCs from deeper ground water and reduce or prevent vapor intrusion into overlying buildings. Field studies and modeling presented in Rivett (1995) suggest that groundwater concentrations one meter below the water table are unlikely to create significant soil gas signatures in the overlying vadose zone. Other studies indicate that because the rate of diffusion of contaminants through the overlying clean ground water is so slow, the overlying groundwater can greatly impede or prevent VOCs in deeper ground water from reaching the unsaturated zone, thus possibly preventing a vapor intrusion situation (Fitzpatrick & Fitzgerald, 2002; McAlary et al., 2004). New Jersey’s vapor intrusion guidance states that sites with a groundwater lens at least 3 feet above contaminated groundwater are not likely to be associated with significant offgassing (NJDEP, 2005).”

A detailed building survey was performed at 7 buildings considered to have the highest vapor intrusion potential, in areas with the highest shallow groundwater concentrations, presence of DNAPL, and/or considered a source area. The survey included building descriptions of the size, potential conduits from soil (joints, floor drains, etc.), potential pathways/driving forces (HVAC systems), potential indoor sources, and if any current mitigation systems exist. A general building survey was performed at 34 buildings to describe the building type, size, status, occupancy, and construction (i.e., slab on grade,

SAP Worksheet #10—Problem Definition (continued)

materials, windows, etc.). The results of the building survey will be presented in the investigation report.

Site-Specific Screening

Site-specific screening levels for groundwater were developed using USEPA's (2004) version of the Johnson-Ettinger (J&E; 1991) model. The J&E model is a one-dimensional analytical solution for convective and diffusive vapor transport into indoor spaces and provides an estimated attenuation coefficient that relates the vapor concentration in the indoor air space to the vapor concentration at the source of contamination. Specific details of the J&E model development, including the model input parameters and assumptions/limitations, are summarized in Appendix B.

Model inputs were based on the results of the building survey, depths to groundwater, and general soil parameters based on the soil type. Three model scenarios were developed based on the size of the industrial buildings: large buildings (more than 100,000 square feet), medium buildings (10,000 - 100,000 square feet), and small buildings (less than 10,000 square feet).

Site-specific screening levels were developed for COPC concentrations exceeding the generic screening levels. The resulting site-specific screening levels are summarized in Table 2.

Selection of Buildings to be Sampled

Groundwater data were compared to the site-specific screening levels. Buildings located within 100 ft of a monitoring well that contained COPC concentrations above the large, medium, and small industrial site-specific screening levels were retained for further investigation. Non-occupied buildings were also removed from further evaluation (this investigation is only evaluating the potential for current vapor intrusion migration). Twenty buildings were retained for further evaluation and are highlighted in Table 1 and shown in Figure 9.

General Problems to Address

The OU1 RI Addendum identified the potential for unacceptable human health risks related to the possible migration of chlorinated VOCs as soil vapor, from contaminated groundwater into overlying buildings. The Partnering Team met in May, July, and November 2008 and agreed that further investigations were needed to assess the potential vapor intrusion migration pathway.

The objective of the vapor intrusion investigation is to understand if a complete exposure pathway from groundwater to indoor air of site buildings exists at OU1, and if there are current unacceptable risks to building occupants that will require further investigations or potential mitigation/remedial actions. Twenty buildings were retained as buildings of interest for this investigation.

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

- **Who will use the data?**

- The data will be used by the Navy and stakeholder agencies (i.e. EPA and NCDENR).

- **What are the Project Action Limits (PALs)?**

- The vapor intrusion evaluation will be consistent with the data evaluation approach outlined in the ITRC, 2007 guidance document. The evaluation approach is outlined in Figure 10 and will include the following:
 - Comparison to screening levels appropriate for each specific medium. A specific detailed list of PALs is provided in Worksheet 15
 - **Groundwater.** Site-specific screening levels for groundwater are generated from the J&E model using the methodology in Appendix D of the 2002 USEPA Draft Vapor Intrusion Guidance for calculating target groundwater concentrations corresponding to target indoor air concentration (USEPA, 2002). The site-specific screening level is calculated by dividing the Regional Screening Level (RSL) for industrial air by an appropriate attenuation factor (0.001) and then converting the vapor concentration to an equivalent groundwater concentration, assuming equilibrium between the aqueous and vapor phases at the water table. The equation is presented below:

$$C_{gw} [\mu\text{g/L}] = C_{\text{target,ia}} [\mu\text{g/m}^3] * 10^{-3} \text{ m}^3/\text{L} * 1/\text{H} * 1/\alpha$$

Where,

C_{gw} = target groundwater concentration (i.e., site-specific screening level),

$C_{\text{target,ia}}$ = target indoor air concentration (i.e., RSL for industrial air),

α = attenuation factor (ratio of indoor air concentration to source vapor concentration; 0.001),

H = dimensionless Henry's Law Constant [(mg/L - vapor)/(mg/L - H₂O)]

- **Soil Gas.** Screening levels for soil gas are calculated using the methodology in Appendix D of the 2002 USEPA Draft Vapor Intrusion Guidance for calculating target soil gas concentration corresponding to target indoor air concentration. The site-specific screening level is calculated by dividing the RSL for industrial air by an appropriate attenuation factor of 0.1 for depths less than 6 feet and 0.01 for depths greater than 6 feet. The equation is presented below:

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

$$C_{\text{soil-gas}} [\mu\text{g}/\text{m}^3] = C_{\text{target,ia}} [\mu\text{g}/\text{m}^3] / \alpha$$

Where,

- $C_{\text{soil-gas}}$ = target soil gas concentration (i.e., SGSL),
- $C_{\text{target,ia}}$ = target indoor air concentration (i.e., RSLs for residential and industrial air), and
- α = attenuation factor [ratio of indoor air concentration to source vapor concentration; 0.1 for shallow soil gas (i.e., soil gas <6 feet) and 0.01 for deep soil gas (i.e., soil gas > 6 feet)]

- Although cis-1,2-DCE and bromodichloromethane exceeded generic screening values, these compounds do not have industrial RSLs for air. Since cis-1,2-DCE is a critical daughter product in the breakdown of TCE, this compound will be analyzed. Bromodichloromethane will not be analyzed as part of this investigation, and will be addressed qualitatively as an uncertainty in the risk evaluation.
- Analytical data will also be evaluated using a “multiple lines of evidence” approach, which includes examination of concentration trends and potential spatial correlations between groundwater and soil gas data. If needed, the ratio of constituents in groundwater, soil gas, and subslab samples will be evaluated to help identify potential vapor intrusion contributions or to screen out background sources. Results of the pressure difference readings, building survey results, and building history information will also be used in the evaluation.
- **What will the data be used for?**
 - The data will be used to evaluate the potential for vapor migration from VOC-contaminated groundwater into overlying buildings, and determine if any current unacceptable risks occur for building occupants.
- **What types of data are needed (matrix, target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques)?**
 - The field investigation logic is provided in Figure 10.
 - Groundwater and soil vapor samples will be submitted to an off-site laboratory for analysis (TAL in Knoxville, TN).
 - COPCs include only VOCs and are shown in Worksheet 15. Petroleum-related compounds are being managed and investigated under the UST program and are therefore excluded from the investigation conducted under this UFP-SAP.

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

- Groundwater samples will be collected within 5 to 15 feet of the building of interest, and collected from a depth within the top 5 feet of the water table. Temporary monitoring wells will be installed using Direct-Push Technology (DPT). The temporary wells will be sampled using a low-flow sampling technique and peristaltic pump.
- Near-slab soil vapor samples will be collected within 5 to 15 feet of the building of interest, and collected at a depth of 1 to 2 feet above the water table. Soil vapor probes will be installed using DPT technology. Near-slab soil vapor samples will be collected in SUMMA canisters.
- Subslab soil vapor samples will only be collected at Buildings 133 and 137. Soil vapor probes will be installed immediately below the building slab using DPT technology. Subslab soil vapor samples will be collected in SUMMA canisters.
- Pressure differential monitoring will be performed at each building investigated.
- Previous building survey results will be used.
- **How “good” do the data need to be in order to support the environmental decision?**
 - The data will be of the quantity and quality necessary to provide technically sound and defensible assessments of potential risks to human receptors posed by the contaminants identified. For risk assessment and risk management decisions, laboratory methods will be validated by a third-party validator using the procedures outlined in Worksheet 36.
- **How much data should be collected (number of samples for each analytical group, matrix, and concentration)?**
 - The proposed sample locations are shown in Figure 11.

Building 133

- 5 subslab soil gas (2 locations are above the suspected DNAPL occurrence; other locations are to assess the spatial variability)
- 2 groundwater/near-slab soil vapor (assess spatial variability)

Building 137

- 3 subslab soil gas (located above the groundwater plume)
- 7 groundwater/near-slab soil vapor (assess spatial variability)

Other Buildings

- 1 to 4 groundwater/near-slab soil vapor per building depending on the size and proximity to other proposed sampling locations

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

- Total of 8 subslab soil gas and 45 groundwater/near-slab soil vapor samples will be collected
- **Where, when, and how should the data be collected/generated?**
 - Samples will be collected near the 20 buildings of interest within OU1. The data will be collected during one field mobilization event planned to occur in Summer 2009.
 - Data will be collected and generated in accordance with the procedures outlined in this UFP-SAP. Specifically, see the SOPs in Appendix C for more details.
- **Who will collect and generate the data? How will the data be reported?**
 - CH2M HILL field staff will collect the samples.
 - Laboratory analysis will be performed by Test America Laboratories in Knoxville, TN.
 - The data report will include a Contract Laboratory Program (CLP) Level IV-equivalent package. This will include a Supplemental Naval Installation Restoration Information Solution Electronic Data Deliverable (SNEDD) deliverable in Microsoft Excel format and a hardcopy of the raw data.
- **How will the data be archived?**
 - The data will be archived according to procedures dictated in the Navy CLEAN program/contract. At the end of the project, archived data will be returned to the Navy.
- **List the PQOs in the form of if/then qualitative and quantitative statements.**
 - The decision tree, including the if/then statements, to be used for the data evaluation during this investigation is presented in Figure 12.

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

Matrix: Groundwater

Analytical Group: Volatile Organic Compounds (VOCs)

Concentration Level: Medium

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)
Equipment Rinsate Blank	VOCs	One per day of sampling	Contamination/ bias	No target analytes > Quantitation Limit (QL); with the exception of common field/laboratory contaminants (methylene chloride)	S&A
Ambient Field Blank		One per week of sampling	Contamination/ bias		S&A
Trip Blank		One per cooler to the laboratory	Contamination/ bias		S&A
Cooler Temperature Blank		One per cooler to the laboratory	Accuracy/ Representativeness	4 ± 2 °C	S
Field Duplicate		One per 10 samples per matrix	Precision	Relative Percent Difference (RPD) ≤ 25%	S&A
Matrix Spike/ Matrix Spike Duplicate (MS/MSD)		One per 20 set of field samples	Accuracy/ Bias/ Precision	See recovery limits in Worksheet #28-1a ; RPD ≤ 20%	A

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

Matrix: Air (Subslab and Near-slab Vapor)

Analytical Group: VOCs

Concentration Level: Medium

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)
Field Duplicate	VOCs	One per 10 samples per matrix	Precision	RPD < 25%	S&A

SAP Worksheet #13—Secondary Data Criteria and Limitations Table

Secondary Data	Data Source	Data Generator(s)	How Data Will Be Used	Limitations on Data Use
No secondary data were used in the development of this SAP				

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SAP Worksheet #14—Summary of Project Tasks

Major Tasks Associated with the Vapor Intrusion Evaluation

The technical approach for the proposed field activities at OU1 is detailed below. The *Final Master Field Sampling Plan, MCAS Cherry Point, North Carolina* (CH2M HILL, 2004) addresses the protocols and standard operating procedures (SOPs) to be used for all investigations at MCAS Cherry Point. A site-specific Health and Safety Plan (HSP) to address site-specific details relevant to the Master Field Sampling Plan (FSP) will be completed prior to commencement of the field event.

Mobilization Activities

Prior to mobilization, NAVFAC Mid-Atlantic, MCAS Cherry Point, NCDENR, and EPA will be notified to allow for appropriate oversight and coordination.

As part of the field mobilization, CH2M HILL will procure the following subcontractors to support investigation activities:

- Utility clearance
- Drillers able to provide DPT and temporary monitoring well and soil vapor installation capabilities
- Analytical laboratory
- Data validation
- Investigation-derived waste (IDW) handler with hazardous waste disposal capabilities

Mobilization for the field effort includes procurement of necessary field equipment and initial transport to the site. Equipment and supplies will be brought to the site when the CH2M HILL field team mobilizes for field activities.

Prior to beginning any phase of work, CH2M HILL and its subcontractors will have field meetings to discuss the work items and worker responsibilities, and to familiarize workers with the HSP. Prior to any intrusive activities, the PM and the FTL will coordinate with Mr. Jeff Christopher, MCAS Cherry Point EAD. The utilities in the area will be marked out prior to mobilization of the drilling staff. No intrusive activities will be initiated until the utility clearance has been completed.

Direct-Push Technology Sampling

Forty-five co-located groundwater and near-slab soil vapor samples and eight subslab soil vapor samples will be collected at OU1. Groundwater/near-slab soil vapor samples will be collected 5 to 15 feet from the building of interest. Subslab soil vapor samples will be collected only from Buildings 133 and 137. The proposed sampling locations are shown in Figure 11.

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

Groundwater

Groundwater samples will be collected from temporary monitoring wells installed using DPT technology. Monitoring wells will be installed no more than 5 feet below the groundwater table with a 5 feet screen interval. In an email dated May 13, 2009, the NCDENR Ground Water Protection Unit stated that construction or abandonment well records are not required for a DPT groundwater sample well point installed for the purpose of taking a grab sample. Thus, monitoring well construction or abandonment records will not need to be submitted to the NCDENR. Groundwater samples will be collected using low-flow purging techniques with a peristaltic pump to minimize turbidity. Samples will be contained in laboratory-prepared, pre-preserved sample bottles. Samples will be analyzed for the selected list of VOCs using EPA method SW846 8260B.

Soil Gas

Near-slab soil vapor samples will be collected from temporary sampling probes installed 1 to 2 feet above the groundwater table by DPT. Subslab soil vapor samples will be collected from a temporary sampling probe installed immediately beneath the building slab by a hammer drill.

Soil gas samples will be collected using a vacuum pump and SUMMA™ canisters and will be submitted to the laboratory for analysis of the selected list of VOCs using EPA method TO-15. Each sample will be collected in accordance with the CH2M HILL field standard operating procedure (SOP), *Standard Operating Procedure for the Collection of Soil Gas Samples from Soil Gas Probes (GeoProbe System - PRT) using SUMMA Canisters and a Helium Leak Check* (Appendix C). Air quality will be monitored and recorded from each temporary probe using a photo ionization detector (PID) (MiniRAE 2000 or equivalent). The PID will monitor for methane, oxygen, carbon dioxide, and lower explosive limit. The FTL will follow the guidelines for air monitoring outlined in the HSP.

The SUMMA™ canisters will be affixed with 1-hour regulators. Canisters will be deployed and collected 1 hour later. The flow rate for the canisters will be approximately 90 milliliters per minute (mL/min).

In addition, indoor and outdoor temperature measurements will be collected using a standard thermometer. Air pressure measurements will be collected inside and outside the buildings using a digital micromanometer in order to determine if there are negatively pressurized areas in the building that are more likely to be impacted by vapor intrusion.

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

Quality Assurance/Quality Control

The quality assurance/quality control (QA/QC) sample collection frequency is as follows (also shown in Worksheet 20):

Groundwater Samples:

- **Duplicates:** 1 per 10 field samples
- **MS/MSD:** 1 per 20 samples (including field and QA/QC samples)
- **Field Blank:** 1 per week
- **Equipment Blank:** 1 per day
- **Trip Blank:** 1 per cooler sent to the laboratory

Air Samples:

- **Duplicates:** 1 per 10 field samples

Sampling Equipment Decontamination

All non-disposable sampling equipment will be decontaminated immediately after each use in accordance with the applicable SOPs. Heavy equipment such as DPT rods will be power-washed clean with hot water prior to each new grab groundwater location.

Investigation-Derived Waste (IDW)

IDW is expected to consist of soil from DPT borings, purge water (from groundwater sampling), and decontamination fluids. Aqueous IDW will be stored in drums and transported to the IWTP for disposal on a daily basis. Soil IDW will be containerized in 55-gallon steel drums and will be labeled appropriately. The soil IDW will be chemically characterized and will be properly disposed of by subcontractors within 90 days of generation. Disposable equipment, including personal protective equipment (PPE), poly sheeting, paper towels, sample tubing, and sampling spoons will be containerized in drums. If soil and groundwater results are determined to be non-hazardous, PPE will be disposed of in trash dumpsters at the base.

Soil analysis of the IDW is dependent on the disposal facility's requirements.

Sample Analysis and Data Validation

CH2M HILL Environmental Information Specialist (EIS) Kyle Block will track the samples from collection through analysis and obtain a Level IV data package from TAL- Knoxville within 28 calendar days from sample receipt. A signed certificate of analysis will be provided in the narrative section of each laboratory data package. The laboratory will submit the data in hard copy and an electronic format. CH2M HILL will manage the data according to the Navy CLEAN Data Management Plan (Appendix E).

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

Analytical results will be validated according to the procedures in [Worksheet 36](#) by EDS. EDS will be provided with the hard copy and electronic version of the laboratory results and will add data validation qualifiers to both versions. The electronic version will be examined for completeness and accuracy and compared to the hardcopy results by Megan Morrison, project chemist, and then loaded into the CH2M HILL master database.

The following information can be found in the Data Management Plan in [Appendix E](#):

- Procedures for recording data, including guidelines for recording and correcting data,
- Computerized and manual procedures of data generation to final use and storage and QC checks for error detection to ensure data integrity,
- Guidance on data management steps such as data recording, data transformation, data reduction, data transfer and transmittal, data analysis, and data review,
- Procedures for data tracking, storage, archiving, retrieval and security for both electronic and hardcopy data:

The project EIS, Kyle Block, is responsible for data tracking and storage.

Stacy Davenport of the CH2M HILL Chantilly, VA office coordinates archiving and retrieval of data.

SAP Worksheet #15—Reference Limits and Evaluation Table

The following applies to all of [Worksheet #15](#):

There are those instances where a laboratory's QL for a specific constituent will be greater than the corresponding PAL. In those cases where this specific constituent is nondetect, the analyte will be considered not present. In efforts to reach lower limits, the laboratory will report concentrations between the QL and MDL as estimated. These results will have a J qualifier applied to them.

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SAP Worksheet #15-1—Reference Limits and Evaluation Table

Matrix: Groundwater
Analytical Group: VOCs

Analyte	CAS Number	Large Building Industrial Scenario (µg/L)	Medium Building Industrial Scenario (µg/L)	Small Building Industrial Scenario (µg/L)	Project Quantitation Limit Goal (µg/L)	Laboratory-specific	
						QLs (µg/L)	MDLs (µg/L)
1,1,1-Trichloroethane	71-55-6	189,000	78,600	59,700	1	1	0.07
1,1,2,2-Tetrachloroethane	79-34-5	98.7	41.4	31.6	1	1	0.32
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	210,000	210,000	210,000	2	2	0.036
1,1,2-Trichloroethane	79-00-5	130	53.5	40.5	1	1	0.079
1,1-Dichloroethane	75-34-3	202	85.5	70	1	1	0.034
1,1-Dichloroethene	75-35-4	4,610	1,830	1,360	1	1	0.036
1,2-Dichloroethane	107-06-2	67.8	25.5	18.3	1	1	0.043
Bromoform	75-25-2	5,570	3,730	3,360	1	1	0.32
Chloromethane	74-87-3	94.4	33.6	23.4	2	2	0.064
Dichlorodifluoromethane (Freon-12)	75-71-8	1,400	1,400	1,400	2	2	0.082
Methylene chloride	75-09-2	1,620	616	447	2	2	0.07
Tetrachloroethene	127-18-4	17.9	7.7	5.9	1	1	0.051
Trichloroethene	79-01-6	89.6	37.1	28.2	1	1	0.043
Vinyl chloride	75-01-4	13.1	4.9	3.6	2	2	0.088
trans-1,2-Dichloroethene	156-60-5	4,170	1,790	1,390	1	1	0.04

Large, Medium, and Small Industrial Building Scenario screening levels are calculated based on Appendix D of the 2002 EPA Draft Vapor Intrusion Guidance.

SAP Worksheet #15-2—Reference Limits and Evaluation Table

Matrix: Air (Subslab and Near-slab Vapor)
Analytical Group: VOCs

Analyte	CAS Number	PAL; Depths less than 6 feet ($\mu\text{g}/\text{m}^3$)	PAL; Depths greater than 6 feet ($\mu\text{g}/\text{m}^3$)	Project Quantitation Limit Goal ($\mu\text{g}/\text{m}^3$)	Laboratory-specific	
					QLs ($\mu\text{g}/\text{m}^3$)	MDLs ($\mu\text{g}/\text{m}^3$)
1,1,1-Trichloroethane	71-55-6	220,000	2,200,000	1.091	1.091	0.1637
1,1,2,2-Tetrachloroethane	79-34-5	2.1	21	1.373	1.373	0.4188
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	1,300,000	13,000,000	1.533	1.533	0.2376
1,1,2-Trichloroethane	79-00-5	7.7	77.7	1.091	1.091	0.2946
1,1-Dichloroethane	75-34-3	77	770	0.809	0.809	0.1052
1,1-Dichloroethene	75-35-4	8,800	88,000	0.793	0.793	0.1269
1,2-Dichloroethane	107-06-2	4.7	47	0.809	0.809	0.1902
Bromoform	75-25-2	110	1100	2.067	2.067	0.4962
Chloromethane	74-87-3	68	680	1.033	1.033	0.3304
Dichlorodifluoromethane (Freon-12)	75-71-8	8800	88000	0.989	0.989	0.3363
Methylene chloride	75-09-2	260	2600	1.737	1.737	0.1563
Tetrachloroethene	127-18-4	21	210	1.356	1.356	0.2713
Trichloroethene	79-01-6	61	610	1.075	1.075	0.1935
Vinyl chloride	75-01-4	28	280	0.511	0.511	0.1815
trans-1,2-Dichloroethene	156-60-5	2600	26000	0.793	0.793	0.1982

PALs are calculated based on Appendix D of the 2002 EPA Draft Vapor Intrusion Guidance.

SAP Worksheet #16—Project Schedule / Timeline Table

The field investigation activities are currently anticipated to occur in Summer 2009. A draft study report will be submitted to the Partnering Team for review 45 days after receipt of the analytical data.

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SAP Worksheet #17—Sampling Design and Rationale

The sampling design and rationale was developed using the ITRC and Department of Defense (DoD) vapor intrusion guidance documents, and also from the Guidance for Performing Site Inspections Under CERCLA (Interim Final, U.S. Environmental Protection Agency, EPA/540-R-92-021, PB92-963375, September 1992). The sampling design is shown in Figure 10.

Each sampling point was located to evaluate the potential for soil vapor migration into overlying buildings, and limit the possibility of interferences from other sources (e.g., chemical use within buildings). The number and locations of sampling points were discussed and modified with the Partnering Team's consensus. The proposed sampling locations are shown in Figure 11.

Subslab soil vapor samples will be collected at Building 133, since the DNAPL source occurs beneath the footprint of the building. Other subslab soil vapor samples will be collected within the building to assess the spatial variability. A subslab soil vapor sample will also be collected at Building 137, since the groundwater plume within the upper surficial aquifer occurs beneath the footprint of the building. Co-located groundwater and near-slab soil vapor samples will also be collected outside Buildings 133 and 137 to assess the spatial variability.

At all other buildings, co-located groundwater and near-slab soil vapor samples will be collected. Each sampling location is dependant on the size of the building and proximity to other proposed sampling location.

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

Sampling Location / ID Number	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference ¹
OU1-14TW01-MMY OU1-14TW02-MMY OU1-14TW03-MMY OU1-14TW04-MMY OU1-16TW01-MMY OU1-16TW02-MMY OU1-16TW03-MMY OU1-16TW04-MMY OU1-16TW04P-MMY (duplicate) OU1-42TW01-MMY OU1-42TW02-MMY OU1-42TW02P-MMY (duplicate) OU1-42TW03-MMY OU1-42TW04-MMY OU1-51TW01-MMY OU1-51TW02-MMY OU1-51TW03-MMY OU1-51TW04-MMY OU1-51TW05-MMY OU1-51TW06-MMY OU1-51TW07-MMY OU1-51TW08-MMY OU1-51TW09-MMY OU1-51TW09P-MMY (duplicate) OU1-52TW01-MMY OU1-52TW02-MMY OU1-52TW02P-MMY (duplicate) OU1-52TW03-MMY OU1-52TW04-MMY OU1-52TW04P-MMY (duplicate) OU1-52TW05-MMY OU1-52TW06-MMY OU1-52TW07-MMY OU1-52TW08-MMY OU1-52TW09-MMY OU1-52TW10-MMY OU1-52TW11-MMY OU1-52TW12-MMY OU1-52TW13-MMY OU1-74TW01-MMY OU1-74TW02-MMY OU1-98TW01-MMY OU1-98TW02-MMY OU1-98TW03-MMY OU1-98TW04-MMY OU1-98TW05-MMY OU1-98TW06-MMY OU1-98TW07-MMY OU1-98TW08-MMY	Groundwater	5 feet below the water table	VOCs	45 (plus 5 field duplicates)	

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

Sampling Location / ID Number	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference ¹
OU1-51SG01-MMYY OU1-51SG02-MMYY OU1-51SG03-MMYY OU1-52SG01-MMYY OU1-52SG02-MMYY OU1-52SG02P-MMYY (duplicate) OU1-52SG03-MMYY OU1-52SG04-MMYY OU1-52SG05-MMYY	Subslab Vapor	Immediately under slab	VOCs	8 (plus 1 field duplicate)	
OU1-14NS01-MMYY OU1-14NS02-MMYY OU1-14NS03-MMYY OU1-14NS04-MMYY OU1-16NS01-MMYY OU1-16NS02-MMYY OU1-16NS03-MMYY OU1-16NS03P-MMYY (duplicate) OU1-16NS04-MMYY OU1-42NS01-MMYY OU1-42NS02-MMYY OU1-42NS02P-MMYY (duplicate) OU1-42NS03-MMYY OU1-42NS04-MMYY OU1-51NS01-MMYY OU1-51NS02-MMYY OU1-51NS03-MMYY OU1-51NS04-MMYY OU1-51NS05-MMYY OU1-51NS06-MMYY OU1-51NS07-MMYY OU1-51NS08-MMYY OU1-51NS08P-MMYY (duplicate) OU1-51NS09-MMYY OU1-52NS01-MMYY OU1-52NS02-MMYY OU1-52NS02P-MMYY (duplicate) OU1-52NS03-MMYY OU1-52NS04-MMYY OU1-52NS04P-MMYY (duplicate) OU1-52NS05-MMYY	Near-slab Vapor	1 to 2 feet above water table	VOCs	45 (plus 5 field duplicates)	

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

Sampling Location / ID Number	Matrix	Depth (units)	Analytical Group	Number of Samples (identify field duplicates)	Sampling SOP Reference ¹
OU1-52NS06-MMY OU1-52NS07-MMY OU1-52NS08-MMY OU1-52NS09-MMY OU1-52NS10-MMY OU1-52NS11-MMY OU1-52NS12-MMY OU1-52NS13-MMY OU1-74NS01-MMY OU1-74NS02-MMY OU1-98NS01-MMY OU1-98NS02-MMY OU1-98NS03-MMY OU1-98NS04-MMY OU1-98NS05-MMY OU1-98NS06-MMY OU1-98NS07-MMY OU1-98NS08-MMY	Near-slab Vapor	1 to 2 feet above water table	VOCs	45 (plus 5 field duplicates)	

¹Standard operating procedure (SOP) or worksheet listed in Worksheet #21 that describes the sample collection procedures. All samples will be named in accordance with sample nomenclature scheme “Cherry Point SN” included in Appendix C. IDA – Aqueous Investigation Derived Waste, IDS – Solid Investigation Derived Waste, MMY – Month and Year sample collected

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SAP Worksheet #19—Analytical SOP Requirements Table

Matrix	Analytical Group	Analytical and Preparation Method/ SOP Reference ¹	Containers	Sample Volume	Preservation Requirements	Maximum Holding Time (Preparation/ Analysis) ²
Air	VOCs	TO-15/ KNOX-MS-0001	(1) 6 liter (L) summa canister	600 mL ³	None	30 days
Groundwater	VOCs	SW846 8260B/ KNOX-MS-0015	(3) 40 mL glass VOA vials	(3) 40 mL ⁴	4 ± 2 °C; adjust pH <2; 0.008% Na ₂ S ₂ O ₃ ⁵	7 days

¹ See [Worksheet 23](#).

² Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted. (Not VTSR)

³ The minimum sample size is based on a 200ml analysis allowing for sufficient sample for reanalysis. The use of calibrated flow controllers are designed to provide sufficient sample for analysis in the specified timed sampling event (e.g. 24 hour sample)

⁴ Triple volume is needed for the laboratory Matrix Spike/Matrix Spike Duplicate sample analysis.

⁵ Free Chlorine must be removed by the appropriate addition of Na₂S₂O₃. This preservation is not necessary if free chlorine is not present in the groundwater.

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SAP Worksheet #20—Field Quality Control Sample Summary Table

Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	No. of MS/MSDs	No. of Field Blanks	No. of Equip. Blanks	No. of VOA Trip Blanks	Total No. of Samples to Lab
Groundwater	VOCs	45	5	4/4	2	2	10	72
Subslab Vapor	VOCs	6	1	0	0	0	0	7
Near-slab Vapor	VOCs	45	5	0	0	0	0	50

QA/QC samples will be collected for select metals analysis only based on the following guidelines:

1 Field duplicate will be collected for every 10 field samples.

1 MS/MSD pair will be collected for every 20 samples, including QA/QC and field samples. (Groundwater samples only)

1 Field blank will be collected during each week in the field. (Groundwater samples only)

1 Equipment blank will be collected per day for reusable equipment that is decontaminated daily. (Groundwater samples only)

1 Trip blank will be collected per cooler containing aqueous VOC samples. (Groundwater samples only)

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SAP Worksheet #21—Project Sampling SOP References Table

Reference Number	Title, Revision Date and / or Number	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
DPGW	Direct-Push Groundwater Sample Collection, 5/20/03	CH2M HILL	Geoprobe sampling rods, slotted lead rod, sample containers	N	
DPAir	Soil Gas Sampling 6/25/08	CH2M HILL	Geoprobe sampling rods, slotted lead rod, sample containers	N	
EquipClean	Equipment Cleaning	CH2M HILL	DI Water	N	
FieldMeas	Field Measurements	CH2M HILL	Thermometer, pH meter, SEC meter	N	
MiniRam	Miniram Personal Monitor, 5/16/03	CH2M HILL	Miniram, calibration kit	Y	The MiniRAE 2000 will be used for this project. See the Manufacturer's Instructions, Appendix C, for more details.
HSE-408	Waste Management: Analysis and Characterization, 10/11/07	CH2M HILL	Field logbook, Chain of Custody, sample labels, custody seals	N	
HSE-411	Waste Management: Non-Hazardous Waste, 10/12/07	CH2M HILL	Container labels, waste containers,	N	

Field SOPs are included in Appendix C.

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

Field Equipment	Activity	Frequency	Acceptance Criteria	Corrective Action	Resp. Person	SOP Reference ¹	Comments
Horiba U-22 pH probe	Calibration	Daily, before use	pH reads 4.0 +/- 3%	Clean probe with Deionized water and calibrate again. Do not use instrument if not able to calibrate properly	Field Team Lead	HoribaU22	
Horiba U-22 Specific conductance probe	Calibration	Daily, before use	Conductivity reads 4.49 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	Field Team Lead	HoribaU22	
Horiba U-22 Turbidity probe	Calibration	Daily, before use	Turbidity reads 0 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	Field Team Lead	HoribaU22	
Horiba U-22 Dissolved oxygen and Temperature Probes	Testing	Daily, before use	Consistent with the current atmospheric pressure and ambient temperature	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	Field Team Lead	HoribaU22	
Horiba U-22	Maintenance- Check mechanical and electronic parts, verify system continuity, check battery, and clean probes. Calibration check	Daily before use, at the end of the day, and when unstable readings occur.	Stable readings after 3 minutes. pH reads 4.0 +/- 3% conductivity reads 4.49 +/- 3% turbidity reads 0 +/- 3%	Clean probe with deionized water and calibrate again. Do not use instrument if not able to calibrate properly.	Field Team Lead	HoribaU22	
MiniRAE 2000	Calibration	Daily before use and when unstable readings occur	isobutylene reads 100 ppm methane reads 50% LEL Oxygen reads 20.9% Hydrogen Sulfide reads 25 ppm Carbon Monoxide reads 50 ppm	Inspect connections to ensure proper seal. Calibrate again. Do not use instrument if not able to calibrate properly.	Field Team Lead	MiniRAE 2000 Manufacturer's Instructions	Activities are described in the MiniRAE 2000 Manufacturer's Instructions, provided in Appendix C

¹Standard operating procedure (SOP) or worksheet listed in Worksheet #21 that describes the sample collection procedures.

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SAP Worksheet #23—Analytical SOP References Table

Lab SOP Number	Title, Revision Date, and/or Number	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Organization Performing Analysis	Modified for Project Work (Y/N)
KNOX-MS-0001	<u>VOA Canister Analysis</u> , Revision 9, 10/28/08	Definitive	Air, VOCs	GC/MS	TestAmerica Knoxville	N
KNOX-MS-0015	<u>Determination of Volatile Organics by GCMS based on Method 8260B</u> , Revision 11, 10-9-08		Water, VOCs	GC/MS		
KNOX-SC-0003	<u>Sample Login and Receipt</u> , Rev. 12, 10/17/08		All	N/A		

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SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Person Responsible for CA	SOP Reference
GC/MS (SW846 8260B VOCs)	Mass scale calibration using BFB (tuning)	Verify tune every 12 hours	Ion abundance within method specified ranges as listed in SOP	Inspect system; correct problem; rerun BFB.		KNOX-MS-0015
	Initial Calibration (ICAL) (minimum 5 point calibration)	Prior to sample analysis, after major instrument changes and when continuing calibration criteria are not met.	% Relative Standard Deviation (RSD) \leq 30% for Calibration Check Compounds (CCCs); System Performance Check Compounds (SPCCs) minimum avg. RF; ICAL % Relative Standard Deviation (RSD) $<$ 15%, or linear / quadratic curve $r^2 \geq 0.990$.	Inspect system; correct problem; repeat ICAL.		
	Initial Calibration Verification (ICV)	After ICAL; prior to sample analysis	\pm 30% Difference from ICAL.	Inspect system; correct problem; reanalyze ICV or repeat ICAL.		
	Continuing Calibration Verification (CCV)	At the beginning of each 12 hour shift	CCV % Difference $<$ 20% for CCCs; SPCCs minimum avg. RF.	Inspect system; correct problem; repeat CCV. If still unacceptable, repeat ICAL.		
GC/MS (TO-15 VOCs)	Mass scale calibration verification using BFB (tuning)	Verify tune every 24 hours	Ion abundance within method specified ranges as listed in SOP	Inspect system; correct problem; rerun BFB.	Analyst	KNOX-MS-0001
	ICAL (minimum 5 point calibration)	Prior to sample analysis, after major instrument changes and when continuing calibration criteria are not met.	ICAL % RSD \leq 30% with \leq 2 analytes \leq 40%, or linear / quadratic curve $r^2 \geq 0.990$.	Inspect system; correct problem; repeat ICAL.		
	ICV	After ICAL; prior to sample analysis	\pm 35% Difference from ICAL.	Inspect system; correct problem; reanalyze ICV or repeat ICAL.		
	CCV	At the beginning of each 24 hour shift	CCV % Difference \leq 30% with \leq 4 analytes \leq 40%.	Inspect system; correct problem; repeat CCV. If still unacceptable, repeat ICAL.		

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

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
GC/MS (TO-15)	Clean source, change traps, replace filaments; maintain vacuum pumps	QC Standards	Refer to Worksheet #24	Service vacuum pumps twice per year; other maintenance as needed	Refer to Worksheet #24	Refer to Worksheet #24	Analyst	KNOX-MS- 0001
GC/MS (8260B)	Clean source, change traps, replace filaments; maintain vacuum pumps			Service vacuum pumps twice per year; other maintenance as needed				KNOX-MS- 0015

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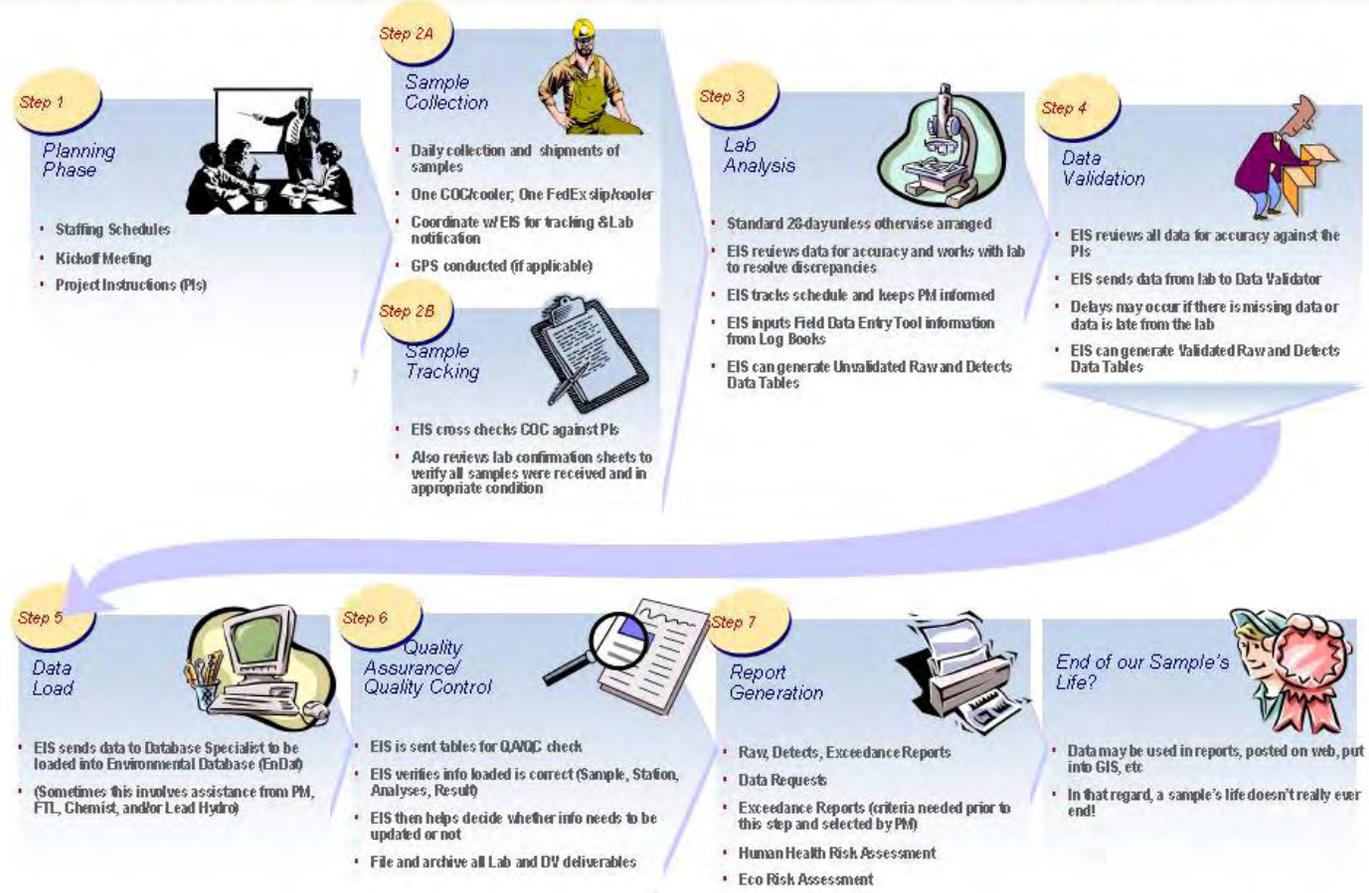
SAP Worksheet #26-1—Sample Handling System

SAMPLE COLLECTION, PACKAGING, AND SHIPMENT
Sample Collection (Personnel/Organization): Project Field Team, FTL/CH2M HILL. Field SOPs are in Appendix C of this SAP.
Sample Packaging (Personnel/Organization): Project Field Team, FTL/CH2M HILL. Field SOPs are in Appendix C of this SAP.
Coordination of Shipment (Personnel/Organization): FTL/CH2M HILL
Type of Shipment/Carrier: FedEx Priority Overnight
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): Bryan Dameron
Sample Custody and Storage (Personnel/Organization): Bryan Dameron
Sample Preparation (Personnel/Organization): David Flores (TO 15 VOCs), Anna Barlozhetskaya (8260B VOCs)
Sample Determinative Analysis (Personnel/Organization): Holly Taj (TO 15 VOCs Analyst), David Wiles (VOCs Department Manager), and Scot Goss (8260B VOCs Analysis)
SAMPLE ARCHIVING
Field Sample Storage (No. of days from sample collection): 90 days from receipt
Sample Extract/Digestate Storage (No. of days from extraction/digestion): 1 year
Biological Sample Storage (No. of days from sample collection): n/a
SAMPLE DISPOSAL
Personnel/Organization: Ryan Henry
Number of Days from Analysis: After submission, the laboratory will keep samples 90 days and the sample extracts for a minimum of 60 days.

SAP Worksheet #26-2—Sample Handling Flow Diagram Navy CLEAN Data Management Process

A Sample's Life

Step-by-Step Outline of Navy Clean Data Management Process, and EIS Roles & Responsibilities



SAP Worksheet #27—Sample Custody Requirements Table

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

Samples will be collected by field team members under the supervision of the FTL. As samples are collected, they will be placed into containers and labeled. Labels will be taped to the jar to ensure they do not separate. Samples will be cushioned with packaging material and placed into coolers containing enough ice to keep the samples 4 ± 2 degrees Celsius until they are received by the laboratory.

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

See [Worksheet #21](#) for SOPs containing sample custody guidance.

The CH2M HILL field team will ship all environmental samples to TAL- Knoxville.

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

Laboratory custody procedures can be found in the following SOP, which is referenced in [Worksheet #23](#) and can be found in Appendix D of this SAP:
KNOX-SC-0003

Sample Identification Procedures:

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

Chain-of-custody Procedures:

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

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SAP Worksheet #28-1—Laboratory QC Samples Table

Matrix: Groundwater

Analytical Group: VOCs

Analytical Method/SOP Reference: SW846 8260B/ KNOX-MS-0015

QC Sample	Frequency/ Number	Method/ SOP QC Acceptance Limits	Corrective Action	Person(s) Resp. for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1/Batch (20 samples)	No Target Compounds > ½ QL; no common lab contaminants (methylene chloride) > 5x QL	If sufficient sample is available, reanalyze samples. Qualify data as needed. Report results if sample results >20x blank result or sample results are nondetect.	Analyst / Section Supervisor	Accuracy/Bias- Contamination	No Target Compounds > ½ QL; no common lab contaminants (methylene chloride) > 5x QL
Instrument Blank	Once per 12 hours if method blank is not run				Accuracy/Bias- Contamination	
Laboratory Control Sample (LCS)	1/Batch (20 samples)	See recovery limits in Worksheet #28-1a	If sufficient sample is available, reanalyze samples. Qualify data as needed.		Accuracy/Bias	See recovery limits in Worksheet #28-1a
Surrogates	Every sample	1,2-Dichloroethane-d4 70-120% 4-Bromofluorobenzene 75-120% Dibromofluoromethane 85-115% Toluene-d8 85-120%	Check calculations and instrument performance; recalculate, reanalyze.		Accuracy/Bias	1,2-Dichloroethane-d4 70-120% 4-Bromofluorobenzene 75-120% Dibromofluoromethane 85-115% Toluene-d8 85-120%

SAP Worksheet #28-1a—LCS and MS/MSD Recoveries

Analyte	CAS Number	Recovery Limits	
		Lower	Upper
1,1,1-Trichloroethane	71-55-6	65	130
1,1,2,2-Tetrachloroethane	79-34-5	65	130
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	65	130
1,1,2-Trichloroethane	79-00-5	75	125
1,1-Dichloroethane	75-34-3	70	135
1,1-Dichloroethene	75-35-4	70	130
1,2-Dichloroethane	107-06-2	70	130
Bromodichloromethane	75-27-4	75	120
Bromoform	75-25-2	70	130
Chloromethane	74-87-3	40	125
Dichlorodifluoromethane (Freon-12)	75-71-8	30	155
Methylene chloride	75-09-2	55	140
Tetrachloroethene	127-18-4	45	150
Trichloroethene	79-01-6	70	125
Vinyl chloride	75-01-4	50	145
cis-1,2-Dichloroethene	156-59-2	70	125
trans-1,2-Dichloroethene	156-60-5	60	140

SAP Worksheet #28-2—Laboratory QC Samples Table

Matrix: Air

Analytical Group: VOCs

Analytical Method/SOP Reference: TO-15 / KNOX-MS-0001

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Resp. for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	1 per 20 samples or 24 hr tune, whichever is more frequent	No Target Compounds > ½ QL	If sufficient sample is available, reanalyze samples. Qualify data as needed. Report results if sample results >20x blank result or sample results ND.	Analyst / Section Supervisor	Accuracy/Bias- Contamination	No Target Compounds > ½ QL
Laboratory Control Sample	1 per 20 samples or 24 hr tune, whichever is more frequent	Non-polar analytes: 70- 130% Recovery with ≤ 2 within 60-140%. Polar analytes: 60- 140% Recovery with ≤ 2 within 45-155%.	If sufficient sample is available, reanalyze samples. Qualify data as needed.		Accuracy/Bias	Non-polar analytes: 70- 130% Recovery with ≤2 within 60-140%. Polar analytes: 60-140% Recovery with ≤2 within 45-155%.
Laboratory Duplicate	1/Batch (20 samples)	RPD ≤25% for analytes >5x QL	Determine root cause; reanalyze DUP; flag data; discuss in narrative.		Precision	RPD ≤25% for analytes >5x QL
Surrogate	Every sample	70-130% Recovery	Check calculations and instrument performance; recalculate, reanalyze.		Accuracy/Bias	70-130% Recovery

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SAP Worksheet #29—Project Documents and Records Table

Document	Where Maintained
<ul style="list-style-type: none"> • Field Notebooks • Chain-of-Custody Records • Air Bills • Custody Seals • Corrective Action Forms • Electronic Data Deliverables • Identification of QC Samples • Meteorological Data from Field • Sampling instrument calibration logs • Sampling locations and sampling plan • Sampling notes and drilling logs • Water quality parameters • Sample Receipt, Chain-of-Custody, and Tracking Records • Standard Traceability Logs • Equipment Calibration Logs • Sample Prep Logs • Run Logs • Equipment Maintenance, Testing, and Inspection Logs • Corrective Action Forms • Reported Field Sample Results • Reported Result for Standards, QC Checks, and QC Samples • Instrument printouts (raw data) for Field Samples, Standards, QC Checks, and QC Samples • Data Package Completeness Checklists • Sample disposal records • Extraction/Clean-up Records • Raw Data (archived per Navy CLEAN contract) • Fixed Laboratory Audit Checklists • Data Validation Reports • Corrective Action Forms • Laboratory QA Plan • MDL Study Information • Waste disposal records such as IWTP disposal chit, waste manifests, waste profiles, weigh tickets, certificate of disposal, TSDF permit, landfill permit, and CERCLA disposal letter 	<ul style="list-style-type: none"> • Field data deliverables such as logbooks entries, chain of custodies, air bills, EDDs, etc will be kept on CH2M HILL's local internet server. • Field parameter data will be loaded with the analytical data into EnDat • Analytical laboratory hardcopy deliverables and data validation reports will be saved on the network server and archived per the Navy CLEAN contract. • Electronic data from the laboratory will be loaded into EnDat

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SAP Worksheet #30—Analytical Services Table

Matrix	Analytical Group	Sample Locations/ID Numbers	Analytical Method	Data Package Turnaround Time	Laboratory/ Organization	Backup Laboratory/ Organization
Groundwater	Chlorinated VOCs	See Worksheet #18	SW846 8260B	28 calendar days	TAL- Knoxville Linda McWhirter 5815 Middlebrook Pike Knoxville, TN 37921 865.291.3006 Fax: 865.584.4315	TBD ¹
Subslab Vapor			TO-15			
Near-slab Vapor						

¹ A backup laboratory has not been determined. If circumstances render the subcontracted laboratory unable to perform analytical services, another laboratory will be determined at that time.

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SAP Worksheet #31—Planned Project Assessments Table

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person Resp. for Performing Assessment	Person Resp. for Responding to Assess. Findings	Person Resp. for Identifying and Implementing CA	Person Resp. for Monitoring Effectiveness of CA
Offsite Laboratory Technical Systems Audit	Laboratory must have current Naval Facilities Engineering Service Center (NFESC) evaluation letter, which will identify the period of performance. The laboratory must be re-evaluated prior to expiration of period of performance	External	U.S. Navy Naval Facilities Engineering Service Center (NFESC)	Project QA Officer- Pati Moreno/ NFESC, Port Hueneme, CA	TAL- Knoxville's QA Officer, Chris Rigell	TAL- Knoxville's QA Officer, Chris Rigell	Program Chemist- Anita Dodson- CH2M HILL

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SAP Worksheet #32—Assessment Findings and Corrective Action Responses

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Timeframe of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Timeframe for Response
Laboratory Performance and Systems Audits	Written Audit Report	TAL- Knoxville's QA Officer, Chris Rigell	Within 2 months of audit	Memorandum	NFESC Auditor, TBD	Within 2 months of receipt of initial notification.

SAP Worksheet #32-1—Corrective Action Form

Person initiating corrective action _____ Date _____

Description of problem and when identified: _____

Cause of problem, if known or suspected: _____

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

CA implemented by: _____ Date: _____

CA initially approved by: _____ Date: _____

Follow-up date: _____

Final CA approved by: _____ Date: _____

Information copies to:

Anita Dodson/ Navy CLEAN Program Chemist

NAVFAC Chemist

SAP Worksheet #33—QA Management Reports Table

Type of Report	Frequency	Projected Delivery Date	Person Responsible for Report Preparation	Report Recipient(s)
Site Investigation Report	Post-Field Event	Fall 2009	Bill Hannah/CH2M HILL	Stakeholders, see Worksheet 4

The Site Investigation Report will address the following:

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

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

Verification Input	Description	Internal / External	Responsible for Verification
Planning Documents	Evidence of approval and completeness of UFP-SAP.	Internal	Bill Hannah CH2M HILL
Chain of Custody and shipping forms	COC forms and shipping documentation will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the COC will be initialed by the reviewer, a copy of the COC retained in the site file, and the original and remaining copies taped inside the cooler for shipment. See COC SOP (on CD) for further details.	Internal	FTL and Kyle Block CH2M HILL
Field Log Notebooks	Field notes will be reviewed to ensure completeness of field data parameters, shipping information, sample collection times, etc. The logbook will also be used to document, explain, and justify all deviations from the approved work plan and UFP-SAP.	Internal	Bill Hannah CH2M HILL
Sample Login/ Receipt	Upon their arrival at the laboratory, the samples will be cross-referenced against the COC records. All sample labels will be checked against the COC, and any mislabeling will be identified, investigated, and corrected. The samples will be logged in at every storage area and work station required by the designated analyses. Individual analysts will verify the completeness and accuracy of the data recorded on the forms.	Internal	TAL- Knoxville employees
QC Summary Report	A summary of all QC sample results will be verified for completeness once the data is received from the laboratory.	External	Kyle Block CH2M HILL
Field Investigation Interpretive Data	Immediately following receipt of the analytical data from the laboratory and prior to submittal to the data validator, a population to population comparison will be conducted comparing site results. The data will also be compared to screening criteria (see Worksheet #15).	Internal	Bill Hannah and Roni Warren CH2M HILL

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

Step IIa / IIb ¹	Validation Input	Description	Responsible for Validation
IIa	SOPs	Review field logbooks, laboratory case narratives, data deliverables for compliance to methods and signatures.	FTL, Bill Hannah CH2M HILL
IIa	QC Results	Establish that all field and lab QC samples were run and compliant with method-required limits as specified in Worksheets #12 and 28 .	Nancy Weaver EDS
IIb	QC Results	Verify that QC samples were run and compliant with limits established in the UFP-SAP.	Megan Morrison CH2M HILL Nancy Weaver EDS
IIb	Project QLs	Ensure all sample results met the project quantification and action limits specified in Worksheet #15 .	Bill Hannah, Megan Morrison CH2M HILL
IIb	Raw data	10% review of raw data to confirm laboratory calculations.	Nancy Weaver EDS

¹IIa= Compliance with methods, procedures, and contracts
 IIb= Comparison with measurement performance criteria in the SAP

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

Step IIa / IIb	Matrix	Analytical Group	Validation Criteria	Data Validator
IIa	Groundwater, Subslab Vapor, Near-slab Vapor	Chlorinated VOCs	Analytical methods and laboratory SOPs as presented in this SAP will be used to evaluate compliance against QA/QC criteria. Should adherence to QA/QC criteria yield deficiencies, data may be qualified. The data qualifiers that may be used are those presented in <i>National Functional Guidelines for Organic Data Review, (October 1999)</i> . National Functional Guidelines will not be used for data validation; however, the specific qualifiers listed therein may be applied to data should non-conformances against the QA/QC criteria as presented in this SAP be identified.	Nancy Weaver EDS
IIb			See project action limits in Worksheet #15	Megan Morrison and Bill Hannah CH2M HILL

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SAP Worksheet #37—Usability Assessment

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

- Non-detected site contaminants will be evaluated to ensure that project required quantitation limits in [Worksheet #15](#) were achieved. If project quantitation limits were achieved and the verification and validation steps yielded acceptable data, then the data is considered usable.
- During verification and validation steps, data may be qualified as estimated with the following qualifiers: J, UJ, K, L, or UL. These qualifiers represent minor QC deficiencies which will not affect the usability of the data. When major QC deficiencies are encountered, data will be qualified with an R and in most cases is not considered usable for project decisions.
 - J- Analyte present. Reported value may or may not be accurate or precise
 - UJ- Analyte not detected. Quantitation limit may be inaccurate or imprecise
 - K- Analyte present. Reported value may be biased high. Actual value is expected to be lower
 - L- Analyte present. Reported value may be biased low. Actual value is expected to be higher
 - UL- Analyte not detected. Quantitation limit is probably higher.
 - R- Rejected result. Result not reliable.
- Additional qualifiers that may be given by the validator are:
 - B- Not detected substantially above the level reported in laboratory or field blanks
 - Interferences present which may cause the results to be biased high
 - N- Tentative Identification. Consider Present. Special methods may be needed to confirm its presence or absence in future sampling efforts
 - NJ- Qualitative identification questionable due to poor resolution. Presumptively present at approximate quantity
 - U- Not Detected
- For statistical comparisons non-detect values will be represented by a concentration equal to one-half the sample reporting limit. For duplicate sample results, the most conservative value will be used for project decisions.
- Analytical data will be checked to ensure the values and any qualifiers are appropriately transferred to the electronic database. These checks include comparison of hardcopy data and qualifiers to the electronic data deliverable. Once the data has been uploaded into the electronic database, another check will be performed to ensure all results were loaded accurately.
- Field and laboratory precision will be compared as RPD between the two results.
- Deviations from the SAP will be reviewed to assess whether corrective action is warranted and to assess impacts to achievement of project objectives.

SAP Worksheet #37—Usability Assessment (continued)

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

- To assess whether a sufficient quantity of acceptable data are available for decision making, the data will be reconciled with measurement performance criteria following validation and review of data quality indicator.
- If significant biases are detected with laboratory QA/QC samples it will be evaluated to assess impact on decision making. Low biases will be described in greater detail as they represent a possible inability to detect compounds that may be present at the site.
- If significant deviations are noted between lab and field precision the cause will be further evaluated to assess impact on decision making.

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

The following will be prepared by CH2M HILL and presented to and submitted to the Tier I Partnering Team for review and decisions on the path forward for the site.

- Data tables will be produced to reflect detected and non-detected site COC's and geochemical parameters. Data qualifiers will be reflected in the tables and discussed in the data quality evaluation.
- Graphical representations will be produced to reflect increasing and/or decreasing concentrations of COCs.
- A data quality evaluation considering all of the above will be provided as part of presentations to the Tier I Partnering Team, followed by the technical memorandum prepared to assess remedy effectiveness. The technical memorandum will identify any data usability limitations and make recommendations for corrective action if necessary.

Identify the personnel responsible for performing the usability assessment.

The CH2M HILL Team, including the PM and Project Chemist, will review the data and compile a presentation for the Partnering Team. The Tier I Partnering Team as a whole will assess the usability of the data.

References

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Figures



- Legend**
- Cities
 - Rivers and Streams
 - Military Installation
 - County Boundary

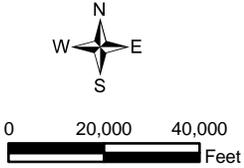
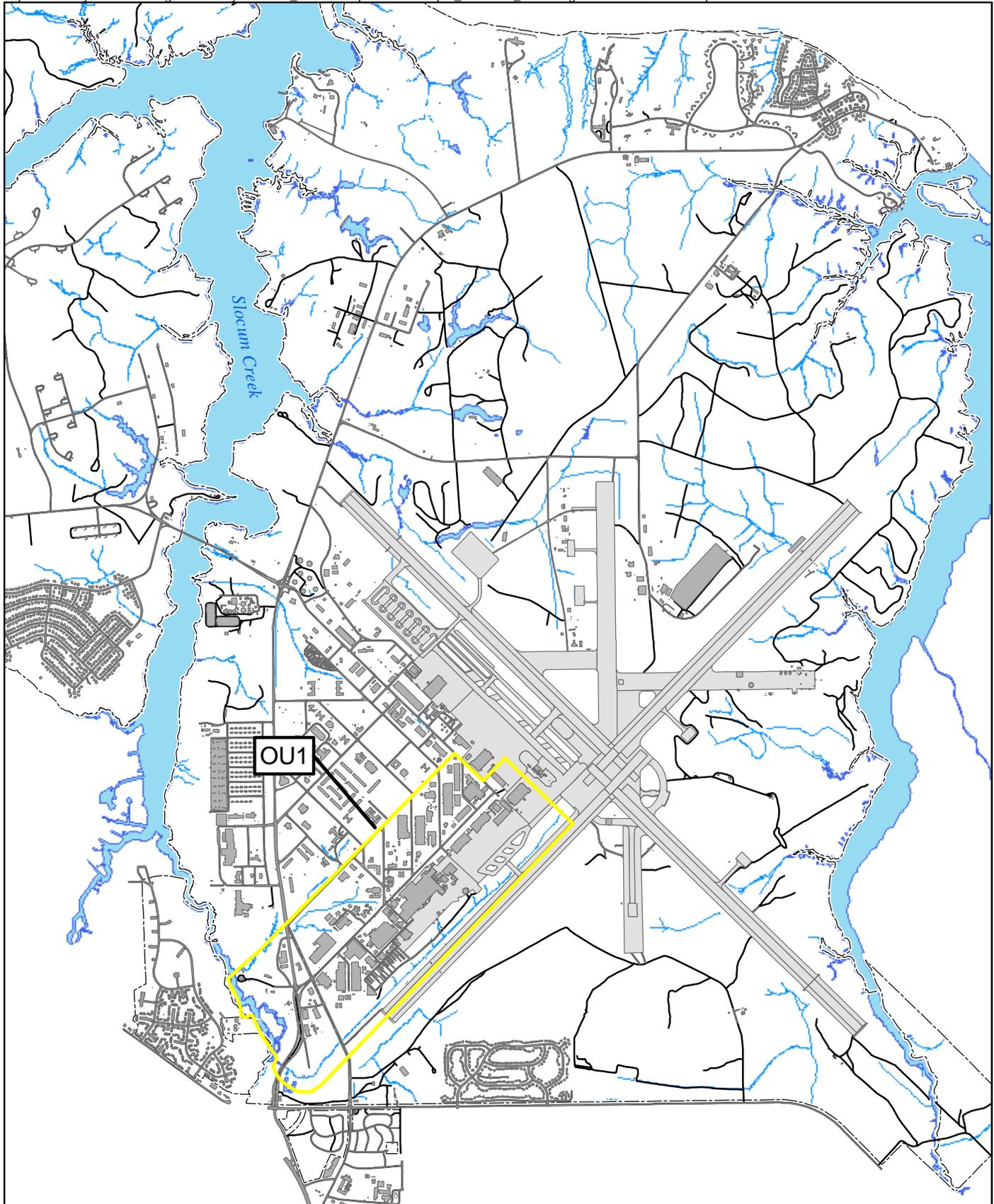


Figure 1
Base Location Map
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina



- Legend**
- OU Boundary
 - Base Boundary
 - Buildings
 - Runway
 - Road
 - Surface Water

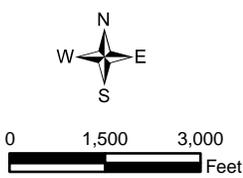


Figure 2
OU1 - Site Location Map
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

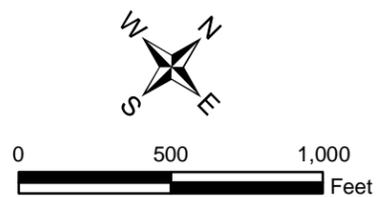
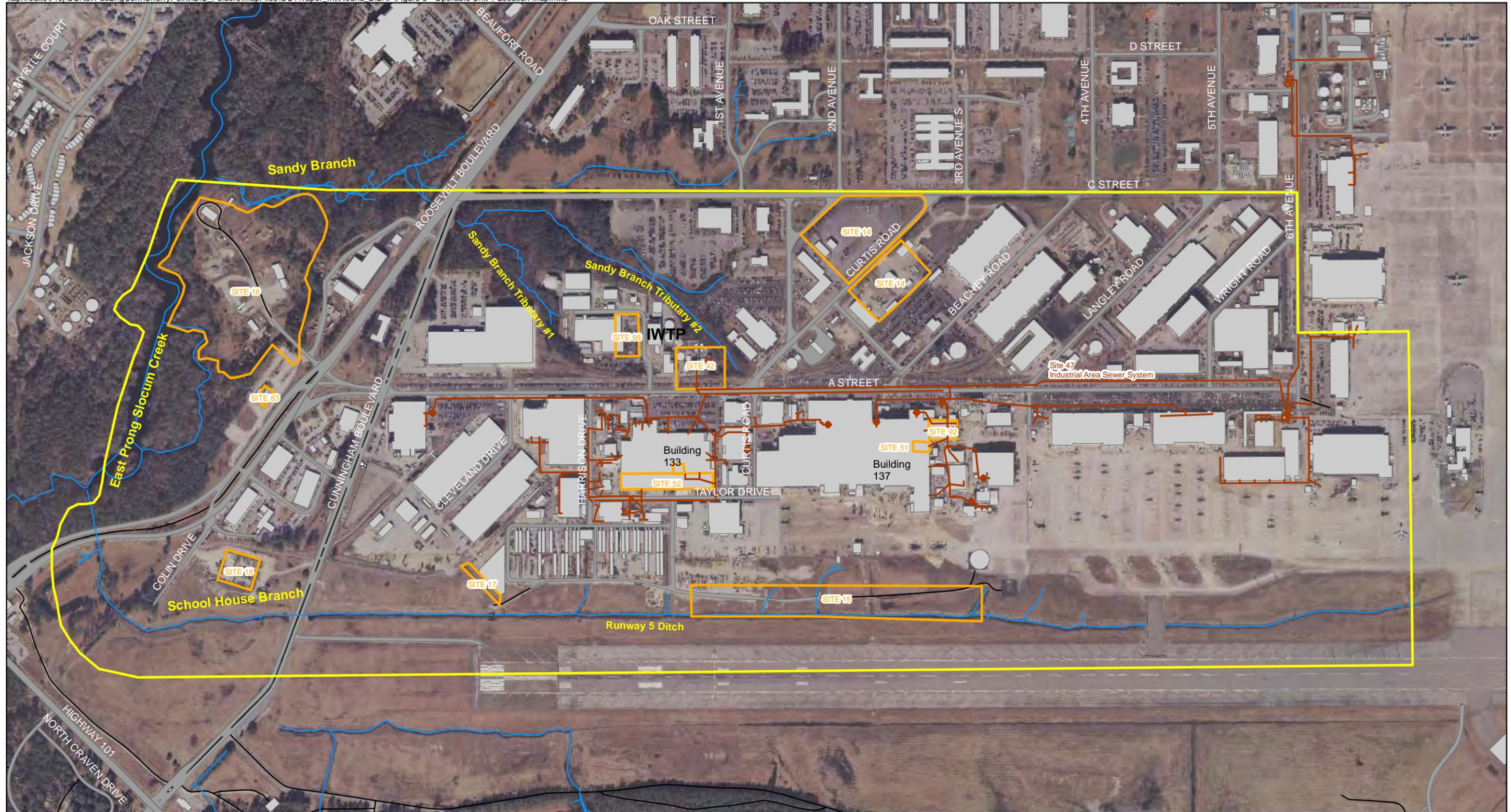


Figure 3
Operable Unit 1 Location Map
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

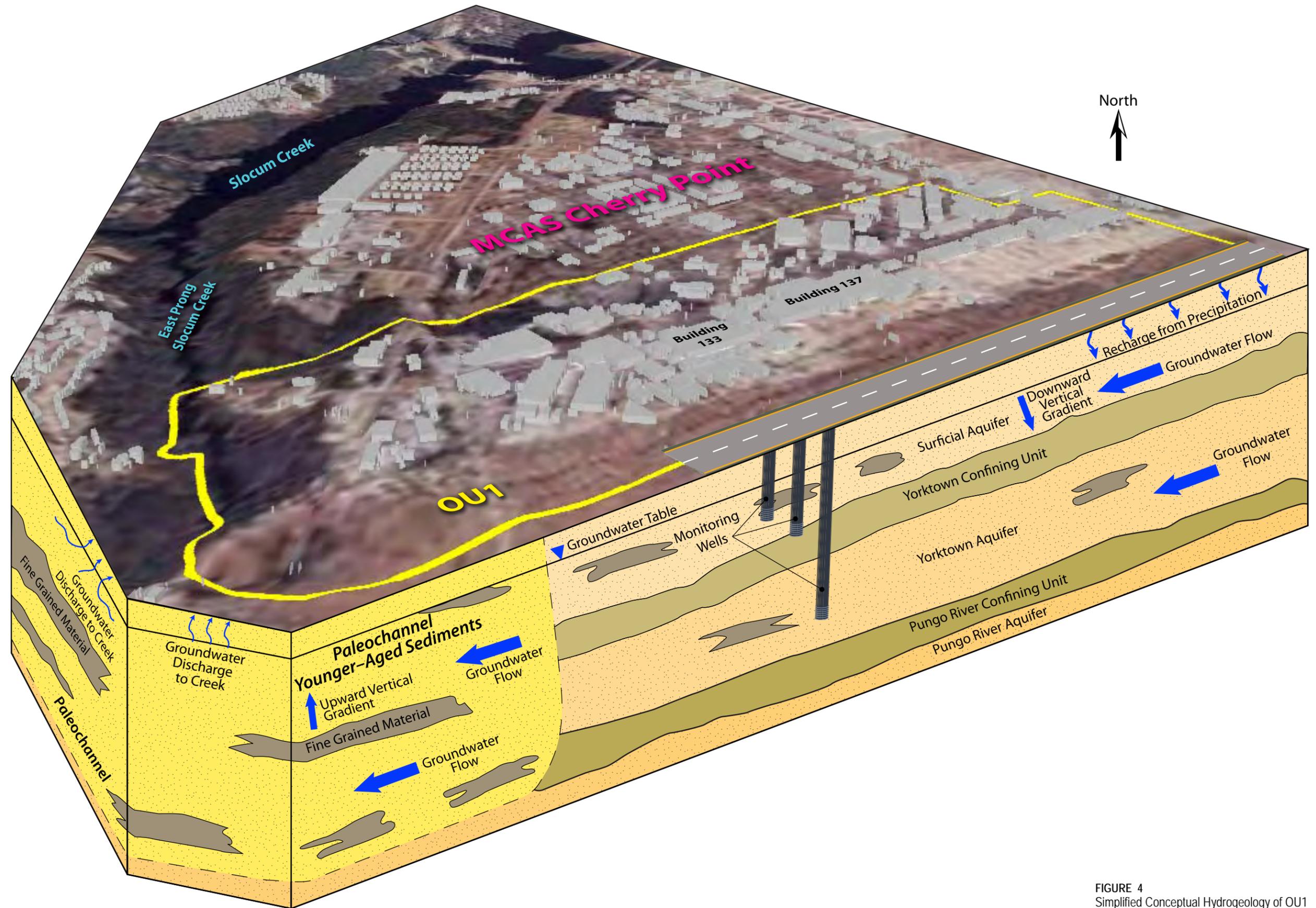


FIGURE 4
 Simplified Conceptual Hydrogeology of OU1
 Marine Corps Air Station Cherry Point
 Cherry Point, NC



Legend

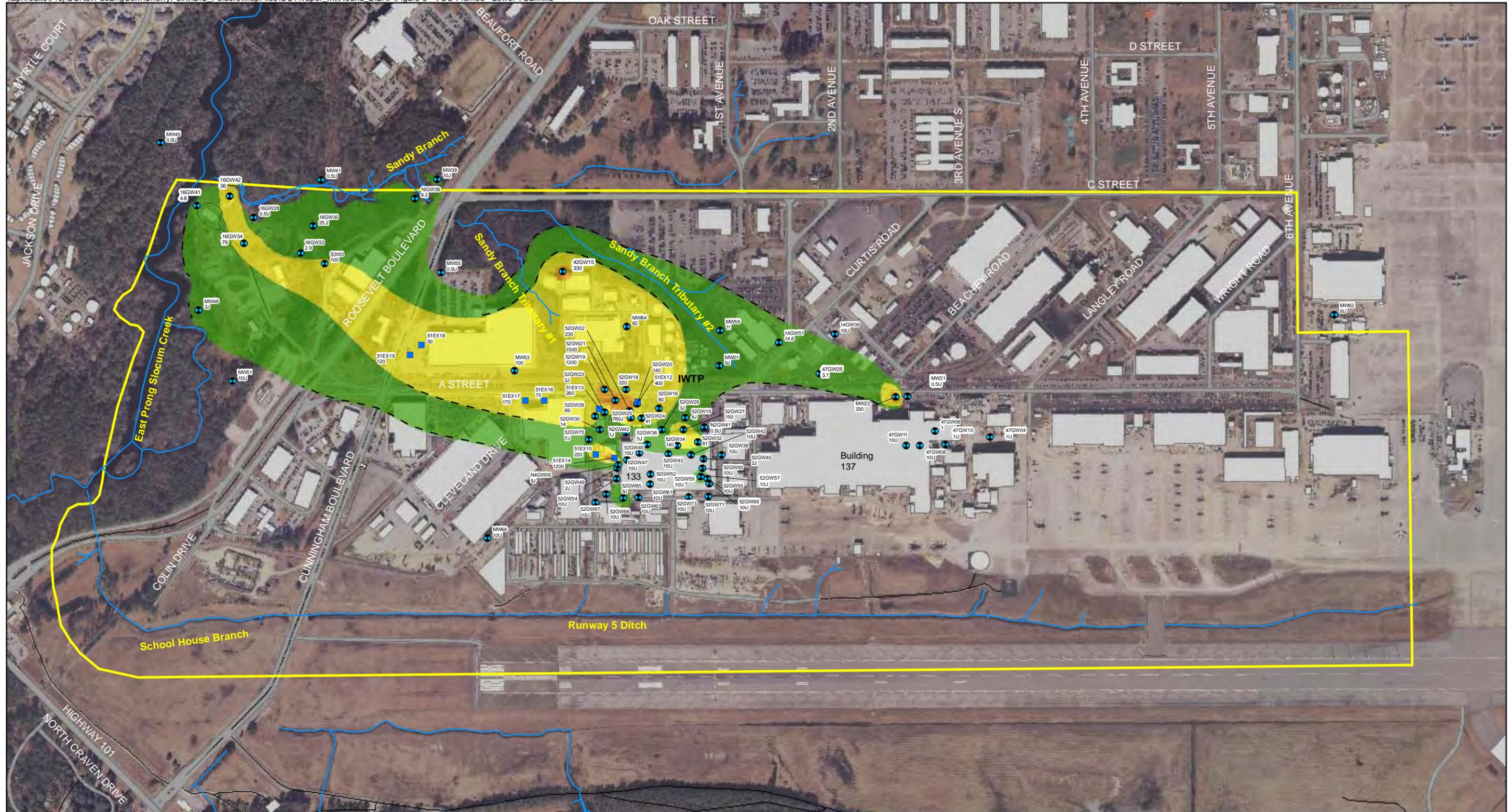
- Extraction Well
- Monitoring Well
- Surface Water
- - Inferred
- OU1 Boundary
- Existing Buildings
- IWTP - Industrial Wastewater Treatment Plant

	NC2L - 10x NC2L
	10x NC2L - 100x NC2L
	100x NC2L - 1000x NC2L
	1000x NC2L - 11,000 µg/L
	> 11,000 µg/L

Notes:
 NC2L - North Carolina Groundwater Standard
 NC2L = 2.8 µg/L
 NU = Not Used
 Concentrations are from most recent groundwater sampling event, if applicable (majority of the concentrations are from the Spring 2006 sampling event)
 µg/L = micrograms per liter
 U - analyte not detected above detection limit
 J - concentration is estimated



Figure 5
 Trichloroethene (TCE) Isoconcentration Map
 Upper Surficial Aquifer
 Marine Corps Air Station Cherry Point
 Cherry Point, North Carolina



- Legend**
- Extraction Well
 - Monitoring Well
 - Surface Water
 - - Inferred
 - OU1 Boundary
 - Existing Buildings
 - IWTP - Industrial Wastewater Treatment Plant
- NC2L - 10x NC2L
 - 10x NC2L - 100x NC2L
 - 100x NC2L - 1000x NC2L

Notes:
 NC2L - North Carolina Groundwater Standard
 NC2L = 2.8 µg/L
 NU = Not Used
 Concentrations are from most recent groundwater sampling event, if applicable (majority of the concentrations are from the Spring 2006 sampling event)
 µg/L = micrograms per liter
 U - analyte not detected above detection limit
 J - concentration is estimated

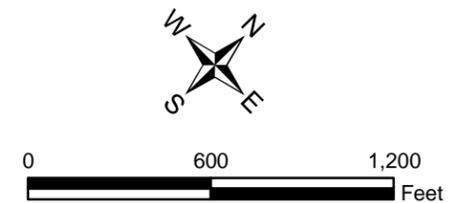


Figure 6
 Trichloroethene (TCE) Isoconcentration Map
 Lower Surficial Aquifer
 Marine Corps Air Station Cherry Point
 Cherry Point, North Carolina

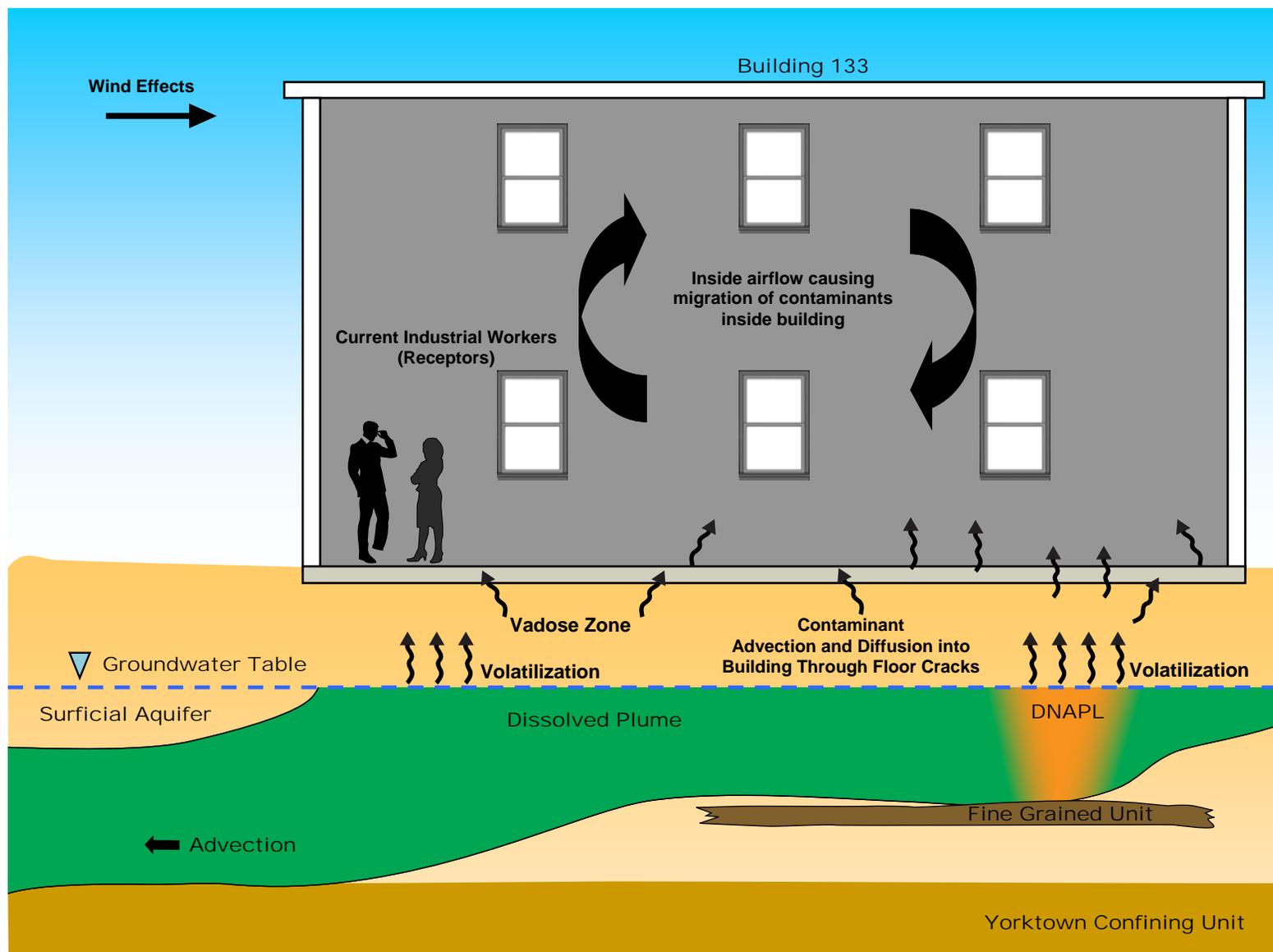


Figure 7
 Vapor Intrusion Conceptual Site Model for Building 133
 MCAS Cherry Point, NC



- Legend**
- Surface Water
 - OU1 Boundary
 - Buildings within 100 ft of Monitoring Wells Exceeding Small Building Criteria
 - Buildings within 100 ft of Monitoring Wells Exceeding Medium Building Criteria
 - Buildings within 100 ft of Monitoring Wells Exceeding Large Building Criteria
 - Building

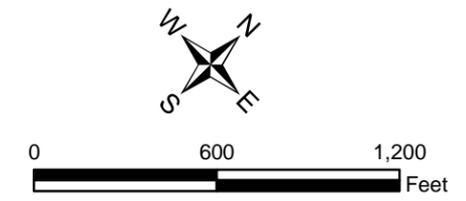


Figure 9
Buildings Retained for Sampling
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

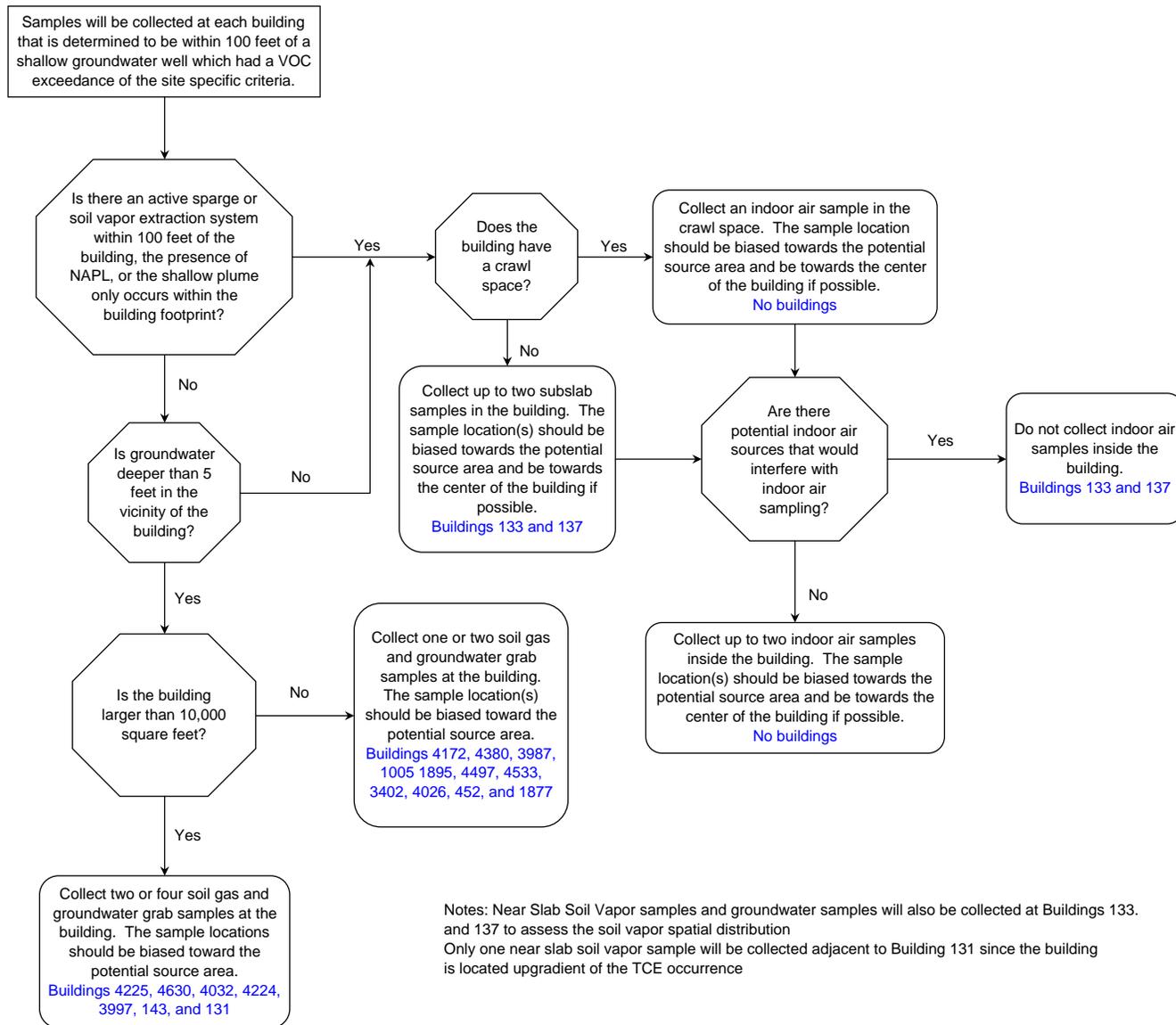
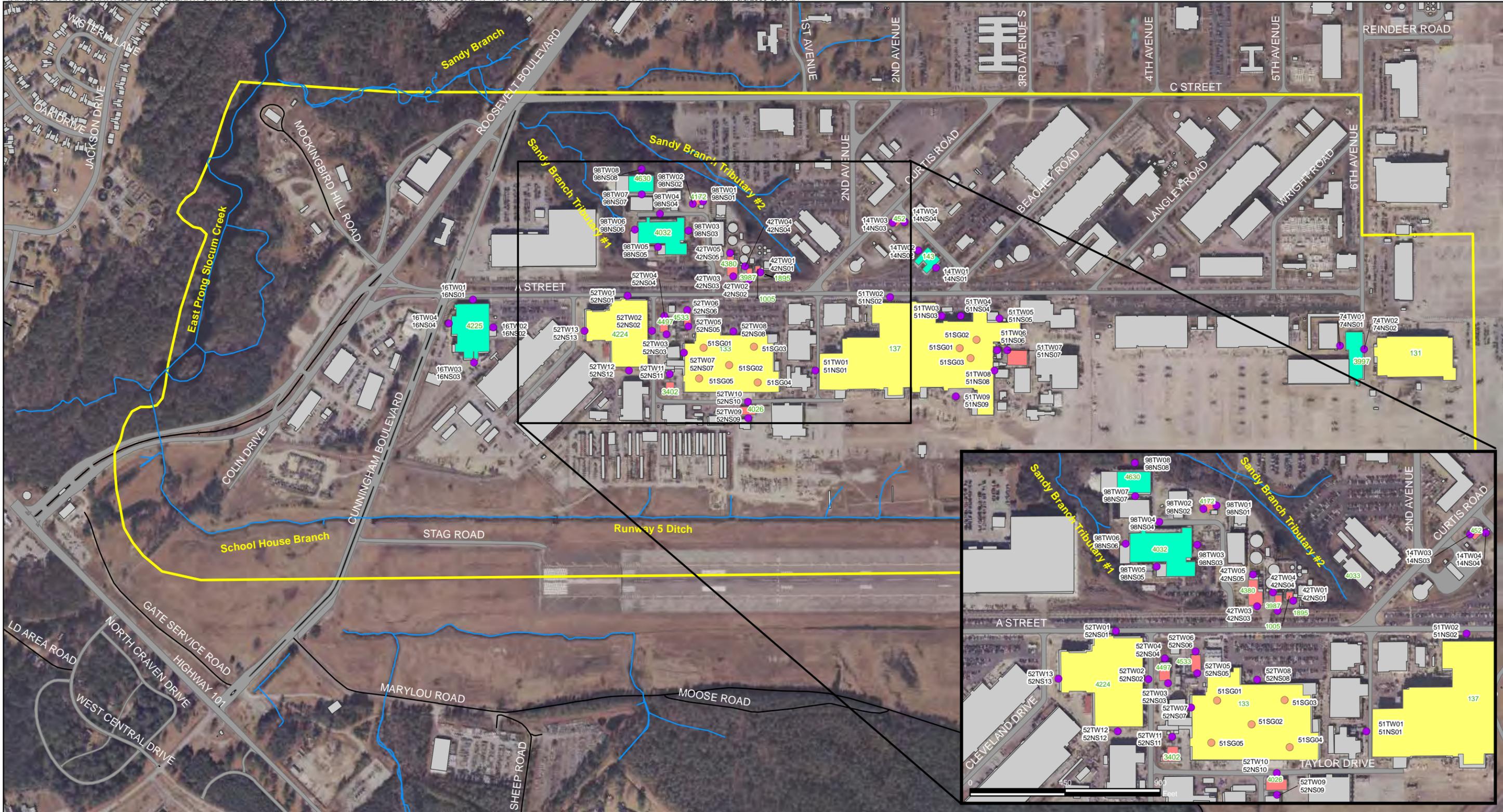


FIGURE 10
Field Investigation Decision Logic
Vapor Intrusion SAP



- Legend**
- Proposed Near Slab Soil Vapor and Groundwater Sample
 - Proposed Subslab Soil Vapor Sample
 - Surface Water
 - OU1 Boundary
 - Buildings within 100 ft of Monitoring Wells Exceeding Small Building Criteria
 - Buildings within 100 ft of Monitoring Wells Exceeding Medium Building Criteria
 - Buildings within 100 ft of Monitoring Wells Exceeding Large Building Criteria
 - Building

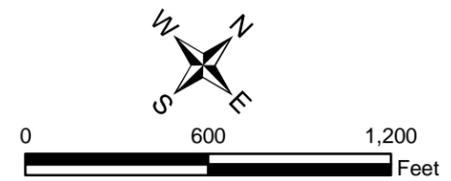


Figure 11
Proposed Sample Locations
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

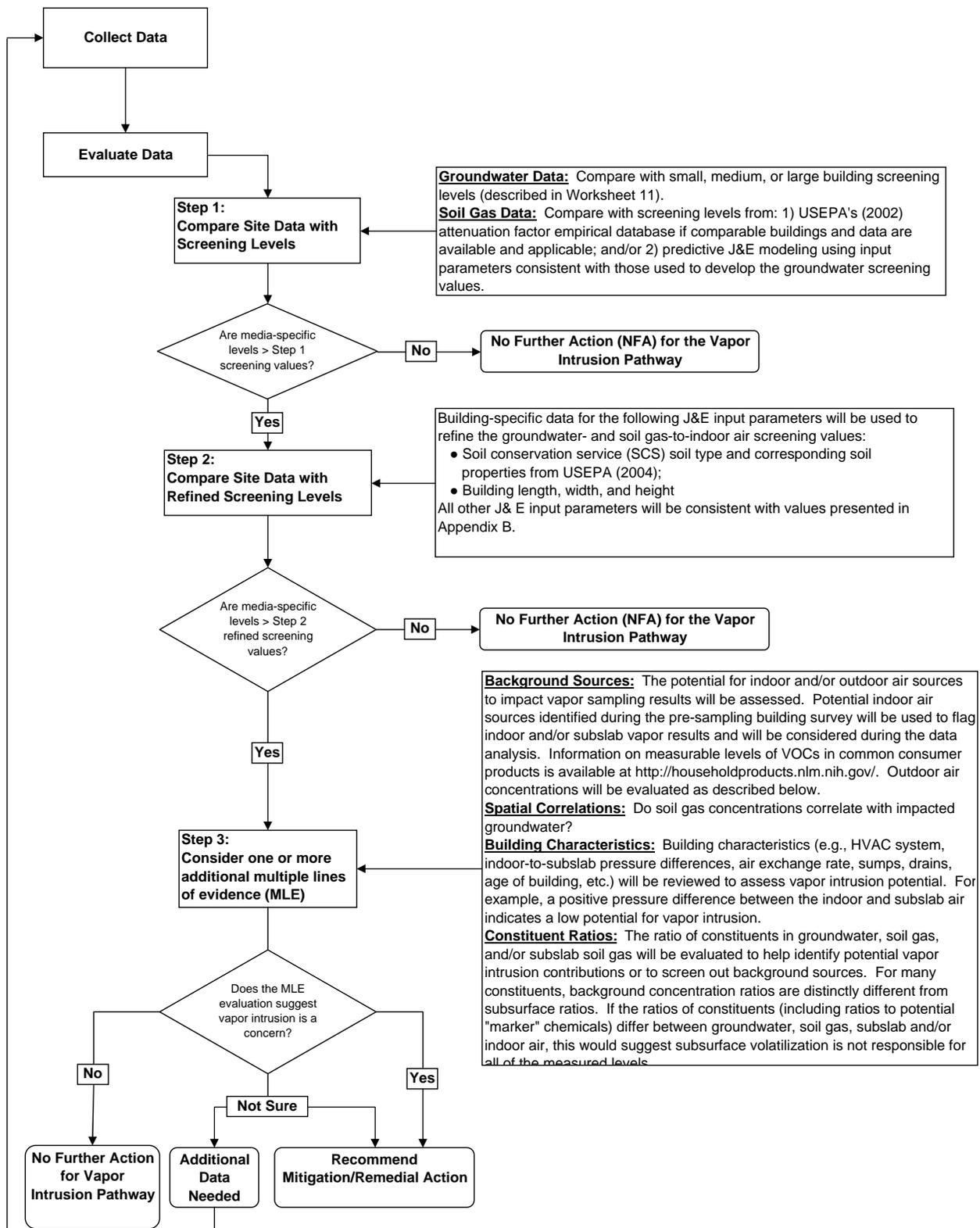


FIGURE 12
Risk Evaluation Strategy
 (adapted from ITRC [2007])

Tables

Table 1
 Building Inventory at OU1
 Marine Corps Air Station, Cherry Point
 Cherry Point, North Carolina

Building Number	Description	Building Status	Year Building Constructed	Building Levels	Building Size (ft ²)	Occupancy	Notes	Excluded?	Reason for Exclusion	Proposed Samples
131	Aircraft Maintenance Hanger (MALS-14)	Existing	1942	2	123,850	--	VMR-1, Air Ops, Avionics, GSE, Parachute Riggers	No	--	1 near slab soil vapor
133	Dedicated Aircraft and Engine Accessories - Overhaul and Test Building [FRCE]	Existing	1944	1	211,090	High	An expansion was recently built on the northwest corner	No	--	5 subslab soil gas (due to presence of DNAPL beneath the building); 5 near slab soil vapor
137	Aircraft Rework Shop - Overhaul and Repair Shops [FRCE]	Existing	1943	1	504,760	High	--	No	--	3 subslab soil gas (due to location of plume beneath the building); 7 near slab soil vapor;
143	Quality and Safety Administrative Office [FRCE]	Existing	1943	1	10,670	High	Slab on grade; windows and doors closed; multiple rooms; multiple air conditioner units; appears to be wood construction	No	--	2 near slab soil vapor
452	NAVAIR Administration [FRCE]	Existing	1945	1	1,290	Low	--	No	--	2 near slab soil vapor
1005	Industrial Wastewater Treatment Building	Existing	1958	2	1,085	Low	Top floor with admin has 2 rooms AC; first floor has controls, no AC, doors left open; above ground; brick construction	No	--	1 near slab soil vapor
3402	Engine Test Cell [FRCE]	Existing	1968	1	3,820	--	--	No	--	1 near slab soil vapor
3987	Industrial Waste Treatment Building - Sludge Digester	Existing	1984	1	1,440	Low	Slab on grade; concrete floor with sealed joints; brick and concrete bldg; no air conditioning; doors and windows left open; small control room with AC; 30' ceilings; window vents with fans blowing out	No	--	2 near slab soil vapor
3997	Engine Maintenance Shop (MALS-14)	Existing	1987	2	28,845	High	Primarily open warehouse with some shops/admin spaces.	No	--	2 near slab soil vapor
4026	Engine Examination and Evaluation Shop (NDI) [FRCE]	Existing	1984	1	4,939	Low	Small administration room	No	--	2 near slab soil vapor
4032	Ground Support Equipment Rework Shop [FRCE]	Existing	1985	1	50,602	High	Administrative and labs; no open windows or doors; AC throughout; slab on grade; brick and cinder block construction;	No	--	4 near slab soil vapor
4172	Ground Support Equipment Rework Shop [FRCE]	Existing	1985	1	1,645	Low	2 roof vents for ventilation; slab on grade; concrete; brick and cinderblock construction	No	--	2 near slab soil vapor
4224	Non-Metal Components Shop V/STOL Rework [FRCE]	Existing	1990	2	126,700	High	--	No	--	4 near slab soil vapor
4225	Dedicated Aircraft Engine Overhaul General Process [FRCE]	Existing	1990	2	63,465	High	--	No	--	4 near slab soil vapor
4380	Industrial Waste Treatment Building	Existing	1990	1	6,785	Low	--	No	--	2 near slab soil vapor
4497	Test and Calibration Shop (H53) [FRCE]	Existing	1997	1	3,510	Low	--	No	--	2 near slab soil vapor
4533	Customer Service [FRCE]	Existing	1944	1	3,560	Low	--	No	--	2 near slab soil vapor
4630	ASKARS Storage [FRCE]	Existing	--	1	15,710	Low	Slab on grade; metal bldg; no AC units; bldg has been expanded.	No	--	2 near slab soil vapor
4808	V-22 Prop Rotor Blade Repair Facility [FRCE]	Existing	2008	1	12,138	Low	This building recently replaced former Building 424	No	--	1 near slab soil vapor
80	Administrative Office	Existing	1944	2	9,565	--	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
82	Public Works Shop	Demolished	1944	1	8,115	na	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None

Table 1
 Building Inventory at OU1
 Marine Corps Air Station, Cherry Point
 Cherry Point, North Carolina

Building Number	Description	Building Status	Year Building Constructed	Building Levels	Building Size (ft ²)	Occupancy	Notes	Excluded?	Reason for Exclusion	Proposed Samples
85	Public Works Shop	Existing	1945	1	22,645	--	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
86	Thrift Shop	Demolished	1944	1	2,960	na	Area is vacant.	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
93	Public Works Shop	Existing	1944	1	20,395	--	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
95	Public Works Maintenance Storage	Demolished	1948	1	465	na	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
138	Plant Services for Aircraft Overhaul [FRCE]	Existing	1943	2	1,660	None	Building will need to be addressed if future occupancy changes	Yes	No occupancy	None
139	Plant Services for Aircraft Overhaul - Air Compressor Room [FRCE]	Existing	1943	2	4,350	None	Building will need to be addressed if future occupancy changes	Yes	No occupancy	None
155	General Warehouse	Existing	1943	1	121,690	--	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
159	General Warehouse and Engineering [FRCE]	Existing	1954	2	180,500	High	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
160	Vehicle Holding Shed	Existing	1942	1	25,220	--	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
246	General Warehouse	Existing	1957	1	10,185	--	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
247	Public Works Maintenance Storage	Demolished	1955	1	13,625	na	Trailer compound has been built/occupied in same location. Elevated several feet.	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
421	Jet Engine Overhaul Shop [FRCE]	Demolished	1944	1	5,625	na	Replaced with Bldg 133 extension.	Yes	Demolished	None
424	Corrosion Control - Cleaning Shop [FRCE]	Demolished	1947	1	10,390	na	Replaced with Bldg 4808 V-22	Yes	Demolished	None
434	Public Works Maintenance Storage	Demolished	1949	1	5,200	na	Area is vacant.	Yes	No occupancy	None
1386	Storage Air Ground Organic Units MARCOR	Demolished	1949	1	2,790	na	a.k.a. Aircraft Can (Storage)	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
1387	Storage Air Ground Organic Units [FRCE]	Existing	1949	1	2,815	None	Pending demolition; a.k.a. Aircraft Can (Storage)	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
1388	Storage Air Ground Organic Units (2-MAW)	Existing	1949	1	2,815	None	a.k.a. Aircraft Can (Storage)	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
1391	Storage Air Ground Organic Units MARCOR	Demolished	1949	1	2,820	na	Replaced with Bldg 4809 FRC Xray Facility.	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
1392	Storage Air Ground Organic Units MARCOR	Demolished	1949	1	2,815	na	Replaced with Bldg 4809 FRC Xray Facility.	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
1393	Storage Air Ground Organic Units (2-MAW)	Existing	1949	1	2,810	None	a.k.a. Aircraft Can (Storage)	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
1395	Storage Air Ground Organic Units (MCCS)	Existing	1949	1	2,800	None	a.k.a. Aircraft Can (Storage)	Yes	Groundwater concentrations do not exceed site-specific screening levels	None

Table 1
 Building Inventory at OU1
 Marine Corps Air Station, Cherry Point
 Cherry Point, North Carolina

Building Number	Description	Building Status	Year Building Constructed	Building Levels	Building Size (ft ²)	Occupancy	Notes	Excluded?	Reason for Exclusion	Proposed Samples
1396	Storage Air Ground Organic Units MARCOR	Demolished	1949	1	2,795	na	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
1397	Storage Air Ground Organic Units MARCOR	Demolished	1949	1	2,795	na	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
1690	Potable Water Storage Tank - Elevated	Demolished	1961	1	260	na	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
1798	Metal Components Shop [FRCE]	Existing	1969	1	32,115	High	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
1821	Loading Ramp	Existing	1961	-	1,885	Occupany not expected	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
1877	High Voltage Substation	Existing	1955	1	400	None	Fenced compound; no roof; slab on grade; electrical components only provide external access for maintenance workers.	No	--	None
1895	Industrial Waste Treatment Building	Existing	1960	-	235	None	Building will need to be addressed if future occupancy changes	Yes	No occupancy	None
1902	Vehicle Wash Platform	Demolished	1952	1	330	na	Area is vacant.	Yes	--	None
3310	Storage Air Ground Organic Units MARCOR	Existing	1963	1	320	None	a.k.a. Aircraft Can (Storage)	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
3455	Potable Water Storage Tank - Elevated	Existing	1970	-	2,460	None	--	Yes	No occupancy	None
3745	Fixed Aircraft Start System	Existing	1974	1	5,070	Occupancy not expected	Fenced compound; metal roof; concrete floor; contains compressed cylinders and associated mechanical and electrical equipment. Not in operation.	No	--	None
3761	Pumping Station #1	Existing	1974	1	10	None	Fenced area containing backup generator and aboveground storage tank for generator fuel.	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
3767	Liquid Oxygen/Nitrogen Facility (Non-Industrial) [FRCE]	Existing	1976	1	4,430	None	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
3768	Pneumatic Oxygen Shop [FRCE]	Existing	1976	1	2,205	Low	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
3978	Lift Station	Existing	1975	1	75	Occupancy not expected	Sewage and industrial waste pumping station; concrete block structure on slab.	Yes	No occupancy	None
3985	Compressed Air Distribution System - Mechanical Building	Existing	1972	1	80	Occupancy not expected	Building will need to be addressed if future occupancy changes	Yes	No occupancy	None
3996	CNATT Training Building	Existing	1985	1	19,490	High	Contains ordnance training school classrooms and admin offices; possibly includes ordnance GSE shop.	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
3999	Ground Support Equipment Holding Shed	Existing	1985	1	8,890	Low	Covered shed; metal roof (~20 ft high); fenced within large asphalt/concrete area; no permanent personnel assigned to area.	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
3998	Aircraft Maintenance Hanger	Existing	1987	2	58,405	High	VMAT-203 Squadron Hanger	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
4000	Storage Air Ground Organic Units MARCOR	Demolished	1984	1	825	na	Area is vacant.	Yes	Demolished	None
4033	Production Support Administrative Office	Existing	1985	1	12,615	High	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None

Table 1
 Building Inventory at OU1
 Marine Corps Air Station, Cherry Point
 Cherry Point, North Carolina

Building Number	Description	Building Status	Year Building Constructed	Building Levels	Building Size (ft ²)	Occupancy	Notes	Excluded?	Reason for Exclusion	Proposed Samples
4056	Sewage and Industrial Waste Pumping Station (Underground)	Existing	1984	-	240	Occupancy not expected	--	Yes	No occupancy	None
4057	Test Cell Utility Bldg General Storage Shed [FRCE]	Existing	1984	1	1,000	Occupancy not expected	--	Yes	No occupancy	None
4188	F402 Engine Test Cell [FRCE]	Existing	1989	2	20,550	Low	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
4227	Public Works Maintenance Storage	Existing	1985	1	1,755	Occupancy not expected	Open-air concrete slab with metal roof.	Yes	Groundwater concentrations do not exceed site-specific screening levels and no occupancy	None
4247	Hazardous Material Storehouse [FRCE]	Existing	1989	1	11,450	Low	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
4381	Loading Ramp	Existing	1993	-	1,035	Occupancy not expected	--	Yes	No occupancy	None
4382	Sewage and Industrial Waste Pumping Station	Existing	1993	1	225	None	--	Yes	No occupancy	None
4399	Hazardous Waste Storage Area [DRMO]	Existing	1984	-	21,960	Occupancy not expected	Fenced, open-air concrete staging area, no occupancy expected except during loading/unloading operations.	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
4407	Electronic Sign	Existing	1990	-	55	None	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
4464	Warehouse	Existing	1995	1	37,030	Low	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
4466	Hazardous Waste Storage Area	Existing	1993	1	5,710	None	--	Yes	No occupancy	None
4469	General Storage Shed	Existing	1995	1	3,605	Occupancy not expected	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
4471	Weighting Facility [DRMO]	Existing	1995	1	340	Occupancy not expected	--	Yes	No occupancy	None
4528	Hazardous Waste Storage Area [FRCE]	Existing	1996	1	3,500	Occupancy not expected	--	Yes	No occupancy	None
4561	Storage Shed V-22 [FRCE]	Existing	1993	1	1,510	Occupancy not expected	--	Yes	No occupancy	None
4582	Hazardous Waste Storage Facility	Existing	1999	1	540	None	--	Yes	No occupancy	None
4587	Hazardous Waste Storage Facility [FRCE]	Existing	--	--	1,435	None	--	Yes	Groundwater concentrations do not exceed site-specific screening levels	None
4612	Tank with secondary Containment	Existing	--	--	1,655	None	--	Yes	No occupancy	None

¹ - Chemical of concern exceeds the generic vapor intrusion screening value for groundwater within 100 feet of building

TCA = Trichloroethane

PCE = Tetrachloroethene

TCE = Trichloroethene

DCE = Dichloroethene

DCA = Dichloroethane

Highlighted = Buildings retained for further evaluation

-- = Information not available

na = not applicable

Low Occupancy = less than 20 people

High Occupancy = greater than 20 people

Table 2

Site-Specific Vapor Intrusion Screening Levels

OU1 Vapor Intrusion Evaluation

MCAS Cherry Point, North Carolina

CAS #	Chemical Name	Final Indoor Exposure Groundwater Concentration (ug/L) ^{1,2}		
		Industrial Scenario		
		Large Building	Medium Building	Small Building
71556	1,1,1-Trichloroethane	1.89E+05	7.86E+04	5.97E+04
79005	1,1,2-Trichloroethane	1.30E+02	5.35E+01	4.05E+01
79345	1,1,2,2-Tetrachloroethane	9.87E+01	4.14E+01	3.16E+01
76131	1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-11)	2.10E+05	2.10E+05	2.10E+05
75343	1,1-Dichloroethane	2.02E+02	8.55E+01	7.00E+01
75354	1,1-Dichloroethene	4.61E+03	1.83E+03	1.36E+03
107062	1,2-Dichloroethane	6.78E+01	2.55E+01	1.83E+01
75252	Bromoform	5.57E+03	3.73E+03	3.36E+03
74873	Chloromethane	9.44E+01	3.36E+01	2.34E+01
75718	Dichlorodifluoromethane (Freon-12)	1.40E+03	1.40E+03	1.40E+03
75092	Methylene Chloride	1.62E+03	6.16E+02	4.47E+02
127184	Tetrachloroethene	1.79E+01	7.68E+00	5.92E+00
156605	trans-1,2-Dichloroethene	4.17E+03	1.79E+03	1.39E+03
79016	Trichloroethylene	8.96E+01	3.71E+01	2.82E+01
75014	Vinyl Chloride	1.31E+01	4.93E+00	3.55E+00

Notes:

¹Site-specific vapor intrusion screening levels were calculated using the Johnson and Ettinger Model.

The assumptions for the Johnson and Ettinger input parameters are provided in Appendix B.

²Target risk levels used to develop the site-specific screening values were based on 1×10^{-6} for carcinogens and an HQ of 1 for noncarcinogens.³The NC2L water quality standard was identified as the screening value in cases where the site-specific screening level is lower than the NCAC 2L value.⁴cis-1,2-Dichloroethene used as a surrogate for 1,2-Dichloroethene.

Appendix A
Generic Screening Values

Table A-1
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	Generic Vapor Intrusion Screening Value for Groundwater ^a	14GW18	14GW34		14GW36	16GW01		16GW02			16GW03					
Sample ID		14GW18-1204	14GW34-0603	14GW34-1203	14GW36-0506	16GW01-0903	16GW01-0504	16GW02-0604	16GW02-1104	16MW02-0905	16GW02-0406	16GW03-0903	16GW03-1203	16GW03-0304	16GW03-0604	16GW03-0904
Sample Date		12/15/04	06/30/03	12/22/03	05/04/06	09/30/03	05/13/04	06/15/04	11/30/04	09/22/05	04/21/06	09/30/03	12/17/03	03/18/04	06/15/04	09/16/04
Aquifer		Upper Surficial	Upper Surficial		Upper Surficial	Upper Surficial		Upper Surficial			Upper Surficial					
Volatile Organic Compounds (µg/L)																
1,1,1-Trichloroethane	7092 b	10 U	20 U	40 U	10 U	2 U	0.5 U	2 U	0.5 U	1 U	10 U	2 U	2 U	2 U	2 U	2 U
1,1,2,2-Tetrachloroethane	3	10 U	20 U	40 U	10 U	2 U	0.5 U	1.1 J	4.6	3.7	6 J	0.59 J	0.79 J	0.97 J	2 U	0.58 J
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	1500	NA	NA	NA	10 U	NA	0.16 J	NA	0.5 U	NA	2 J	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	5	10 U	20 U	40 U	10 U	2 U	0.5 U	2 U	0.5 U	0.79 J	10 U	0.64 J	2 U	2 U	2 U	0.51 J
1,1-Dichloroethane	2200	7.9 J	20 U	40 U	10 U	2 U	0.5 U	2 U	0.5 U	1 UJ	10 U	2 U	2 U	2 U	2 U	2 U
1,1-Dichloroethene	190	10 U	20 U	40 U	10 U	2 U	0.5 U	2 U	0.5 U	1 U	10 U	2 U	2 U	2 U	2 U	2 U
1,2-Dichloroethane	5	10 U	20 U	40 U	10 U	1.5 J	0.36 J	2 U	0.5 U	1 U	10 U	2 U	2 U	2 U	2 U	2 U
1,2-Dichloroethene (total)	210	NA	NA	NA	10 U	NA	NA	NA	NA	NA	37	NA	NA	NA	NA	NA
Benzene	1.4 b	5 U	311	2,280	1 J	1 U	0.5 U	1 U	0.5 U	1 U	10 U	1 U	1 U	1 U	1 U	1 U
Bromodichloromethane	2.1	10 U	20 U	40 U	10 U	2 U	0.5 U	2 U	0.5 U	1 U	10 U	2 U	2 U	2 U	2 U	2 U
Bromoform	0.0083	10 U	20 U	40 U	10 U	2 U	0.2 J	2 U	0.5 U	1 U	10 U	2 U	2 U	2 U	2 U	2 U
Chloromethane	6.7	10 U	20 U	40 U	10 U	2 U	0.5 U	2 U	0.5 U	2 U	10 U	2 U	2 U	2 U	2 U	2 U
Dichlorodifluoromethane (Freon-12)	14	NA	NA	NA	10 U	NA	1	NA	0.5 U	NA	10 U	NA	NA	NA	NA	NA
Ethylbenzene	700	10 U	673	1,770	63	2 U	0.5 U	2 U	0.5 U	1 U	10 U	2 U	2 U	2 U	2 U	2 U
Isopropylbenzene	8.4	NA	NA	NA	11	NA	0.5 U	NA	0.5 U	NA	10 U	NA	NA	NA	NA	NA
Tetrachloroethene	5	10 U	20 U	40 U	10 U	1.7 J	1.6	2 U	0.5 U	1 U	10 U	2 U	2 U	0.57 J	2 U	2 U
Trichloroethene	2.9 b	105	20 U	40 U	10 U	2.9	1.6	4	3.6	5.3	7 J	23.9	24.3	25.4	26.8	18.7
Vinyl chloride	2	5 U	10 U	20 U	10 U	1.2	0.5 U	1 U	0.5 U	2.2	10 U	1 U	1 U	1 U	1 U	1 U
Xylene, total	341	30 U	3,920	5,200	10 U	6 U	0.5 U	6 U	0.5 U	3 U	10 U	6 U	6 U	6 U	6 U	6 U
cis-1,2-Dichloroethene	210	195	20 U	40 U	10 U	5.3	2.4	33.7	21	25.9	37.0	NA	NA	NA	58.4	NA
trans-1,2-Dichloroethene	180	3.9 J	20 U	40 U	10 U	1.1 J	0.36 J	0.58 J	0.5 U	0.67 J	10 U	NA	NA	NA	4.4	NA

Notes:

- J - Reported value may be imprecise
- R - Unreliable result
- U - Not detected
- UJ - Not detected, quantitation limit may be imprecise
- NA - Not analyzed
- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Groundwater = Target groundwater screening concentration from the 2002 USEPA draft Subsurface Vapor Intrusion Guidance that correspond to an indoor air concentration not exceeding a Target Cancer Risk of 1x10⁻⁶ and Hazard Index of 1, where the soil gas to indoor air attenuation factor = 0.001 and partitioning across the water table obeys Henry's Law.

^b Screening values were updated based on current toxicity values following the USEPA draft Subsurface Vapor Intrusion Guidance, November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,2-dichloroethene (total).

Highlighted cells exceed the screening value.

Table A-1
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	16GW03					16GW04											
Sample ID	16GW03-1204	16GW03-0305	16GW03-0406	16GW03-0607	16GW03P-0607	16GW04-0903	16GW04-1203	16GW04-0304	16GW04-0505	16GW04-0504	16GW04P-0504	16GW04-0604	16GW04-0904	16GW04-1204	16GW04-1204	16GW04-0305	16GW04-0605
Sample Date	12/15/04	03/18/05	04/20/06	06/26/07	06/26/07	09/30/03	12/17/03	03/18/04	05/12/04	05/13/04	05/13/04	06/15/04	09/16/04	12/01/04	12/15/04	03/18/05	06/15/05
Aquifer	Upper Surficial					Upper Surficial											
Volatile Organic Compounds (µg/L)																	
1,1,1-Trichloroethane	2 U	1 U	10 U	10 U	10 U	2 U	2 U	10 U	0.5 U	0.5 U	0.5 U	2 U	2 U	0.5 U	2 U	1 U	5 U
1,1,2,2-Tetrachloroethane	1.1 J	1 U	10 U	1.2 J	10 U	2 U	2 U	10 U	0.5 U	0.5 U	0.5 U	2 U	2 U	0.5 U	2 U	1 U	5 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	NA	NA	10 U	10 U	10 U	NA	NA	NA	0.5 U	0.5 U	0.5 U	NA	NA	0.5 U	NA	NA	NA
1,1,2-Trichloroethane	2 U	1 U	10 U	10 U	10 U	2 U	2 U	10 U	0.5 U	0.5 U	0.5 U	2 U	2 U	0.5 U	2 U	1 U	5 U
1,1-Dichloroethane	2 U	1 U	10 U	10 U	10 U	2 U	2 U	10 U	0.31 J	0.5 U	0.5 U	2 U	2 U	0.5 U	2 U	1 U	5 U
1,1-Dichloroethene	2 U	1 U	10 U	10 U	10 U	2 U	2 U	10 U	0.5 U	0.11 J	0.11 J	2 U	2 U	0.5 U	2 U	1 U	5 U
1,2-Dichloroethane	2 U	1 U	10 U	10 U	10 U	2 U	2 U	10 U	0.5 U	0.5 U	0.5 U	2 U	2 U	0.5 U	2 U	1 U	5 U
1,2-Dichloroethene (total)	NA	NA	60	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	1 U	1 U	10 U	10 U	10 U	1 U	1.1	5 U	0.5 U	0.14 J	0.11 J	1 U	1.7	0.5 U	1 U	1 U	5 U
Bromodichloromethane	2 U	1 U	10 U	10 U	10 U	2 U	2 U	10 U	0.5 U	0.5 U	0.5 U	2 U	2 U	0.5 U	2 U	1 U	5 U
Bromoform	2 U	1 U	10 U	10 U	10 U	2 U	2 U	10 U	0.5 UJ	0.5 U	0.5 U	2 U	2 U	0.5 U	2 U	1 U	5 U
Chloromethane	2 U	2 U	10 U	10 U	10 U	2 U	2 U	10 U	0.5 U	0.5 U	0.5 U	2 U	2 U	0.5 U	2 U	2 U	10 U
Dichlorodifluoromethane (Freon-12)	NA	NA	10 U	10 UJ	10 UJ	NA	NA	NA	0.5 U	0.5 U	0.5 U	NA	NA	0.5 U	NA	NA	NA
Ethylbenzene	2 U	1 U	10 U	10 U	10 U	2 U	2 U	10 U	0.5 U	0.5 U	0.5 U	2 U	2 U	0.5 U	2 U	0.97 J	5 U
Isopropylbenzene	NA	NA	10 U	10 U	10 U	NA	NA	NA	0.5 U	0.5 U	0.5 U	NA	NA	0.5 U	NA	NA	NA
Tetrachloroethene	2 U	1 U	10 U	10 U	10 U	2 U	2 U	10 U	0.5 U	0.5 U	0.5 U	2 U	2 U	0.5 U	2 U	1 U	5 U
Trichloroethene	25.0	29.5	24.0	29	27	9.9	21.6	14.3	8.8	4.7	4.8	3.5	5.5	3.7	3.7	4.5	9.1
Vinyl chloride	1 U	1 U	10 U	10 U	10 U	0.94 J	18.4	5.5	0.5 U	6.7	6.3	6.3	9.3	7.2	3.4	4.2	5 U
Xylene, total	6 U	3 U	10 U	10 U	10 U	6 U	6 U	30 U	0.5 U	0.5 U	0.5 U	6 U	6 U	0.5 U	6 U	3 U	15 U
cis-1,2-Dichloroethene	NA	NA	NA	60	63	52.9	288.0	160	260	110	110	93	23.7	83.0	93.4	151.0	254
trans-1,2-Dichloroethene	NA	NA	NA	5 J	4.6 J	3.9	13.2	7.0 J	15	6	5.9	5.6	1.9 J	3.7	5.3	9	16.8

Notes:

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- R - Unreliable result
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- NA - Not analyzed
- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Ground groundwater screening concentration from the 2002 U Subsurface Vapor Intrusion Guidance that corresponds to a concentration not exceeding a Target Cancer Risk of Hazard Index of 1, where the soil gas to indoor air attenuation factor is 0.001 and partitioning across the water table obeys Henry's Law.

^b Screening values were updated based on current toxicology following the USEPA draft Subsurface Vapor Intrusion Screening Values November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,2-dichloroethene (total).

Highlighted cells exceed the screening value.

Table A-1
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	16GW04					16GW05						16GW06					
Sample ID	16MW04-0905	16GW04-0406	16GW04P-0406	16GW04-0607	16GW04-0807	16GW05-0903	16GW05-1203	16GW05-0304	16MW05-0604	16GW05-0904	16MW05-0905	16GW06-0903	16GW06-1203	16GW06-0304	16GW06-0504	16GW06P-0504	16GW06-0604
Sample Date	09/22/05	04/20/06	04/20/06	06/26/07	08/29/07	09/30/03	12/17/03	03/18/04	06/15/04	09/16/04	09/22/05	09/30/03	12/17/03	03/18/04	05/12/04	05/12/04	06/15/04
Aquifer	Upper Surficial					Upper Surficial						Upper Surficial					
Volatile Organic Compounds (µg/L)																	
1,1,1-Trichloroethane	10 U	10 U	10 U	10 U	0.5 U	2 U	2 U	100 U	40 U	2 U	1 U	100 U	100 U	100 U	0.5 U	0.5 U	100 U
1,1,2,2-Tetrachloroethane	10 U	10 U	10 U	10 U	0.5 U	2 U	2 U	100 U	40 U	2 U	3.6	100 U	100 U	100 U	0.5 U	0.5 U	100 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	NA	1 J	2 J	10 U	0.5 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.5 U	0.5 U	NA
1,1,2-Trichloroethane	10 U	10 U	10 U	10 U	0.6	2 U	2 U	100 U	40 U	2 U	0.82 J	100 U	100 U	100 U	0.5 U	0.5 U	100 U
1,1-Dichloroethane	10 U	10 U	1 J	10 U	0.6	2 U	6.2	100 U	40 U	4.5	1 U	100 U	100 U	100 U	8	9	100 U
1,1-Dichloroethene	10 U	10 U	10 U	10 U	0.5 U	2 U	11.6	100 U	40 U	7.1	1 U	100 U	100 U	100 U	12	13	100 U
1,2-Dichloroethane	10 U	10 U	10 U	10 U	0.5 U	1.8 J	2 U	100 U	40 U	2 U	0.66 J	100 U	100 U	100 U	0.34 J	0.37 J	100 U
1,2-Dichloroethene (total)	NA	540	470	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	10 U	10 U	1 J	10 U	0.3 J	1 U	2.5	50 U	20 U	2.4	1 U	50 U	50 U	50 U	2.8	3	50 U
Bromodichloromethane	10 U	10 U	10 U	10 U	0.5 U	2 U	2 U	100 U	40 U	2 U	1 U	100 U	100 U	100 U	0.5 U	0.5 U	100 U
Bromofom	10 U	10 U	10 U	10 U	0.5 U	2 U	2 U	100 U	40 U	2 U	1 U	100 U	100 U	100 U	0.14 J	0.12 J	100 U
Chloromethane	20 U	10 U	10 U	10 U	0.5 U	2 U	2 U	100 U	40 U	2 U	2 U	100 U	100 U	100 U	0.5 U	0.5 U	100 U
Dichlorodifluoromethane (Freon-12)	NA	10 U	10 U	10 UJ	0.5 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.5 U	0.5 U	NA
Ethylbenzene	10 U	10 U	10 U	10 U	0.5 U	2 U	2 U	100 U	40 U	2 U	1 U	100 U	100 U	100 U	0.5 U	0.5 U	100 U
Isopropylbenzene	NA	10 U	10 U	10 U	0.5 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.5 U	0.5 U	NA
Tetrachloroethene	10 U	10 U	1 J	10 U	0.5 U	1.3 J	2 U	100 U	40 U	2 U	1 U	100 U	100 U	100 U	0.5 U	0.5 U	100 U
Trichloroethene	61.7	270.0	260	7 J	29	3.4	155	172	159	95	5	41.5 J	127	138	150	190	194
Vinyl chloride	5.5 J	21	21	1.2 J	11	2.2	57.5	45.0 J	166	62	1.9	89.7	69.3	47.6 J	53 J	44 J	98.3
Xylene, total	30 U	10 U	10 U	10 U	0.5 U	6 U	6 U	300 U	120 U	6 U	3 U	300 U	300 U	300 U	0.5 U	0.5 U	300 U
cis-1,2-Dichloroethene	330	500	440	120	160	NA	NA	NA	2130	NA	23.4	2,400	2,970	2,600	2,200	2,400	2,290
trans-1,2-Dichloroethene	22.5	44.0	38	6.2 J	16	NA	NA	NA	143	NA	0.62 J	173	203	178	160	180 R	181

Notes:

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- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Ground groundwater screening concentration from the 2002 U Subsurface Vapor Intrusion Guidance that correspond to a concentration not exceeding a Target Cancer Risk of Hazard Index of 1, where the soil gas to indoor air attenuation factor is 0.001 and partitioning across the water table obeys Henry's Law.

^b Screening values were updated based on current toxicology following the USEPA draft Subsurface Vapor Intrusion Screening Values November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,2-dichloroethene (total).

Highlighted cells exceed the screening value.

Table A-1
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	16GW06								16GW07				16GW08			16GW09
Sample ID	16MW06-0904	16GW06-1104	16MW06-1204	16GW06-0305	16GW06-0505	16GW06-0605	16MW06-0905	16GW06-0406	16GW07-0305	16MW07-1204	16GW07-0605	16MW07-0905	16GW08-1204	16GW08-0505	16GW08-0406	16GW09-0604
Sample Date	09/16/04	11/30/04	12/15/04	03/18/05	05/12/05	06/15/05	09/22/05	04/21/06	03/18/05	12/15/04	06/15/05	09/22/05	12/01/04	05/16/05	04/22/06	06/16/04
Aquifer	Upper Surficial								Upper Surficial				Upper Surficial			Upper Surficial
Volatile Organic Compounds (µg/L)																
1,1,1-Trichloroethane	2 U	0.5 U	2 U	1 U	0.5 U	50 U	1 U	10 U	1 U	2 U	20 U	20 U	0.5 U	0.5 U	10 U	2 U
1,1,2,2-Tetrachloroethane	2 U	0.5 U	2 U	1 U	0.5 U	50 U	1 U	10 U	1 U	2 U	20 U	20 U	0.5 U	0.5 U	10 U	2 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	NA	0.5 U	NA	NA	0.5 U	NA	NA	10 U	NA	NA	NA	NA	0.5 U	0.5 U	10 U	NA
1,1,2-Trichloroethane	2 U	0.5 U	2 U	1 U	0.5 U	50 U	1 U	10 U	1 U	2 U	20 U	20 U	0.5 U	0.5 U	10 U	2 U
1,1-Dichloroethane	4.1	3.6	3	8.8	2.6	50 U	8.1	5 J	9.1	2.9	20 U	20 U	0.5 U	0.5 U	10 U	2 U
1,1-Dichloroethene	6.9	5.6	5.9	14.9	3.8	50 U	14.4	9.0 J	12.9	5.9	20 U	20 U	0.5 U	0.5 U	10 U	2 U
1,2-Dichloroethane	2 U	0.5 U	2 U	1 U	0.5 U	50 U	1 U	10 U	1 U	2 U	20 U	20 U	0.5 U	0.5 U	10 U	2 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA	2100	NA	NA	NA	NA	NA	NA	8 J	NA
Benzene	2.3	2.1	2	2.4	1.5	50 U	2	2 J	2.6	2.1	20 U	20 U	0.5 U	0.5 U	10 U	0.6 J
Bromodichloromethane	2 U	0.5 U	2 U	1 U	0.5 U	50 U	1 U	10 U	1 U	2 U	20 U	20 U	0.5 U	0.5 UJ	10 U	2 U
Bromoform	2 U	0.5 U	2 U	1 U	0.5 UJ	50 U	1 U	10 U	1 U	2 U	20 U	20 U	0.5 U	0.5 U	10 U	2 U
Chloromethane	2 U	0.5 U	2 U	2 U	100	100 U	2 U	10 U	2 U	2 U	40 U	40 U	0.5 U	0.5 U	10 U	2 U
Dichlorodifluoromethane (Freon-12)	NA	0.5 U	NA	NA	0.5 U	NA	NA	10 U	NA	NA	NA	NA	0.5 U	0.5 U	10 U	NA
Ethylbenzene	2 U	0.5 U	2 U	1 U	0.5 U	50 U	1 U	10 U	1 U	2 U	20 U	20 U	0.5 U	0.5 U	10 U	2 U
Isopropylbenzene	NA	0.5 U	NA	NA	0.5 U	NA	NA	10 U	NA	NA	NA	NA	0.5 U	0.5 U	10 U	NA
Tetrachloroethene	2 U	0.5 U	2 U	1 U	0.5 U	50 U	1 U	10 U	1 U	2 U	20 U	20 U	5.1	5.7	8 J	2 U
Trichloroethene	93.9	75 J	67.1	114	56	71.9	46.6	120.0	99.7	70.5	79.7	36.5	4.7	3.2	5 J	3.6
Vinyl chloride	59.6	50	59.5	58.8	96	50 U	58.6	44.0	1 U	61.2	21.3	39.8	0.5 U	0.5 U	10 U	1 U
Xylene, total	6 U	0.5 U	6 U	3 U	0.5 U	150 U	3 U	10 U	3 U	6 U	60 U	60 U	0.5 U	0.5 U	10 U	6 U
cis-1,2-Dichloroethene	NA	1,200	NA	2,360	990	1,040	997	2,000	1870	NA	966	742	5.6	6.1	8 J	NA
trans-1,2-Dichloroethene	NA	67	NA	143	64	69.3	64.2	180.0	123	NA	61.4	38.8	0.5 U	0.5 U	10 U	NA

Notes:

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- U - Not detected
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- NA - Not analyzed
- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Ground groundwater screening concentration from the 2002 U Subsurface Vapor Intrusion Guidance that correspond concentration not exceeding a Target Cancer Risk of Hazard Index of 1, where the soil gas to indoor air att 0.001 and partitioning across the water table obeys H

^b Screening values were updated based on current tox following the USEPA draft Subsurface Vapor Intrusion November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,2-dic (total).

Highlighted cells exceed the screening value.

Table A-2
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	Generic Vapor Intrusion Screening Value for Groundwater ^a	16GW10					16GW16		16GW23	16GW29			
		16GW10-0504	16GW10-0604	16GW10-1204	16GW10-0505	16GW10-0406	16GW16-0903	16GW16-0406	16GW23-0504	16MW29-0903	16MW29-1203	16MW29-0304	16GW29-0406
Sample ID		05/12/04	06/16/04	12/02/04	05/11/05	04/22/06	09/30/03	04/20/06	05/18/04	09/30/03	12/17/03	03/18/04	04/21/06
Sample Date													
Aquifer		Upper Surficial					Upper Surficial		Upper Surficial	Upper Surficial			
Volatile Organic Compounds (µg/L)													
1,1,1-Trichloroethane	7092 b	0.5 U	2 U	0.5 U	0.5 U	10 U	2 U	10 U	0.54	2 U	2 U	10 U	10 U
1,1,2,2-Tetrachloroethane	3	0.5 U	2 U	0.5 U	0.5 U	10 U	2 U	10 U	0.5 U	2 U	2 U	10 U	10 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	1500	0.5 U	NA	0.5 U	0.5 U	10 U	NA	10 U	0.12 J	NA	NA	NA	3 J
1,1,2-Trichloroethane	5	0.5 U	2 U	0.5 U	0.5 U	10 U	2 U	10 U	0.5 U	2 U	2 U	10 U	10 U
1,1-Dichloroethane	2200	0.13 J	2 U	0.5 U	0.5 U	10 U	2 U	10 U	0.2 J	2 U	2 U	10 U	10 U
1,1-Dichloroethene	190	0.5 U	2 U	0.5 U	0.5 U	10 U	0.59 J	10 U	0.5 U	1.6 J	2 U	10 U	10 U
1,2-Dichloroethane	5	0.5 U	2 U	0.5 U	0.5 U	10 U	3.6	2 J	0.5 U	2 U	2 U	10 U	10 U
1,2-Dichloroethene (total)	210	NA	NA	NA	NA	39	NA	13	NA	NA	NA	NA	210
Benzene	1.4 b	0.12 J	0.65 J	0.5 U	0.5 U	10 U	1.8	10 U	0.5 U	1 U	1 U	5 U	10 U
Bromodichloromethane	2.1	0.5 U	2 U	0.5 U	0.5 U	10 U	2 U	10 U	0.5 U	2 U	2 U	10 U	10 U
Bromoform	0.0083	0.5 U	2 U	0.5 U	0.5 U	10 U	2 U	10 U	0.18 J	2 U	2 U	10 U	10 U
Chloromethane	6.7	0.5 U	2 U	0.5 U	0.5 U	10 U	2 U	10 U	0.5 U	2 U	2 U	10 U	10 U
Dichlorodifluoromethane (Freon-12)	14	0.5 U	NA	0.5 U	0.5 U	10 U	NA	10 U	0.5 U	NA	NA	NA	10 U
Ethylbenzene	700	0.5 U	2 U	0.5 U	0.5 U	10 U	2 U	10 U	0.5 U	2 U	2 U	10 U	10 U
Isopropylbenzene	8.4	0.5 U	NA	0.5 U	0.5 U	10 U	NA	10 U	0.5 U	NA	NA	NA	10 U
Tetrachloroethene	5	0.5 U	2 U	0.5 U	0.5 U	10 U	1 J	4 J	0.69	2 U	2 U	10 U	10 U
Trichloroethene	2.9 b	4.9	5.1	5.3	3	4 J	4	6 J	0.9	1.4 J	2.1	4.8 J	12 J
Vinyl chloride	2	0.57	1 U	0.5 U	0.5 U	10 U	1.9	10 U	0.5 U	3.5	2.4	8.8	12
Xylene, total	341	0.5 U	6 U	0.5 U	0.5 U	10 U	6 U	10 U	0.5 U	6 U	6 U	30 U	10 U
cis-1,2-Dichloroethene	210	26	21.9	30	23	37	NA	NA	0.5 U	NA	NA	NA	NA
trans-1,2-Dichloroethene	180	1.5	1.2 J	1.5	1	2 J	NA	NA	0.5 U	NA	NA	NA	NA

Notes:

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- UJ - Not detected, quantitation limit may be imprecise
- NA - Not analyzed
- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Groundwater = Target groundwater screening concentration from the 2002 USEPA draft Subsurface Vapor Intrusion Guidance that correspond to an indoor air concentration not exceeding a Target Cancer Risk of 1x10⁻⁶ and Hazard Index of 1, where the soil gas to indoor air attenuation factor = 0.001 and partitioning across the water table obeys Henry's Law.

^b Screening values were updated based on current toxicity values following the USEPA draft Subsurface Vapor Intrusion Guidance, November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,2-dichloroethene (total).

Highlighted cells exceed the screening value.

Table A-3
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	Generic Vapor Intrusion Screening Value for Groundwater ^a	16GW35						16GW37								
		16MW35-0903	16MW35-1203	16GW35-0304	16MW35-0604	16MW35-1204	16MW35-0305	16MW37-0903	16MW37-1203	16MW37-0304	16MW37-0604	16MW37-0904	16MW37-1204	16MW37-0305	16GW37-0406	
Sample ID	Sample Date	09/30/03	12/17/03	03/18/04	06/15/04	12/15/04	03/18/05	09/30/03	12/17/03	03/18/04	06/15/04	09/16/04	12/15/04	03/18/05	04/22/06	
Aquifer		Upper Surficial						Upper Surficial								
Volatile Organic Compounds (µg/L)																
1,1,1-Trichloroethane	7092 b	2 U	2 U	2 U	2 U	2 U	1 U	40 U	40 U	40 U	40 U	2 U	2 U	1 U	10 U	
1,1,2,2-Tetrachloroethane	3	1.8 J	2 U	3.1	2.6	1.5 J	0.83 J	40 U	40 U	40 U	40 U	2 U	2 U	1 U	10 U	
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	1500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10 U	
1,1,2-Trichloroethane	5	2 U	2 U	2 U	2 U	2 U	1 U	40 U	40 U	40 U	40 U	2 U	2 U	1 U	10 U	
1,1-Dichloroethane	2200	2 U	2 U	2 U	2 U	2 U	1 U	40 U	40 U	40 U	40 U	1.7 J	8.6	7.8	10 U	
1,1-Dichloroethene	190	2 U	2 U	2 U	2 U	2 U	1 U	40 U	17.4 J	40 U	40 U	2.5	14.5	9.2	10 U	
1,2-Dichloroethane	5	2 U	2 U	2 U	2 U	2 U	1 U	40 U	40 U	40 U	40 U	2 U	2 U	1 U	10 U	
1,2-Dichloroethene (total)	210	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	250	
Benzene	1.4 b	1 U	1 U	1 U	1 U	1 U	1 U	20 U	20 U	20 U	20 U	0.85 J	2.8	1.1	10 U	
Bromodichloromethane	2.1	2 U	2 U	2 U	2 U	2 U	1 U	40 U	40 U	40 U	40 U	2 U	2 U	1 U	10 U	
Bromoform	0.0083	2 U	2 U	2 U	2 U	2 U	1 U	40 U	40 U	40 U	40 U	2 U	2 U	1 U	10 U	
Chloromethane	6.7	2 U	2 U	2 U	2 U	2 U	2 U	40 U	40 U	40 U	40 U	2 U	2 U	2 U	10 U	
Dichlorodifluoromethane (Freon-12)	14	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10 U	
Ethylbenzene	700	2 U	2 U	2 U	2 U	2 U	1 U	40 U	40 U	40 U	40 U	2 U	2 U	1 U	10 U	
Isopropylbenzene	8.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	10 U	
Tetrachloroethene	5	2 U	2 U	0.73 J	2 U	2 U	1 U	40 U	40 U	40 U	40 U	2 U	2 U	1 U	10 U	
Trichloroethene	2.9 b	11.8	5.8	17	9.7	4.9	6.1	144	261	141	147	17.8	172	47.4	13	
Vinyl chloride	2	1 U	1 U	0.93 J	1 U	1 U	1 U	20 U	20 U	50.2	45.7	25.6	42	49.2	3 J	
Xylene, total	341	6 U	6 U	6 U	6 U	6 U	3 U	120 U	120 U	120 U	120 U	6 U	6 U	3 U	10 U	
cis-1,2-Dichloroethene	210	34.4	14.3	49.5	26	21.9	19.2	1,470	1,930	1,400	1,550	787	2,170	1,770	220	
trans-1,2-Dichloroethene	180	2	0.72 J	1.9 J	1.5 J	0.72 J	0.73 J	91.4	129	92.4	109	43.9	185	70.3	14	

Notes:

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- U - Not detected
- UJ - Not detected, quantitation limit may be imprecise
- NA - Not analyzed
- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Groundwater = Target groundwater screening concentration from the 2002 USEPA draft Subsurface Vapor Intrusion Guidance that correspond to an indoor air concentration not exceeding a Target Cancer Risk of 1x10⁻⁶ and Hazard Index of 1, where the soil gas to indoor air attenuation factor = 0.001 and partitioning across the water table obeys Henry's Law.

^b Screening values were updated based on current toxicity values following the USEPA draft Subsurface Vapor Intrusion Guidance, November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,2-dichloroethene (total).

Highlighted cells exceed the screening value.

Table A-3
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	16GW38				17GW01		42GW05				42GW08		42GW09		OU1-47GW05		
Sample ID	16MW38-1203	16MW38-0304	16MW38-0604	16GW38-0406	17GW01-0504	17GW01P-0504	42GW05-0504	42GW05-1204	42GW05-0505	42GW05-0406	42GW05P-0406	42MW08-0603	42MW08-0604	42MW09-0603	42GW09-0504	47GW05	47GW05-0506
Sample Date	12/17/03	03/18/04	06/15/04	04/21/06	05/19/04	05/19/04	05/11/04	12/05/04	05/17/05	04/23/06	04/23/06	06/30/03	06/16/04	06/30/03	05/12/04	03/22/00	05/03/06
Aquifer	Upper Surficial				Upper Surficial		Upper Surficial				Upper Surficial		Upper Surficial		Upper Surficial		
Volatile Organic Compounds (µg/L)																	
1,1,1-Trichloroethane	2 U	2 U	2 U	10 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	10 U	10 U	2 U	2 U	2 U	0.5 U	1.7 U	10 U
1,1,2,2-Tetrachloroethane	2 U	2 U	2 U	10 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	10 U	10 U	2 U	2 U	2 U	0.5 U	1.7 U	10 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	NA	NA	NA	10 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	10 U	10 U	NA	NA	NA	0.5 U	NA	10 U
1,1,2-Trichloroethane	2 U	2 U	2 U	10 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	10 U	10 U	2 U	2 U	2 U	0.5 U	1.7 U	10 U
1,1-Dichloroethane	2 U	2 U	2 U	10 U	0.5 U	0.5 U	0.14 J	0.35 J	1	5 J	4 J	2 U	2 U	2 U	1.8	2.6	10 U
1,1-Dichloroethene	2 U	2 U	2 U	10 U	0.5 U	0.5 U	7.4	9.1 J	5.2	22	20	2 U	2 U	2 U	0.85	1.7 U	10 U
1,2-Dichloroethane	2 U	2 U	2 U	10 U	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 U	10 U	10 U	2 U	2 U	2 U	0.5 U	1.7 U	10 U
1,2-Dichloroethene (total)	NA	NA	NA	34	NA	NA	NA	NA	NA	16,000	14,000	NA	NA	NA	NA	1.7 U	10 U
Benzene	1 U	1 U	1 U	10 U	0.5 U	0.5 U	1.4	0.5 U	1.1	10 U	10 U	6.3	13.2	6.3	0.24 J	3.4	6 J
Bromodichloromethane	2 U	2 U	2 U	10 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	10 U	10 U	2 U	2 U	2 U	0.5 U	1.7 U	10 U
Bromoform	2 U	2 U	2 U	10 U	0.21 J	0.29 J	0.5 U	0.5 UJ	0.5 U	10 U	10 U	2 U	2 U	2 U	0.1 J	1.7 U	10 U
Chloromethane	2 U	2 U	2 U	10 U	0.5 U	0.5 U	0.5 U	0.5 U	36 J	10 U	10 U	2 U	2 U	2 U	0.5 U	3.3 U	10 U
Dichlorodifluoromethane (Freon-12)	NA	NA	NA	10 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	10 U	10 U	NA	NA	NA	0.5 U	NA	10 U
Ethylbenzene	2 U	2 U	2 U	10 U	0.5 U	0.5 U	0.4 J	0.5 U	0.5 U	10 U	10 U	2 U	2 U	2 U	0.5 U	4.1	30
Isopropylbenzene	NA	NA	NA	10 U	0.5 U	0.5 U	0.62	0.5 U	0.35 J	10 U	10 U	NA	NA	NA	0.5 U	NA	46
Tetrachloroethene	2 U	2 U	2 U	10 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	10 U	10 U	2 U	2 U	2 U	0.5 U	1.7 U	10 U
Trichloroethene	2.9	7.8	3.9	7 J	0.5 U	0.5 U	0.5 U	0.5 U	11	1 J	1 J	2 U	2 U	2 U	24	1.7 U	10 U
Vinyl chloride	1 U	1 U	1 U	4 J	0.5 U	0.5 U	2,500 R	6,100	8,000	6,000	5,900	1 U	1 U	1 U	1.5	39	46
Xylene, total	6 U	6 U	6 U	10 U	0.5 U	0.5 U	2.3	500 R	1.4	1 J	1 J	6 U	6 U	6 U	0.5 U	3.8	9 J
cis-1,2-Dichloroethene	7.1	22.9	13.2	33	0.12 J	0.5 U	5,600	11,000	3,900	16,000	14,000	2 U	2 U	2 U	23	NA	10 U
trans-1,2-Dichloroethene	2 U	2 U	2 U	1 J	0.5 U	0.5 U	6.2	3.7	5	22	21	2 U	2 U	2 U	1.8	NA	10 U

Notes:

- J - Reported value may be imprecise
- R - Unreliable result
- U - Not detected
- UJ - Not detected, quantitation limit may be imp
- NA - Not analyzed
- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Gr
 Target groundwater screening concentration from draft Subsurface Vapor Intrusion Guidance that c
 indoor air concentration not exceeding a Target C
 1x10⁻⁶ and Hazard Index of 1, where the soil gas
 attenuation factor = 0.001 and partitioning across
 obeys Henry's Law.

^b Screening values were updated based on curren
 following the USEPA draft Subsurface Vapor Intr
 November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,
 (total).

Highlighted cells exceed the screening value.

Table A-3
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	OU1-47GW07																
Sample ID	47GW07	47GW07-0601	47GW07P-0601	47GW07-0302	47GW07-0402	47GW07-0602	47GW07-0902	47GW07P-0902	47GW07-1202	47GW07-0504	OU1-47GW07-04D	OU1-47GW07-05A	47GW07-0505	47GW07-0505-2	47GW07-0705	47GW07-1105	47GW07-0406
Sample Date	03/24/00	06/11/01	06/11/01	03/07/02	04/24/02	06/06/02	09/06/02	09/06/02	12/05/02	05/19/04	12/20/04	03/10/05	05/04/05	05/15/05	07/26/05	11/16/05	04/24/06
Aquifer	Upper Surficial																
Volatile Organic Compounds (µg/L)																	
1,1,1-Trichloroethane	49,000	19,000	32,000	1,300	69	10,000	1,100	1,100	1,300	11,000	24,000	11,000	2,400	1,300	1,400	11,000	1,500
1,1,2,2-Tetrachloroethane	5,000 U	500 U	1,100 U	62 U	62 U	250 U	31 U	40 U	50 U	0.29 J	1,700 U	100 U	500 U	50 U	100 U	100 U	10 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	NA	NA	NA	NA	NA	NA	NA	NA	NA	2.5 U	1,700 U	100 U	500 U	50 U	100 U	100 U	10 U
1,1,2-Trichloroethane	5,000 U	500 U	1,100 U	62 U	62 U	250 U	31 U	40 U	50 U	3.2	1,700 U	100 U	500 U	50 U	100 U	100 U	10 U
1,1-Dichloroethane	5,000 U	1,000	1,700	260	810	570	220	240	530	8,800	4,800	5,600	2,800	1,400	1,400	4,800	1,200
1,1-Dichloroethene	5,000 U	1,700	2,900	160	130	960	200	190	220	2,700	2,100	1,800	260 J	240	250	1,100	260
1,2-Dichloroethane	5,000 U	500 U	1,100 U	62 U	62 U	250 U	31 U	40 U	50 U	14	1,700 U	100 U	500 U	50 U	100 U	13 J	2 J
1,2-Dichloroethene (total)	5,000 U	600	980 J	170	100	1,300	630	600	820	NA	NA	NA	NA	NA	NA	NA	1,200
Benzene	5,000 U	500 U	1,100 U	62 U	62 U	250 U	31 U	40 U	50 U	0.28 J	1,700 U	100 U	500 U	50 U	100 U	100 U	10 U
Bromodichloromethane	5,000 U	500 U	1,100 U	62 U	62 U	250 U	31 U	40 U	50 U	0.44 J	1,700 U	100 U	500 U	50 U	100 U	100 U	10 U
Bromoform	5,000 U	500 U	1,100 U	62 U	62 U	250 U	31 U	40 U	50 U	0.5 U	1,700 U	100 U	500 U	50 U	100 U	100 U	10 U
Chloromethane	10,000 U	500 U	1,100 U	62 U	62 U	250 U	31 U	40 U	50 U	0.2 J	1,700 U	100 U	500 U	50 U	100 U	100 U	10 U
Dichlorodifluoromethane (Freon-12)	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.5 U	1,700 U	100 U	500 U	50 U	100 U	100 U	10 U
Ethylbenzene	5,000 U	500 U	1,100 U	62 U	62 U	250 U	31 U	40 U	50 U	0.19 J	1,700 U	100 U	500 U	50 U	100 U	100 U	10 U
Isopropylbenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.5 U	1,700 U	100 U	500 U	50 U	100 U	100 U	10 U
Tetrachloroethene	5,000 U	500 U	1,100 U	62 U	62 U	250 U	31 U	40 U	50 U	2.1	1,700 U	100 U	500 U	50 U	100 U	100 U	10 U
Trichloroethene	8,500	3,900	6,400	470	96	1,700	290	290	320	3,000	7,400 J	5,100	1,500	840	1,200	5,100	670
Vinyl chloride	10,000 U	500 U	1,100 U	62 U	62 U	250 U	31 U	40 U	50 U	38 J	1,700 U	49 J	500 U	77	25 J	400	120
Xylene, total	5,000 U	500 U	1,100 U	62 U	62 U	250 U	31 U	40 U	50 U	0.11 J	1,700 U	100 U	500 U	50 U	100 U	100 U	10 U
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA	6,200	3,200	4,700	2,100	1,100	1,200	5,400	1,200
trans-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA	49 J	1,700 U	110	41 J	50 U	38 J	130	27

Notes:

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^a Generic Vapor Intrusion Screening Value for Gr
 Target groundwater screening concentration from
 draft Subsurface Vapor Intrusion Guidance that c
 indoor air concentration not exceeding a Target C
 1x10⁻⁶ and Hazard Index of 1, where the soil gas
 attenuation factor = 0.001 and partitioning across
 obeys Henry's Law.

^b Screening values were updated based on curren
 following the USEPA draft Subsurface Vapor Intr
 November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,
 (total).

Highlighted cells exceed the screening value.

Table A-4
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	Generic Vapor Intrusion Screening Value for Groundwater ^a	OU1-47GW12							OU1-47GW13						OU1-47GW14	
		47GW12-0504	47GW12-1204	OU1-47GW12-05A	47GW12-0505	47GW12-0505-2	47GW12-0705	47GW12-1105	47GW13-0601	47GW13-0302	47GW13-0402	47GW13-0602	47GW13-0902	47GW13-1202	47GW14-0601	47GW14-0402
Sample ID	Sample Date	05/19/04	12/05/04	03/10/05	05/04/05	05/15/05	07/26/05	11/16/05	06/12/01	03/07/02	04/25/02	06/06/02	09/06/02	12/05/02	06/11/01	04/25/02
Aquifer		Upper Surficial							Upper Surficial						Upper Surficial	
Volatile Organic Compounds (µg/L)																
1,1,1-Trichloroethane	7092 b	0.31 J	0.5 U	10 U	10 U	0.5 U	10 U	6 J	64	94	66 J	92	55	96	0.67 J	1.4
1,1,2,2-Tetrachloroethane	3	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	20 U	20 U	83 U	40 U	17 U	33 U	1 U	1 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	1500	5.9	6.3	2 J	4 J	3.9	10 U	1 J	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	5	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	20 U	20 U	83 U	40 U	17 U	33 U	1 U	1 U
1,1-Dichloroethane	2200	1.5	1.5	1 J	2 J	1.7	1 J	3 J	560	610	700	880	490	940	1.2	0.33 J
1,1-Dichloroethene	190	0.9	0.97	10 U	10 U	0.65	1 J	1 J	64	95	110	160	90	160	1 U	0.27 J
1,2-Dichloroethane	5	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	20 U	20 U	83 U	40 U	17 U	33 U	1 U	1 U
1,2-Dichloroethene (total)	210	NA	NA	NA	NA	NA	NA	NA	61	74	99	100	78	89	13	0.45 J
Benzene	1.4 b	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	20 U	20 U	83 U	40 U	17 U	33 U	1 U	1 U
Bromodichloromethane	2.1	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	20 U	20 U	83 U	40 U	17 U	33 U	1 U	1 U
Bromoform	0.0083	0.32 J	0.5 U	10 U	10 U	0.5 U	10 U	10 U	20 U	20 U	83 U	40 U	17 U	33 UJ	1 U	1 U
Chloromethane	6.7	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	20 U	20 U	83 U	40 UJ	17 U	33 U	1 U	1 U
Dichlorodifluoromethane (Freon-12)	14	0.18 J	0.5 U	10 U	10 U	0.34 J	10 U	10 U	NA	NA	NA	NA	NA	NA	NA	NA
Ethylbenzene	700	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	20 U	20 U	83 U	40 U	17 U	33 U	1 U	1 U
Isopropylbenzene	8.4	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	5	0.52	6.6	7 J	10	15	14	5 J	20 U	20 U	83 U	40 U	17 U	33 U	8.6	1.2
Trichloroethene	2.9 b	0.91	0.85	10 U	10 U	1.6	10 U	4 J	67	80	93	90	67	92	20	3.1
Vinyl chloride	2	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	20 U	20 U	83 U	40 U	17 U	33 U	1 U	1 U
Xylene, total	341	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	20 U	20 U	83 U	40 U	17 U	33 U	1 U	1 U
cis-1,2-Dichloroethene	210	0.31 J	0.5 U	10 U	10 U	0.89	10 U	3 J	NA	NA	NA	NA	NA	NA	NA	NA
trans-1,2-Dichloroethene	180	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

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- U - Not detected
- UJ - Not detected, quantitation limit may be imprecise
- NA - Not analyzed
- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Groundwater = Target groundwater screening concentration from the 2002 USEPA draft Subsurface Vapor Intrusion Guidance that correspond to an indoor air concentration not exceeding a Target Cancer Risk of 1x10⁻⁶ and Hazard Index of 1, where the soil gas to indoor air attenuation factor = 0.001 and partitioning across the water table obeys Henry's Law.

^b Screening values were updated based on current toxicity values following the USEPA draft Subsurface Vapor Intrusion Guidance, November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,2-dichloroethene (total).

Highlighted cells exceed the screening value.

Table A-4
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	OU1-47GW14		OU1-47GW17					OU1-47GW18						OU1-47GW19			
Sample ID	47GW14-0902	47GW14-1202	OU1-47GW17-04D	OU1-47GW17-05A	47GW17-0505	47GW17-0705	47GW17-1105	OU1-47GW18-04D	47GW18-04DP	OU1-47GW18-05A	47GW18-0505	47GW18-0705	47GW18P-0705	47GW18-1105	47GW18P-1105	OU1-47GW19-04D	47GW19-1105
Sample Date	09/06/02	12/05/02	12/20/04	03/10/05	05/04/05	07/26/05	11/16/05	12/20/04	12/20/04	03/10/05	05/04/05	07/26/05	07/26/05	11/16/05	11/16/05	12/20/04	11/16/05
Aquifer	Upper Surficial		Upper Surficial					Upper Surficial						Upper Surficial			
Volatile Organic Compounds (µg/L)																	
1,1,1-Trichloroethane	2.2	4.3	1 J	50	64	10 U	10 U	1 J	1 J	7 J	10 U	10 U	10 U	10 U	10 U	36	18 J
1,1,2,2-Tetrachloroethane	1 U	1 U	10 U	33 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	100 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	NA	NA	10 U	33 U	10 U	10 U	10 U	12	7 J	7 J	13	10 U	10 U	3 J	2 J	10 U	100 U
1,1,2-Trichloroethane	1 U	1 U	10 U	33 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	100 U
1,1-Dichloroethane	1 U	0.34 J	14	440	270	22	11	6 J	7 J	15	15	6 J	7 J	2 J	3 J	510	580
1,1-Dichloroethene	1 U	1 U	10 U	83	68	13	0.9 J	10 U	10 U	2 J	10 U	10 U	10 U	10 U	10 U	17	17 J
1,2-Dichloroethane	1 U	1 U	10 U	33 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	100 U
1,2-Dichloroethene (total)	1 U	1 U	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	1 U	1 U	10 U	33 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	100 U
Bromodichloromethane	1 U	1 U	10 U	33 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	100 U
Bromoform	1 U	1 UJ	10 U	33 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	100 U
Chloromethane	1 U	1 U	10 U	33 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	100 U
Dichlorodifluoromethane (Freon-12)	NA	NA	10 U	33 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	100 U
Ethylbenzene	1 U	1 U	10 U	33 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	100 U
Isopropylbenzene	NA	NA	10 U	33 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	100 U
Tetrachloroethene	0.42 J	0.73 J	10 U	33 U	10 U	10 U	10 U	20	19	25	31	24	25	22	20	3 J	100 U
Trichloroethene	3.3	3.1	10 U	33 U	10 U	10 U	10 U	39	35	47	54	43	45	33	31	32	13 J
Vinyl chloride	1 U	1 U	38	160	180	150	39	10 U	10 U	10 U	10 U	10 U	0.7 J	10 U	10 U	2 J	11 J
Xylene, total	1 U	1 U	10 U	33 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	100 U
cis-1,2-Dichloroethene	NA	NA	3 J	430	320	130	7 J	75	90	160	200	120	130	34	29	33	76 J
trans-1,2-Dichloroethene	NA	NA	10 U	33 U	2 J	2 J	10 U	10 U	10 U	0.9 J	1 J	1 J	1 J	10 U	10 U	1 J	100 U

Notes:

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- R - Unreliable result
- U - Not detected
- UJ - Not detected, quantitation limit may be imp
- NA - Not analyzed
- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Groundwater Target groundwater screening concentration from draft Subsurface Vapor Intrusion Guidance that corresponds to an indoor air concentration not exceeding a Target C of 1x10⁻⁶ and Hazard Index of 1, where the soil gas attenuation factor = 0.001 and partitioning across obeys Henry's Law.

^b Screening values were updated based on current guidance following the USEPA draft Subsurface Vapor Intrusion Screening Values November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,1,2,2-tetrachloroethene (total).

Highlighted cells exceed the screening value.

Table A-4
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	OU1-47GW20					51EX10				51EX11			
Sample ID	OU1-47GW20-04D	OU1-47GW20-05A	47GW20-0505	47GW20-0705	OU1-47GW20-1105	51EX10-1203	51EX10-0604	51EX10-1204	OU1-51EX10-0406	51EX11-1203	OU1-51EX11-0504	51EX11-0604	51EX11-1204
Sample Date	12/21/04	03/10/05	05/04/05	07/26/05	11/16/05	12/22/03	06/16/04	12/15/04	04/27/06	12/23/03	05/19/04	06/16/04	12/15/04
Aquifer	Upper Surficial					Upper Surficial				Upper Surficial			
Volatile Organic Compounds (µg/L)													
1,1,1-Trichloroethane	10 U	1 J	3 J	10 U	10 U	2 U	20 U	20 U	10 U	2 U	0.5 U	2 U	2 U
1,1,2,2-Tetrachloroethane	10 U	10 U	10 U	10 U	10 U	2 U	20 U	20 U	10 U	2 U	0.5 U	2 U	2 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	10 U	10 U	10 U	10 U	2 J	NA	NA	NA	10 U	NA	0.5 U	NA	NA
1,1,2-Trichloroethane	10 U	10 U	10 U	10 U	10 U	2 U	20 U	20 U	10 U	2 U	0.5 U	2 U	2 U
1,1-Dichloroethane	1 J	2 J	3 J	1 J	2 J	56.2	30	16.3 J	25	13.9	15	21.4	13.1
1,1-Dichloroethene	10 U	10 U	10 U	10 U	10 U	101	19.4 J	20.4	30	2	14	4.2	2.4
1,2-Dichloroethane	10 U	10 U	10 U	10 U	10 U	2 U	20 U	20 U	10 U	2 U	0.17 J	2 U	2 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA	NA	490	NA	NA	NA	NA
Benzene	10 U	10 U	10 U	10 U	10 U	0.85 J	10 U	10 U	1 J	0.67 J	1.2	1.2	0.96 J
Bromodichloromethane	10 U	10 U	10 U	10 U	10 U	2 U	20 U	20 U	10 U	2 U	0.5 U	2 U	2 U
Bromoform	10 U	10 U	10 U	10 U	10 U	2 U	20 U	20 U	10 U	2 U	0.5 U	2 U	2 U
Chloromethane	10 U	10 U	10 U	10 U	10 U	2 U	20 U	20 U	10 U	2 U	0.5 U	2 U	2 U
Dichlorodifluoromethane (Freon-12)	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	10 U	NA	0.5 U	NA	NA
Ethylbenzene	10 U	10 U	10 U	10 U	10 U	2 U	20 U	20 U	10 U	2 U	0.5 U	2 U	2 U
Isopropylbenzene	10 U	10 U	10 U	10 U	10 U	NA	NA	NA	10 U	NA	0.5 U	NA	NA
Tetrachloroethene	5 J	5 J	4 J	7 J	11	2 U	20 U	20 U	10 U	2 U	0.23 J	2 U	2 U
Trichloroethene	17	17	14	17	15	19.3	83.1	37.2	50	4.9	16	20	9.9
Vinyl chloride	10 U	10 U	10 U	10 U	10 U	222	94.3	26.6	69	123	21	48.7	7.1
Xylene, total	10 U	10 U	10 U	10 U	10 U	6 U	60 U	60 U	10 U	6 U	0.5 U	6 U	6 U
cis-1,2-Dichloroethene	36	39	25	39	36	539	753	427	470	118	120	121	34.2
trans-1,2-Dichloroethene	10 U	10 U	10 U	10 U	10 U	97.2	21.3	13.2 J	18	2 U	2.6	0.92 J	2 U

Notes:

- J - Reported value may be imprecise
- R - Unreliable result
- U - Not detected
- UJ - Not detected, quantitation limit may be imp
- NA - Not analyzed
- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Groundwater
 Target groundwater screening concentration from draft Subsurface Vapor Intrusion Guidance that corresponds to an indoor air concentration not exceeding a Target C₁ of 1x10⁻⁶ and Hazard Index of 1, where the soil gas attenuation factor = 0.001 and partitioning across obeys Henry's Law.

^b Screening values were updated based on current guidance following the USEPA draft Subsurface Vapor Intrusion Screening Values November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,1,2,2-tetrachloroethene (total).

Highlighted cells exceed the screening value.

Table A-5
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	Generic Vapor Intrusion Screening Value for Groundwater ^a	OU1-51GW02											OU1-52GW01			
		51GW02	51GW02-0601	51GW02-0302	51GW02-0602	51GW02-0902	51GW02-1202	OU1-51GW02-04D	OU1-51GW02-05A	51GW02-0505	51GW02-0705	51GW02-1105	51GW02-0406	52GW01-0504	52GW01P-0504	OU1-52GW01-04D
Sample ID	Sample Date	03/04/00	06/12/01	03/07/02	06/05/02	09/06/02	12/05/02	12/21/04	03/10/05	05/04/05	07/26/05	11/16/05	04/23/06	05/18/04	05/18/04	12/21/04
Aquifer		Upper Surficial											Upper Surficial			
Volatile Organic Compounds (µg/L)																
1,1,1-Trichloroethane	7092 b	12 U	20 U	20 U	25 U	25 U	50 U	31	3 J	10 U	10 U	100 U	10 U	0.63	0.73	10 U
1,1,2,2-Tetrachloroethane	3	12 U	20 U	20 U	25 U	25 U	50 U	10 U	20 U	10 U	10 U	100 U	10 U	0.5 U	0.5 U	10 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	1500	NA	NA	NA	NA	NA	NA	10 U	20 U	10 U	10 U	100 U	10 U	0.12 J	0.13 J	10 U
1,1,2-Trichloroethane	5	12 U	20 U	20 U	25 U	25 U	50 U	10 U	20 U	10 U	10 U	100 U	10 U	0.29 J	0.31 J	10 U
1,1-Dichloroethane	2200	350	610	560	780	880	1,100	13	130	180	180	200	400	24	25	30
1,1-Dichloroethene	190	140	110	67	84	77	160	4 J	2 J	8 J	11	32 J	93	2.2	2.5	4 J
1,2-Dichloroethane	5	12 U	20 U	20 U	25 U	25 U	50 U	10 U	20 U	10 U	10 U	100 U	2 J	0.5 U	0.5 U	10 U
1,2-Dichloroethene (total)	210	39	21	12 J	17 J	20 J	37 J	NA	NA	NA	NA	NA	100	NA	NA	NA
Benzene	1.4 b	12 U	20 U	20 U	25 U	25 U	50 U	10 U	20 U	10 U	10 U	100 U	10 U	0.17 J	0.2 J	10 U
Bromodichloromethane	2.1	12 U	20 U	20 U	25 U	25 U	50 U	10 U	20 U	10 U	10 U	100 U	10 U	0.5 U	0.5 U	10 U
Bromoform	0.0083	12 U	20 U	20 U	25 U	25 U	50 UJ	10 U	20 U	10 U	10 U	100 U	10 U	0.66	0.5 U	5 J
Dichlorodifluoromethane (Freon-12)	14	NA	NA	NA	NA	NA	NA	10 U	20 U	10 U	10 U	100 U	10 U	0.5 U	0.5 U	10 U
Ethylbenzene	700	12 U	20 U	20 U	25 U	25 U	50 U	10 U	20 U	10 U	10 U	100 U	10 U	0.5 U	0.5 U	10 U
Isopropylbenzene	8.4	NA	NA	NA	NA	NA	NA	10 U	20 U	10 U	10 U	100 U	10 U	0.5 U	0.5 U	10 U
Methylene chloride	58	12 U	20 U	20 U	25 U	25 U	50 U	10 U	20 U	12 U	10 U	100 U	10 U	0.78 U	0.83 U	10 U
Tetrachloroethene	5	12 U	20 U	20 U	25 U	25 U	50 U	10 U	20 U	10 U	10 U	100 U	10 U	0.35 J	0.51	10 U
Trichloroethene	2.9 b	21	9.7 J	7.3 J	7.9 J	25 U	24 J	12	20 U	10 U	10 U	12 J	43	1,600 R	1,500	2,200
Vinyl chloride	2	160	180	130	170	230	260	10 U	240 J	270	450	480	970	0.11 J	0.14 J	10 U
Xylene, total	341	12 U	20 U	20 U	25 U	25 U	50 U	10 U	20 U	10 U	10 U	100 U	10 U	0.5 U	0.5 U	10 U
cis-1,2-Dichloroethene	210	NA	NA	NA	NA	NA	NA	4 J	13 J	17	13	44 J	98	420	390	590
trans-1,2-Dichloroethene	180	NA	NA	NA	NA	NA	NA	10 U	2 J	1 J	1 J	100 U	4 J	20	21	30

Notes:

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- U - Not detected
- UJ - Not detected, quantitation limit may be imprecise
- NA - Not analyzed
- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Groundwater = Target groundwater screening concentration from the 2002 USEPA draft Subsurface Vapor Intrusion Guidance that correspond to an indoor air concentration not exceeding a Target Cancer Risk of 1x10⁻⁶ and Hazard Index of 1, where the soil gas to indoor air attenuation factor = 0.001 and partitioning across the water table obeys Henry's Law.

^b Screening values were updated based on current toxicity values following the USEPA draft Subsurface Vapor Intrusion Guidance, November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,2-dichloroethene (total).

Highlighted cells exceed the screening value.

Table A-5
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	OU1-52GW01								OU1-52GW07						OU1-52GW08		
Sample ID	OU1-52GW01-05A	52GW01-0505	52GW01-0505-2	52GW01-0705	52GW01-1105	52GW01P-1105	52GW01-0406	52GW01P-0406	OU1-52GW07-04D	OU1-52GW07-05A	52GW07P-0505	52GW07-0505	52GW07-0705	52GW07-1105	OU1-52GW08-04D	OU1-52GW08-05A	52GW08-0505
Sample Date	03/09/05	05/03/05	05/15/05	07/27/05	11/15/05	11/15/05	04/23/06	04/24/06	12/21/04	03/09/05	05/03/05	05/03/05	07/27/05	11/15/05	12/21/04	03/09/05	05/03/05
Aquifer	Upper Surficial								Upper Surficial						Upper Surficial		
Volatile Organic Compounds (µg/L)																	
1,1,1-Trichloroethane	100 U	10 U	50 U	100 U	170 U	170 U	200 U	200 U	10 U	250 U	10 U	10 U	10 U	10 U	10 U	100 U	10 U
1,1,2,2-Tetrachloroethane	100 U	10 U	50 U	100 U	170 U	170 U	200 U	200 U	10 U	250 U	10 U	10 U	10 U	10 U	10 U	100 U	10 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	100 U	10 U	50 U	100 U	170 U	170 U	200 U	200 U	1 J	250 U	10 U	10 U	10 U	2 J	3 J	100 U	4 J
1,1,2-Trichloroethane	100 U	10 U	50 U	100 U	170 U	170 U	200 U	200 U	10 U	250 U	10 U	10 U	10 U	10 U	7 J	39 J	15
1,1-Dichloroethane	19 J	21	50 U	17 J	20 J	21 J	26 J	200 U	130	52 J	140	160	25	180	13	100 U	12
1,1-Dichloroethene	100 U	3 J	50 U	100 U	170 U	170 U	200 U	200 U	3 J	250 U	6 J	6 J	2 J	8 J	13	10 J	26
1,2-Dichloroethane	100 U	10 U	50 U	100 U	170 U	170 U	200 U	200 U	10 U	250 U	10 U	10 U	10 U	10 U	10 U	100 U	10 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	1,800	1,700	NA	NA	NA	NA	NA	NA	NA	NA	NA
Benzene	100 U	10 U	50 U	100 U	170 U	170 U	200 U	200 U	10 U	250 U	10 U	10 U	10 U	10 U	10 U	100 U	10 U
Bromodichloromethane	100 U	10 U	50 U	100 U	170 U	170 U	200 U	200 U	10 U	250 U	10 U	10 U	9 J	10 U	10 U	100 U	10 U
Bromoform	100 U	10 U	50 U	100 U	170 U	170 U	200 U	200 U	10 U	250 U	10 U	10 U	10 U	10 U	10 U	100 U	10 U
Dichlorodifluoromethane (Freon-12)	100 U	10 U	50 U	100 U	170 U	170 U	200 U	200 U	10 U	250 U	10 U	10 U	10 U	10 U	2 J	100 U	11
Ethylbenzene	100 U	10 U	50 U	100 U	170 U	170 U	200 U	200 U	10 U	250 U	10 U	10 U	10 U	10 U	10 U	100 U	10 U
Isopropylbenzene	100 U	10 U	50 U	100 U	170 U	170 U	200 U	200 U	10 U	250 U	10 U	10 U	10 U	10 U	10 U	100 U	10 U
Methylene chloride	100 U	10 U	71 J	100 U	170 U	170 U	72 U	52 U	10 U	250 U	10 U	10 U	10 U	10 U	10 U	100 U	10 U
Tetrachloroethene	100 U	10 U	50 U	100 U	170 U	170 U	200 U	200 U	10 U	250 U	10 U	10 U	10 U	10 U	36	61 J	65
Trichloroethene	1,600	1,100	810	710	150 J	160 J	36 J	38 J	950	4,000	9,500	9,700	1,400	1,600	49,000	48,000	60,000
Vinyl chloride	100 U	10 U	50 U	100 U	170 U	170 U	200 U	200 U	56	250 U	33	33	31	130	8 J	100 U	20
Xylene, total	100 U	10 U	50 U	100 U	170 U	170 U	200 U	200 U	10 U	250 U	10 U	10 U	10 U	10 U	10 U	100 U	10 U
cis-1,2-Dichloroethene	680	580	620	960	1,400	1,500	1,700	1,600	190	420	1,100	1,100	180	330	3,000	2,900	5,200
trans-1,2-Dichloroethene	20 J	11	50 U	100 U	20 J	31 J	90 J	95 J	3 J	250 U	14	14	2 J	4 J	14	100 U	11

Notes:

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- U - Not detected
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- NA - Not analyzed
- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Gr
 Target groundwater screening concentration from draft Subsurface Vapor Intrusion Guidance that c
 indoor air concentration not exceeding a Target C
 1x10⁻⁶ and Hazard Index of 1, where the soil gas
 attenuation factor = 0.001 and partitioning across
 obeys Henry's Law.

^b Screening values were updated based on curren
 following the USEPA draft Subsurface Vapor Intr
 November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,
 (total).

Highlighted cells exceed the screening value.

Table A-5
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	OU1-52GW08		OU1-52GW10					OU1-52GW11					52GW17	52GW28	52GW31	52GW33	
Sample ID	52GW08-0705	52GW08-1105	OU1-52GW10-04D	OU1-52GW10-05A	52GW10-0505	52GW10-0705	52GW10-1105	OU1-52GW11-04D	52GW11-04DP	OU1-52GW11-05A	52GW11-0505	52GW11-0705	52GW11-1105	52GW17-0406	52GW28-0406	52GW31-0406	52GW33-0506
Sample Date	07/27/05	11/15/05	12/21/04	03/09/05	05/03/05	07/27/05	11/15/05	12/21/04	12/21/04	03/09/05	05/03/05	07/27/05	11/15/05	04/23/06	04/23/06	04/20/06	05/04/06
Aquifer	Upper Surficial		Upper Surficial					Upper Surficial					Upper Surficial	Upper Surficial	Upper Surficial	Upper Surficial	
Volatile Organic Compounds (µg/L)																	
1,1,1-Trichloroethane	10 U	2,500 U	10 U	20 U	10 U	10 U	10 U	10 U	10 U	83 U	100 U	10 U	100 U	10 U	10 U	10 U	20
1,1,2,2-Tetrachloroethane	10 U	2,500 U	10 U	20 U	10 U	10 U	10 U	10 U	10 U	83 U	100 U	10 U	100 U	10 U	1 J	10 U	10 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	10 U	2,500 U	35	21	14	17	8 J	10 U	10 U	83 U	100 U	10 U	100 U	43	630	10 U	2,800
1,1,2-Trichloroethane	10	2,500 U	10 U	20 U	10 U	10 U	10 U	10 U	10 U	83 U	100 U	10 U	100 U	10 U	10 U	10 U	10 U
1,1-Dichloroethane	9 J	2,500 U	2 J	20 U	2 J	2 J	2 J	20	18	83 U	13 J	13	15 J	13	850	7 J	790
1,1-Dichloroethene	120	2,500 U	10 U	20 U	10 U	10 U	10 U	1 J	1 J	83 U	100 U	3 J	100 U	10 U	10 U	5 J	10 U
1,2-Dichloroethane	10 U	2,500 U	10 U	20 U	10 U	10 U	10 U	10 U	10 U	83 U	100 U	10 U	100 U	10 U	10 U	10 U	10 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	220	850	390	710
Benzene	10 U	2,500 U	10 U	20 U	10 U	10 U	10 U	10 U	10 U	83 U	100 U	10 U	100 U	140	10 U	2 J	10 U
Bromodichloromethane	10 U	2,500 U	10 U	20 U	10 U	10 U	10 U	10 U	10 U	83 U	100 U	8 J	100 U	10 U	10 U	10 U	10 U
Bromoform	10 U	2,500 U	10 U	20 U	10 U	10 U	10 U	10 U	10 U	83 U	100 U	10 U	100 U	10 U	10 U	10 U	10 U
Dichlorodifluoromethane (Freon-12)	27	2,500 U	10 U	20 U	10 U	4 J	10 U	10 U	10 U	83 U	100 U	10 U	100 U	10 U	10 U	10 U	10 U
Ethylbenzene	10 U	2,500 U	10 U	20 U	10 U	10 U	10 U	10 U	10 U	83 U	100 U	10 U	100 U	7 J	10 U	10 U	10 U
Isopropylbenzene	10 U	2,500 U	10 U	20 U	10 U	10 U	10 U	10 U	10 U	83 U	100 U	10 U	100 U	11	10 U	3 J	10 U
Methylene chloride	10 U	2,500 U	10 U	20 U	10 U	10 U	10 U	10 U	10 U	83 U	100 U	10 U	100 U	10 U	10 U	10 U	2 U
Tetrachloroethene	30	2,500 U	3 J	3 J	2 J	2 J	1 J	10 U	10 U	83 U	100 U	10 U	100 U	10 U	70	15	48
Trichloroethene	25,000	1,900 J	160	180	43	51	120	1,400	1,400	560	1,100	1,300	1,300	630	2,000	1,000	1,700
Vinyl chloride	18	2,500 U	10 U	20 U	10 U	10 U	10 U	10 U	10 U	83 U	100 U	10 U	100 U	35	18	7 J	4 J
Xylene, total	10 U	2,500 U	10 U	20 U	10 U	10 U	10 U	10 U	10 U	83 U	100 U	10 U	100 U	10 U	1 J	10 U	10 U
cis-1,2-Dichloroethene	33,000	15,000	7 J	9 J	52	46	50	160	160	44 J	140	130	160	180	850	390	710
trans-1,2-Dichloroethene	99 J	2,500 U	10 U	20 U	10 U	10 U	10 U	3 J	3 J	83 U	100 U	1 J	100 U	4 J	5 J	9 J	3 J

Notes:

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- NA - Not analyzed
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^a Generic Vapor Intrusion Screening Value for Gr
 Target groundwater screening concentration from draft Subsurface Vapor Intrusion Guidance that c
 indoor air concentration not exceeding a Target C
 1x10⁻⁶ and Hazard Index of 1, where the soil gas
 attenuation factor = 0.001 and partitioning across
 obeys Henry's Law.

^b Screening values were updated based on curren
 following the USEPA draft Subsurface Vapor Intr
 November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,
 (total).

Highlighted cells exceed the screening value.

Table A-5
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	52GW35	52GW37	52GW41	52GW44	52GW46	52GW48	52GW51	52GW53	52GW58	52GW62	52GW64
Sample ID	52GW35-0506	52GW37-0406	52GW41-0506	52GW44-0406	52GW46-0406	52GW48-0406	52GW51-0406	52GW53-0406	52GW58-0406	52GW62-0406	52GW64-0406
Sample Date	05/04/06	04/21/06	05/05/06	04/26/06	04/22/06	04/22/06	04/24/06	04/25/06	04/22/06	04/23/06	04/21/06
Aquifer	Upper Surficial										
Volatile Organic Compounds (µg/L)											
1,1,1-Trichloroethane	10 U	5,000 U	10 U	10 U							
1,1,2,2-Tetrachloroethane	10 U										
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	150	6 J	10 U								
1,1,2-Trichloroethane	10 U	5,000 U	10 U	10 U							
1,1-Dichloroethane	210	15	4 J	48	10 U	1 J	10 U	10 U	10 U	1 J	10 U
1,1-Dichloroethene	10 U	26	10 U	10	7 J	1 J	10 U	15	4 J	4 J	10 U
1,2-Dichloroethane	10 U										
1,2-Dichloroethene (total)	650	810	12	2,000	1,300	2 J	170	2,400 J	1,100	1,100	8 J
Benzene	10 U	5,000 U	10 U	10 U							
Bromodichloromethane	10 U	5,000 U	10 U	10 U							
Bromoform	10 U	5,000 U	10 U	10 U							
Dichlorodifluoromethane (Freon-12)	10 U										
Ethylbenzene	10 U	8 J	10 U	10 U							
Isopropylbenzene	10 U	1 J	10 U	10 U							
Methylene chloride	10 U										
Tetrachloroethene	6 J	12	10 U	10 U	4 J	10 U	10 U	71	2 J	16	10 U
Trichloroethene	460	3,700	42	780	21,000	25	1,200	62,000	13,000	7,600	190
Vinyl chloride	69	16	10 U	3 J	7 J	10 U	10 U	110	10 U	18	10 U
Xylene, total	10 U	17	10 U	10 U	10 U						
cis-1,2-Dichloroethene	650	810	12	2,000	1,300	2 J	170	2,400 J	1,100	1,100	8 J
trans-1,2-Dichloroethene	3 J	4 J	10 U	32	6 J	10 U	10 U	15	20	3 J	10 U

Notes:

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^a Generic Vapor Intrusion Screening Value for Gr
 Target groundwater screening concentration from draft Subsurface Vapor Intrusion Guidance that c
 indoor air concentration not exceeding a Target C
 1×10^{-6} and Hazard Index of 1, where the soil gas
 attenuation factor = 0.001 and partitioning across
 obeys Henry's Law.

^b Screening values were updated based on curren
 following the USEPA draft Subsurface Vapor Intr
 November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,
 (total).

Highlighted cells exceed the screening value.

Table A-6
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	Generic Vapor Intrusion Screening Value for Groundwater ^a	52GW68	52GW76	74GW08	74GW15	74GW16	74GW17	74GW23	OU1-GW75	OU1-GW76		OU1-MW01		OU1-MW18	OU1-MW20	OU1-MW21	
Sample ID		52GW68-0406	52GW76-0506	74GW08-0406	74GW15-0406	74GW16-0406	74GW17-0406	74GW23-0406	OU1-GW75-0406	OU1-GW76-0406	OU1-GW76P-0406	OU1-MW01-0406	OU1-MW01P-0406	OU1-MW18-0406	OU1-MW20-0504	OU1-MW21-0504	
Sample Date		04/30/06	05/01/06	04/27/06	04/25/06	04/27/06	04/27/06	04/26/06	04/27/06	04/27/06	04/27/06	04/27/06	04/23/06	04/23/06	04/22/06	05/14/04	05/14/04
Aquifer		Upper Surficial		Upper Surficial		Upper Surficial	Upper Surficial	Upper Surficial									
Volatile Organic Compounds (µg/L)																	
1,1,1-Trichloroethane	7092 b	10 U	10 U	10 U	10 U	7.3	4.4										
1,1,2,2-Tetrachloroethane	3	10 U	10 U	10 U	10 U	0.5 U	0.5 U										
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	1500	10 U	10 U	10 U	10 U	34	1 J	4 J	10 U	10 U	10 U	10 U	10 U	10 U	0.22 J	0.5 U	
1,1,2-Trichloroethane	5	10 U	10 U	10 U	10 U	0.5 U	0.5 U										
1,1-Dichloroethane	2200	10 U	90	4 J	10 U	120	2 J	1 J	6 J	20	16	3 J	3 J	10 U	2.8	0.33 J	
1,1-Dichloroethene	190	10 U	4 J	10 U	3 J	42	42	3 J	3 J	10 U	0.22 J						
1,2-Dichloroethane	5	10 U	10 U	10 U	10 U	0.5 U	0.5 U										
1,2-Dichloroethene (total)	210	32	27	5 J	1 J	68	2 J	2 J	110	410	400	28	27	13	NA	NA	
Benzene	1.4 b	10 U	2 J	2 J	2,400	25	2 J	7,700	10 U	10 U	10 U	1 J	1 J	10 U	0.5 U	0.5 U	
Bromodichloromethane	2.1	10 U	10 U	10 U	10 U	0.5 U	0.5 U										
Bromoform	0.0083	10 U	10 U	10 U	10 U	0.16 J	0.17 J										
Dichlorodifluoromethane (Freon-12)	14	10 U	10 U	10 U	10 U	0.5 U	0.5 U										
Ethylbenzene	700	10 U	10 U	10 U	170	66	10 U	420	10 U	10 U	10 U	10 U	10 U	10 U	0.5 U	0.5 U	
Isopropylbenzene	8.4	10 U	10 U	10 U	1,100	22	10 U	470	10 U	10 U	10 U	10 U	10 U	10 U	0.5 U	0.5 U	
Methylene chloride	58	10 U	10 U	10 U	2 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	0.14 J	0.12 J	
Tetrachloroethene	5	10 U	4 J	10 U	10 U	1 J	10 U	10 U	10 U	10 U	0.5 U	0.5 U					
Trichloroethene	2.9 b	22	76	5 J	10 U	10 U	4 J	10 U	14	44	47	9 J	7 J	4 J	0.5 U	0.5 U	
Vinyl chloride	2	3 J	15	10 U	13	130	140	3 J	3 J	10 U	0.5 U	0.5 U					
Xylene, total	341	10 U	10 U	10 U	100	110	10 U	2,000	10 U	10 U	10 U	10 U	10 U	10 U	0.5 U	0.5 U	
cis-1,2-Dichloroethene	210	32	27	5 J	1 J	68	2 J	2 J	110	360	360	26	26	13	0.1 J	0.12 J	
m- and p-Xylene	319 b	10 U	10 U	10 U	60	39	10 U	1,100	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	
o-Xylene	472 b	10 U	10 U	10 U	43	68	10 U	980	10 U	10 U	10 U	10 U	10 U	10 U	NA	NA	
trans-1,2-Dichloroethene	180	10 U	3 J	52	54	2 J	2 J	10 U	0.5 U	0.5 U							

Notes:

- J - Reported value may be imprecise
- R - Unreliable result
- U - Not detected
- UJ - Not detected, quantitation limit may be imprecise
- NA - Not analyzed
- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Groundwater = Target groundwater screening concentration from the 2002 USEPA draft Subsurface Vapor Intrusion Guidance that correspond to an indoor air concentration not exceeding a Target Cancer Risk of 1x10⁻⁶ and Hazard Index of 1, where the soil gas to indoor air attenuation factor = 0.001 and partitioning across the water table obeys Henry's Law.

^b Screening values were updated based on current toxicity values following the USEPA draft Subsurface Vapor Intrusion Guidance, November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,2-dichloroethene (total).

Highlighted cells exceed the screening value.

Table A-6
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	OU1-MW21	OU1-MW28	OU1-MW38	OU1-MW58
Sample ID	OU1-MW21-1204	OU1-MW28-0406	OU1-MW38-0504	OU1-MW58-0504
Sample Date	12/05/04	04/18/06	05/13/04	05/11/04
Aquifer	Upper Surficial	Upper Surficial	Upper Surficial	Upper Surficial
Volatile Organic Compounds (µg/L)				
1,1,1-Trichloroethane	1.8	10 U	0.5 U	0.5 U
1,1,2,2-Tetrachloroethane	0.5 U	10 U	0.5 U	0.5 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	0.5 U	27	0.5 U	0.5 U
1,1,2-Trichloroethane	0.5 U	10 U	0.5 U	0.5 U
1,1-Dichloroethane	0.5 U	10 U	0.5 U	0.5 U
1,1-Dichloroethene	0.5 U	10 U	0.5 U	0.12 J
1,2-Dichloroethane	0.5 U	10 U	0.5 U	0.5 U
1,2-Dichloroethene (total)	NA	6 J	NA	NA
Benzene	0.5 U	10 U	0.5 U	0.15 J
Bromodichloromethane	0.5 U	10 U	0.5 U	0.5 U
Bromoform	2.1 J	10 U	0.12 J	0.2 J
Dichlorodifluoromethane (Freon-12)	0.5 U	10 U	0.5 U	0.13 J
Ethylbenzene	0.5 U	10 U	0.5 U	0.5 U
Isopropylbenzene	0.5 U	10 U	0.5 U	0.5 U
Methylene chloride	0.6 U	10 U	0.5 U	0.5 U
Tetrachloroethene	0.5 U	10 U	0.5 U	0.5 U
Trichloroethene	0.5 U	3 J	0.12 J	0.5 U
Vinyl chloride	0.5 U	10 U	1.1	0.14 J
Xylene, total	0.5 U	10 U	0.5 U	0.26 J
cis-1,2-Dichloroethene	0.5 U	6 J	2	0.5 U
m- and p-Xylene	NA	10 U	NA	NA
o-Xylene	NA	10 U	NA	NA
trans-1,2-Dichloroethene	0.5 U	10 U	0.5 U	0.5 U

Notes:

- J - Reported value may be imprecise
- R - Unreliable result
- U - Not detected
- UJ - Not detected, quantitation limit may be imprecise
- NA - Not analyzed
- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Groundwater. Target groundwater screening concentration from draft Subsurface Vapor Intrusion Guidance that corresponds to an indoor air concentration not exceeding a Target C of 1x10⁻⁶ and Hazard Index of 1, where the soil gas attenuation factor = 0.001 and partitioning across obeys Henry's Law.

^b Screening values were updated based on current guidance following the USEPA draft Subsurface Vapor Intrusion Guidance (November 2002 (Appendix D)).

cis-1,2-Dichloroethene used as a surrogate for 1,2-Dichloroethene (total).

Highlighted cells exceed the screening value.

Table A-7
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	Generic Vapor Intrusion Screening Value for Groundwater ^a	OU1-MW61	OU1-MW65		OU1-MW73		N2GW07	N2GW17		N2GW18			N2GW25	N2GW27	N2GW29
		OU1-MW61-03D	OU1-MW65-0504	OU1-MW65-0506	OU1-MW73-0506	OU1-MW73P-0506	N2GW07-0506	N2GW17-0406	N2GW17P-0406	N2GW18-1204	N2GW18-0505	N2GW18-0406	N2GW25-0406	N2GW27-0406	N2GW29-0603
Sample ID	Sample Date	10/22/01	05/19/04	05/03/06	05/03/06	05/03/06	05/02/06	04/18/06	04/18/06	12/06/04	05/14/05	04/18/06	04/23/06	04/18/06	06/30/03
Aquifer		Upper Surficial	Upper Surficial		Upper Surficial		Upper Surficial	Upper Surficial		Upper Surficial			Upper Surficial	Upper Surficial	Upper Surficial
Volatile Organic Compounds (µg/L)															
1,1,1-Trichloroethane	7092 b	5 U	50 U	10 U	10 U	10 U	10 U	10 U	10 U	20 U	50 U	10 U	10 U	10 U	2 U
1,1,2,2-Tetrachloroethane	3	5 U	50 U	10 U	10 U	10 U	10 U	10 U	10 U	20 U	50 U	10 U	10 U	10 U	2 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	1500	5 U	50 U	10 U	10 U	10 U	10 U	10 U	10 U	20 U	50 U	10 U	10 U	10 U	NA
1,1,2-Trichloroethane	5	5 U	50 U	10 U	10 U	10 U	10 U	10 U	10 U	20 U	50 U	10 U	10 U	10 U	2 U
1,1-Dichloroethane	2200	170	50 U	10 U	10 U	10 U	10 U	10 J	9 J	20 U	50 U	10 U	10 U	10 U	2 U
1,1-Dichloroethene	190	0.3 J	50 U	10 U	10 U	10 U	10 U	13	12	20 U	50 U	10 U	10 U	10 U	2 U
1,2-Dichloroethane	5	1 J	50 U	10 U	10 U	10 U	10 U	10 U	10 U	20 U	50 U	10 U	10 U	10 U	2 U
1,2-Dichloroethene (total)	210	4 J	NA	10 U	1,100	1,000	9 J	1,100	1,100	NA	NA	4 J	10 U	8 J	NA
Benzene	1.4 b	8	14 J	3 J	10 U	10 U	370	52	53	76	77	82	10 U	39 J	2.3
Bromodichloromethane	2.1	5 U	50 U	10 U	10 U	10 U	10 U	10 U	10 U	20 U	50 U	10 U	10 U	10 U	2 U
Bromoform	0.0083	5 U	50 U	10 U	10 U	10 U	10 U	10 U	10 U	20 U	50 U	10 U	10 U	10 U	2 U
Chlorobenzene	390	5 U	930	300	10 U	10 U	10 U	10 U	10 U	20 U	50 U	2 J	10 U	480 J	2 U
Dichlorodifluoromethane (Freon-12)	14	5 U	50 U	10 U	10 U	10 U	10 U	10 U	10 U	20 U	50 U	10 U	10 U	10 U	NA
Ethylbenzene	700	1 J	50 U	10 U	10 U	10 U	190	3 J	2 J	180	150	170	10 U	130 J	2 U
Isopropylbenzene	8.4	5 U	50 U	10 U	10 U	10 U	120	9 J	13	97	100	130	10 U	66 J	NA
Methylene chloride	58	5 U	99 U	10 U	10 U	10 U	10 U	10 U	10 U	20 U	50 B	10 U	10 U	10 U	5 U
Tetrachloroethene	5	5 U	50 U	10 U	10 U	10 U	10 U	10 U	10 U	20 U	50 U	10 U	10 U	10 U	2 U
Trichloroethene	2.9 b	5 U	50 U	10 U	10 U	10 U	10 U	390	390	20 U	50 U	10 U	9 J	10 J	2 U
Vinyl chloride	2	110	50 U	4 J	37	34	16	110 J	180 J	20 U	50 U	14	10 U	72 J	1 U
Xylene, total	341	2 J	50 U	10 U	10 U	10 U	230	26	40	NA	980	520	10 U	37 J	6 U
cis-1,2-Dichloroethene	210	3 J	50 U	10 U	6 J	10	9 J	1,100	1,100	31	50 U	4 J	10 U	7 J	2 U
m- and p-Xylene	319 b	0.6 J	NA	10 U	10 U	10 U	170	3 J	4 J	NA	NA	290	10 U	28 J	NA
o-Xylene	472 b	1 J	NA	10 U	10 U	10 U	59	23 J	36 J	NA	NA	230	10 U	9 J	NA
trans-1,2-Dichloroethene	180	1 J	50 U	10 U	1,100	1,000	10 U	25	22	20 U	50 U	10 U	10 U	1 J	2 U

Notes:

- J - Reported value may be imprecise
- R - Unreliable result
- U - Not detected
- UJ - Not detected, quantitation limit may be imprecise
- NA - Not analyzed
- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Groundwater = Target groundwater screening concentration from the 2002 USEPA draft Subsurface Vapor Intrusion Guidance that correspond to an indoor air concentration not exceeding a Target Cancer Risk of 1x10⁻⁶ and Hazard Index of 1, where the soil gas to indoor air attenuation factor = 0.001 and partitioning across the water table obeys Henry's Law.

^b Screening values were updated based on current toxicity values following the USEPA draft Subsurface Vapor Intrusion Guidance, November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,2-dichloroethene (total).

Highlighted cells exceed the screening value.

Table A-7
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	N2GW30			N2GW36			N2GW44			N4GW07						N4GW14
Sample ID	N2GW30-0504	N2GW30-1204	N2GW30-0505	N2GW36-1204	N2GW36-0505	N2GW36-0406	N2GW44-0603	N2GW44-1203	N2GW44-0604	N4GW07-04D	N4GW07-05A	N4GW07-0505	N4GW07-0705	N4GW07-1105	N4GW07-0406	N4GW14-0504
Sample Date	05/11/04	12/02/04	05/17/05	12/06/04	05/14/05	04/19/06	06/30/03	12/18/03	06/16/04	12/21/04	03/09/05	05/05/05	07/26/05	11/15/05	04/21/06	05/18/04
Aquifer	Upper Surficial			Upper Surficial			Upper Surficial			Upper Surficial						Upper Surficial
Volatile Organic Compounds (µg/L)																
1,1,1-Trichloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	10 U	2 U	2 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,1,2,2-Tetrachloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	10 U	2 U	2 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ	10 U	NA	NA	NA	3 J	10 U	10 U	10 U	10 U	10 U	10 U
1,1,2-Trichloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	10 U	2 U	2 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,1-Dichloroethane	0.5 U	0.5 U	0.5 U	0.5 U	0.41 J	10 U	10.8	23.1	6.9 J	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,1-Dichloroethene	0.5 U	0.5 U	0.5 U	0.5 UJ	0.5 UJ	10 U	6.1	11.6	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichloroethane	0.5 U	0.5 U	0.5 U	1.2	0.99 J	10 U	2 U	2 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	10	NA	NA	NA	NA	NA	NA	NA	NA	8 J	NA
Benzene	15	13	8.4	24 J	26	30	0.6 J	2.5	5 U	3 J	2 J	10 U	10 U	2 J	3 J	0.5 U
Bromodichloromethane	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	10 U	2 U	2 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U
Bromoform	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	10 U	2 U	2 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	0.33 J
Chlorobenzene	0.5 U	0.5 U	0.5 U	440	290	430	2 U	2 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	0.5 U
Dichlorodifluoromethane (Freon-12)	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	10 U	NA	NA	NA	10 U	10 U	10 U	10 U	10 U	10 U	0.5 U
Ethylbenzene	0.12 J	0.5 U	0.5 U	16	14	25	2 U	2 U	10 U	16	15	8 J	4 J	10	14	0.5 U
Isopropylbenzene	3.1	3	2.6	11	11	16	NA	NA	NA	3 J	3 J	2 J	10 U	2 J	3 J	0.5 U
Methylene chloride	0.5 U	0.5 U	0.5 UJ	0.64 U	0.5 UJ	10 U	5 U	5 U	25 U	10 U	10 U	10 U	10 U	10 U	10 U	0.5 U
Tetrachloroethene	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	10 U	2 U	2 U	10 U	10 U	10 U	10 U	10 U	10 U	10 U	0.5 U
Trichloroethene	0.5 U	0.5 U	0.5 U	15 J	13	7 J	81.4	290	42.3	10 U	10 U	10 U	10 U	10 U	10 U	0.5 U
Vinyl chloride	8	13	16	14	36	12	2.9	3.4	5 U	23	16	18	20	20 J	20	0.5 U
Xylene, total	0.5 U	NA	0.5 U	10 R	0.5 U	10 U	6 U	6 U	30 U	25	19	6 J	3 J	14	5 J	0.5 U
cis-1,2-Dichloroethene	9.2	6.7	8.3	18	13	10	357	1,050 E	305	11	9 J	10	5 J	9 J	8 J	0.5 U
m- and p-Xylene	NA	NA	NA	NA	NA	10 U	NA	NA	NA	NA	NA	NA	NA	NA	3 J	NA
o-Xylene	NA	NA	NA	NA	NA	10 U	NA	NA	NA	NA	NA	NA	NA	NA	2 J	NA
trans-1,2-Dichloroethene	0.31 J	0.5 U	0.5 U	0.5 U	0.62	10 U	4.6	15.5	3.4 J	10 U	10 U	10 U	10 U	10 U	10 U	0.5 U

Notes:

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- NA - Not analyzed
- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Groundwater. Target groundwater screening concentration from draft Subsurface Vapor Intrusion Guidance that corresponds to an indoor air concentration not exceeding a Target C of 1x10⁻⁶ and Hazard Index of 1, where the soil gas attenuation factor = 0.001 and partitioning across obeys Henry's Law.

^b Screening values were updated based on current values following the USEPA draft Subsurface Vapor Intrusion Guidance, November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,1,2,2-tetrachloroethene (total).

Highlighted cells exceed the screening value.

Table A-7
 Concentrations Compared to USEPA Groundwater Vapor Intrusion Screening Values
 OU1 UFP SAP Work Plan
 MCAS Cherry Point, North Carolina

Station ID	N4GW22							
Sample ID	N4GW22-0504	N4GW22-1204	N4GW22-05A	N4GW22-0505	N4GW22-0505-2	N4GW22-0705	N4GW22-1105	N4GW22-0406
Sample Date	05/18/04	12/04/04	03/09/05	05/03/05	05/13/05	07/26/05	11/15/05	04/20/06
Aquifer	Upper Surficial							
Volatile Organic Compounds (µg/L)								
1,1,1-Trichloroethane	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	10 U
1,1,2,2-Tetrachloroethane	1.7	0.5 U	10 U	10 U	0.5 U	10 U	10 U	10 U
1,1,2-Trichloro-1,2,2-trifluoroethane(Freon-113)	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	10 U
1,1,2-Trichloroethane	0.5 U	0.5 U	10 U	10 U	0.5 UJ	10 U	10 U	10 U
1,1-Dichloroethane	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	10 U
1,1-Dichloroethene	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	10 U
1,2-Dichloroethane	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	10 U
1,2-Dichloroethene (total)	NA	NA	NA	NA	NA	NA	NA	10 U
Benzene	0.29 J	0.5 U	10 U	10 U	0.44 J	10 U	10 U	10 U
Bromodichloromethane	0.5 U	0.5 UJ	10 U	10 U	0.5 U	10 U	10 U	10 U
Bromoform	0.5 U	0.5 UJ	10 U	10 U	0.5 UJ	10 U	10 U	10 U
Chlorobenzene	0.11 J	0.5 U	10 U	10 U	0.5 U	2 J	10 U	10 U
Dichlorodifluoromethane (Freon-12)	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	10 U
Ethylbenzene	12	14	17	23	21	15	11	16
Isopropylbenzene	15	24	36	31	24	21	19	21
Methylene chloride	0.5 U	0.63 U	10 U	10 U	0.5 UJ	10 U	10 U	10 U
Tetrachloroethene	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	10 U
Trichloroethene	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	10 U
Vinyl chloride	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	10 U
Xylene, total	0.86	NA	10 U	10 U	0.5 U	10 U	10 U	10 U
cis-1,2-Dichloroethene	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	10 U
m- and p-Xylene	NA	NA	NA	NA	NA	NA	NA	10 U
o-Xylene	NA	NA	NA	NA	NA	NA	NA	10 U
trans-1,2-Dichloroethene	0.5 U	0.5 U	10 U	10 U	0.5 U	10 U	10 U	10 U

Notes:

- J - Reported value may be imprecise
- R - Unreliable result
- U - Not detected
- UJ - Not detected, quantitation limit may be imprecise
- NA - Not analyzed
- µg/L - Micrograms per liter

^a Generic Vapor Intrusion Screening Value for Groundwater
 Target groundwater screening concentration from draft Subsurface Vapor Intrusion Guidance that corresponds to an indoor air concentration not exceeding a Target C of 1x10⁻⁶ and Hazard Index of 1, where the soil gas attenuation factor = 0.001 and partitioning across obeys Henry's Law.

^b Screening values were updated based on current guidance following the USEPA draft Subsurface Vapor Intrusion Screening Values November 2002 (Appendix D).

cis-1,2-Dichloroethene used as a surrogate for 1,1,2,2-tetrachloroethene (total).

Highlighted cells exceed the screening value.

Appendix B
Johnson & Ettinger Model

Site-Specific Screening Model Development

This appendix presents details on the development of the site-specific screening levels for the COPCs in groundwater at OU1, using the Johnson & Ettinger (J&E) model.

Model Description

The J&E model was developed by USEPA in 1998 and estimates human health risks from subsurface vapor intrusion into buildings. The model is a one-dimensional analytical solution to convective and diffusive vapor transport into indoor spaces and provides an estimated attenuation coefficient that relates the vapor concentration in the indoor air space to the vapor concentration at the source of contamination. The model is constructed as both a steady-state solution to vapor transport (infinite or non-diminishing source) and as a quasi-steady-state solution (finite or diminishing source).

Model Development

Inputs to the model include chemical parameters of the contaminant, saturated and unsaturated zone soil properties, and structural properties of the building.

Three industrial scenarios were developed based on building characteristics observed during the OU1 building survey. These scenarios include: an industrial large building, an industrial medium building, and an industrial small building. The industrial screening levels were used to identify existing buildings, confirmed as having industrial use, where vapor intrusion might warrant further evaluation.

Information from the preliminary building surveys (specifically, the building footprints and ceiling heights) were used to select building and air exchange parameters for modeling. The parameters were selected to provide a conservative representation of the potential for vapor intrusion in the buildings of interest within the area. Existing boring logs and water level data from OU1 were reviewed to select subsurface parameters (e.g., soil type, depth to groundwater) which provide a conservative representation of vapor diffusion through soil in each area.

The parameters used in the J&E model for each investigation area are provided in Tables B-1 through B-3. A discussion of select parameters is provided below.

- **Depth of Contamination.** This parameter represents separation between the contaminant and the structure. Shallow groundwater was assumed to occur beneath the buildings at a depth of approximately 5 to 15 ft bgs based on existing soil boring logs, well construction records, and water level measurements from OU1.
- **Soil Type.** The J&E model contains default characteristic for the 12 Soil Conservation Survey (SCS) soil texture classifications. Existing data provided on the soil boring logs for OU1 were used to determine the soil type at each area, which are predominantly sands. Some silts and clays are present; however parameters associated with sands are used in the model as a conservative measure.

- **Enclosed Space Volume (Space Floor Length, Floor, Width, and Height).** Three industrial building scenarios were identified for the investigation areas: small, medium, and large buildings. The indoor air mixing volume was based on the average length, width, and height of each building scenario. The average floor length, width, and height of the industrial buildings were based on dimensions of each building obtained during the preliminary building surveys. In most instances, large industrial buildings were considered to be greater than 100,000 square feet (ft²), medium industrial buildings were considered to be between 10,000 and 100,000 ft², and small industrial buildings were considered to be less than 10,000 ft². Buildings with open construction were excluded from the calculation of the averaged building dimensions.
- **Air-Filled Porosity.** Air-filled porosity is used to calculate the effective diffusion coefficient in soil for each chemical, and is also considered to be a sensitive parameter in the model. The air-filled porosity was calculated as a function of soil class in the J&E model. The air-filled porosity calculated for sand is 0.321 cubic centimeters per cubic centimeters (cm³/cm³).
- **Soil Gas Entry Rate.** The soil gas entry rate for the each building scenario was calculated by scaling up the default residential soil gas entry rate described in USEPA's draft vapor intrusion guidance (USEPA, 2002) to the building footprints. As shown in Tables B-1 through B-3, the soil gas entry rate varies widely depending on the building dimensions.
- **Indoor Air Exchange Rate.** The building fresh air flow rate is based on the air exchange rate for the building and the volume of air inside the building. The air-exchange rate for each building scenario was calculated using the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) standard Ventilation for Acceptable Indoor Air Quality (ASHRAE, 2004). As shown in Tables B-1 through B-3, the indoor air exchange rate varies depending on the building dimensions.

Limitations

Major conceptual assumptions/limitations of the J&E model include:

- No free phase liquid/precipitate (i.e., non-aqueous-phase liquid or solid) is present
- Contaminant vapors enter the structure primarily through cracks and openings in the walls and foundation
- Convective transport occurs primarily within the building zone of influence and vapor velocities decrease rapidly with increasing distance from the structure
- Diffusion dominates vapor transport between the source of contamination and the building zone of influence
- All vapors originating from below the building will enter the building unless the floors and walls are perfect vapor barriers
- All soil properties in stratum are homogeneous (up to three strata with different properties can be simulated in the model)
- The contaminant is homogeneously distributed within the zone of contamination

- The areal extent of contamination is greater than that of the building floor in contact with the soil
- Vapor transport occurs in the absence of convective water movement within the soil column (i.e., evaporation or infiltration), and in the absence of mechanical dispersion
- The model does not account for transformation processes (i.e., biodegradation, hydrolysis)
- The soil layer in contact with the structure floor and walls is isotropic with respect to permeability
- Both the building ventilation rate and the difference in dynamic pressure between the interior of the structure and the soil surface are constant values

References

USEPA. 2004. *User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings*. Office of Emergency and Remedial Response. February.

USEPA. 2008. *Vapor Intrusion Database: Preliminary Evaluation of Attenuation Factors*. Draft. Office of Solid Waste. Washington, D.C. March 4. <http://iavi.rti.org/index.cfm>.

Appendix B, Table 1

Site-Specific Assumptions - Industrial Scenario - Large Building
Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Mode
OUI, MCAS Cherry Point, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_s	Average Soil/Groundwater Temperature		20	°C	Based on average groundwater temperature collected from wells in Upper Surficial Aquifer, May 2006.
L_F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Assumed foundation thickness
L_{WT}	Depth Below Grade to Water Table		274	cm	Based on average depth to groundwater (9 ft) collected from wells in Upper Surficial Aquifer, May 2006.
h_A	Thickness of Soil Stratum A		274	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		Sand (S)	unitless	Based on well boring information obtained from, MW-18, MW-20, MW-58, MW-61, MW-65 and MW-73 during the 2005 and 2006 events.
	SCS Soil Type Above Water Table		Sand (S)	unitless	Based on well boring information obtained from, MW-18, MW-20, MW-58, MW-61, MW-65 and MW-73 during the 2005 and 2006 events.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using most prominent soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	Calculated by model	cm ²	Default value
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm ³	Default value for sand
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	Default value for sand
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm ³ /cm ³	Default value for sand
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm ³	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm ³ /cm ³	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm ³	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ_w^C	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm ³ /cm ³	Not Used
L_{crack}	Enclosed Space Floor Thickness		10	cm	Default
Δ_P	Soil-Building Pressure Differential		40	g/cm-s ²	Default
L_B	Enclosed Space Floor Length		16551	cm	Average length (543 feet) of large buildings (i.e., length >296') within 100' of plume(s).
W_B	Enclosed Space Floor Width		10394	cm	Average width (341 feet) of large buildings within 100' of plume(s).
H_B	Enclosed Space Height		427	cm	Average height (14 feet) of large buildings within 100' of plume(s).
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	0.1	cm	Default
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.60	(1/h)	Calculated - ANSI/ASHRAE Standard 62-2001 (See Tabel 1 Supplement A)
Q_{soil}	Average vapor flow rate into building		67	(L/m)	Calculated - NJDEP, 2007 (see Table 1 Supplement B)
AT_C	Averaging Time for Carcinogens		70	yrs	default
AT_{NC}	Averaging Time for Noncarcinogens		25	yrs	EPA, 1991
ED	Exposure Duration		25	yrs	EPA, 1991
EF	Exposure Frequency		250	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality

USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B. Development of

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.

Table 1 Supplement A
Site-Specific Air Exchange Rate - Large Building
Calculations of Building Air Exchange Rate Per Hour
OU1
Cherry Point, North Carolina

Calculation of Air Changes Per Hour Indoors

$$ACH = \frac{Q_{building}}{V} = \frac{m^3/hr}{m^3} = 1/hr$$

Calculation of $Q_{building}$ (volumetric flow into indoor space)

Assumption	Value	Units	Source
Assumed volumetric airflow per person	20	ft ³ /min per person	ASHRAE, 2001, Table 2, minimum outside air requirement for an office
Number of persons per floorspace	7	persons/1,000 ft ²	ASHRAE, 2001, Table 2
Building floorspace (do not input value here)	185,163	ft ²	543 ft x 341 ft (Average size of large buildings within 100' of plume.)
Calculated volumetric flow into indoor space	25,923	ft ³ /min	Includes division by 1000 to account for persons per 1000 ft ²
	44,017	m ³ /hr	Includes conversion of 0.0283 ft ³ /m ³

Calculation of V (volume of indoor space)

Assumption	Value	Units	Source
Building floorspace (input value here)	185,163	ft ²	543 ft x 341 ft (Average size of large buildings within 100' of plume.)
Ceiling height	14	ft	Average height of buildings within 100' of plume.
Volume	2,592,282	ft ³	
	73,362	m ³	Includes conversion of 0.0283 ft ³ /m ³

Calculation of ACH

$Q_{building}$	44,017	m ³ /hr
Volume	73,362	m ³
ACH = Q/V	0.60	1/hr

Source:

ASHRAE. 2001. ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

Table 1, Supplement B

Calculation of Soil Vapor Entry Rate for Johnson and Ettinger Modeling
Large Building

$$Q_{soil} (L/min) = 5 L/min \times \frac{Perimeter (cm)}{4,000 cm}$$

Length (cm) =	16551
Width (cm) =	10394
Perimeter (cm) = 2L + 2W	53888.64
Qsoil (L/min) =	67

This presents a method for calculating the soil vapor entry rate (Qsoil) into a building for purposes of performing vapor intrusion modeling using the Johnson and Ettinger model.

It scales up the default residential soil gas entry rate described in EPA's draft vapor intrusion guidance document (USEPA, 2002) to any other building footprint. This procedure and the accompanying rationale is discussed in detail in the NJDEP vapor intrusion guidance document (NJDEP, 2007). It is based on the following assumptions:

1. The residential default Qsoil value is 5 L/min.
2. The Qsoil value is proportional to the building perimeter.
3. The building is rectangular

Appendix B, Table 2

Site-Specific Assumptions - Industrial Scenario - Medium Building
Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model
OU1, MCAS Cherry Point, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T_s	Average Soil/Groundwater Temperature		20	°C	Based on average groundwater temperature collected from wells in Upper Surficial Aquifer, May 2006.
L_f	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Assumed foundation thickness
L_{WT}	Depth Below Grade to Water Table		274	cm	Based on average depth to groundwater (9 ft) collected from wells in Upper Surficial Aquifer, May 2006.
h_A	Thickness of Soil Stratum A		274	cm	Soil stratum is modeled as a single soil type.
h_B	Thickness of Soil Stratum B		NA	cm	Not Used
h_C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		Sand (S)	unitless	Based on well boring information obtained from, MW-18, MW-20, MW-58, MW-61, MW-65 and MW-73 during the 2005 and 2006 events.
	SCS Soil Type Above Water Table		Sand (S)	unitless	Based on well boring information obtained from, MW-18, MW-20, MW-58, MW-61, MW-65 and MW-73 during the 2005 and 2006 events.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using most prominent soil type present.
k_v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	Calculated by model	cm ²	Default value
ρ_b^A	Stratum A Soil Dry Bulk Density		1.66	g/cm ³	Default value for sand
n^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air filled porosity (see below)	0.375	unitless	Default value for sand
θ_w^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm ³ /cm ³	Default value for sand
ρ_b^B	Stratum B Soil Dry Bulk Density		NA	g/cm ³	Not Used
n^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air filled porosity (see below)	NA	unitless	Not Used
θ_w^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm ³ /cm ³	Not Used
ρ_b^C	Stratum C Soil Dry Bulk Density		NA	g/cm ³	Not Used
n^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air filled porosity (see below)	NA	unitless	Not Used
θ_w^C	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm ³ /cm ³	Not Used
L_{crack}	Enclosed Space Floor Thickness		10	cm	Default
Δ_p	Soil-Building Pressure Differential		40	g/cm-s ²	Default
L_B	Enclosed Space Floor Length		4206	cm	Average length (138 feet) of medium buildings (i.e., length >115') within 100' of plume(s).
W_B	Enclosed Space Floor Width		2195	cm	Average width (72 feet) of medium buildings within 100' of plume(s).
H_B	Enclosed Space Height		335	cm	Average height (11 feet) of medium buildings within 100' of plume(s).
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	0.1	cm	Default
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.76	(1/h)	Calculated - ANSI/ASHRAE Standard 62-2001 (See Tabel 2 Supplement A)
Qsoil	Average vapor flow rate into building		16	(L/m)	Calculated - NJDEP, 2007 (see Table 2 Supplement B)
AT _c	Averaging Time for Carcinogens		70	yrs	default
AT _{NC}	Averaging Time for Noncarcinogens		25	yrs	EPA, 1991
ED	Exposure Duration		25	yrs	EPA, 1991
EF	Exposure Frequency		250	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1×10^{-6}	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality

USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of Risk-based

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.

Table 2 Supplement A
 Site-Specific Air Exchange Rate - Medium Building
 Calculations of Building Air Exchange Rate Per Hour
 OU1
 Cherry Point, North Carolina

Calculation of Air Changes Per Hour Indoors

$$ACH = \frac{Q_{building}}{V} = \frac{m^3/hr}{m^3} = 1/hr$$

Calculation of $Q_{building}$ (volumetric flow into indoor space)

Assumption	Value	Units	Source
Assumed volumetric airflow per person	20	ft ³ /min per person	ASHRAE, 2001, Table 2, minimum outside air requirement for an office
Number of persons per floorspace	7	persons/1,000 ft ²	ASHRAE, 2001, Table 2
Building floorspace (do not input value here)	9,936	ft ²	138 ft x 72 ft (Average size of medium buildings within 100' of plume.)
Calculated volumetric flow into indoor space	1,391	ft ³ /min	Includes division by 1000 to account for persons per 1000 ft ²
	2,362	m ³ /hr	Includes conversion of 0.0283 ft ³ /m ³

Calculation of V (volume of indoor space)

Assumption	Value	Units	Source
Building floorspace (input value here)	9,936	ft ²	138 ft x 72 ft (Average size of medium buildings within 100' of plume.)
Ceiling height	11	ft	Average height of buildings within 100' of plume.
Volume	109,296	ft ³	
	3,093	m ³	Includes conversion of 0.0283 ft ³ /m ³

Calculation of ACH

$Q_{building}$	2,362	m ³ /hr
Volume	3,093	m ³
ACH = Q/V	0.76	1/hr

Source:
 ASHRAE. 2001. ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

Table 2, Supplement B

Calculation of Soil Vapor Entry Rate for Johnson and Ettinger Modeling
Medium Building

$$Q_{soil} (L/min) = 5 L/min \times \frac{Perimeter (cm)}{4,000 cm}$$

Length (cm) =	4206
Width (cm) =	2195
Perimeter (cm) = 2L + 2W	12801.6
Q _{soil} (L/min) =	16

This presents a method for calculating the soil vapor entry rate (Q_{soil}) into a building for purposes of performing vapor intrusion modeling using the Johnson and Ettinger model.

It scales up the default residential soil gas entry rate described in EPA's draft vapor intrusion guidance document (USEPA, 2002) to any other building footprint. This procedure and the accompanying rationale is discussed in detail in the NJDEP vapor intrusion guidance document (NJDEP, 2007). It is based on the following assumptions:

1. The residential default Q_{soil} value is 5 L/min.
2. The Q_{soil} value is proportional to the building perimeter.
3. The building is rectangular

Appendix B, Table 3

Site-Specific Assumptions - Industrial Scenario - Small Building
 Groundwater to Indoor Air Parameters Used in the Johnson and Ettinger Model
 OU1, MCAS Cherry Point, North Carolina

Symbol	Parameter	Description	Selected Value	Units	Sources
T _s	Average Soil/Groundwater Temperature		20	°C	Based on average groundwater temperature collected from wells in Upper Surficial Aquifer, May 2006.
L _F	Depth Below Grade to Bottom of Enclosed Space Floor	This is the depth from soil surface to the bottom of the floor in contact with soil	15	cm	Assumed foundation thickness
L _{WT}	Depth Below Grade to Water Table		274	cm	Based on average depth to groundwater (9 ft) collected from wells in Upper Surficial Aquifer, May 2006.
h _A	Thickness of Soil Stratum A		274	cm	Soil stratum is modeled as a single soil type.
h _B	Thickness of Soil Stratum B		NA	cm	Not Used
h _C	Thickness of Soil Stratum C		NA	cm	Not Used
	Soil Stratum Directly Above Water Table		Sand (S)	unitless	Based on well boring information obtained from, MW-18, MW-20, MW-58, MW-61, MW-65 and MW-73 during the 2005 and 2006 events.
	SCS Soil Type Above Water Table		Sand (S)	unitless	Based on well boring information obtained from, MW-18, MW-20, MW-58, MW-61, MW-65 and MW-73 during the 2005 and 2006 events.
	Soil Stratum A SCS Soil Type	Used to estimate soil vapor permeability	S	unitless	Soils modeled using most prominent soil type present.
k _v	User-defined Soil Vapor Permeability	A parameter associated with convective transport of vapors within the zone of influence of a building. It is related to the size and shape of connected soil pores	Calculated by model	cm ²	Default value
ρ _b ^A	Stratum A Soil Dry Bulk Density		1.66	g/cm ³	Default value for sand
n ^A	Stratum A Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	0.375	unitless	Default value for sand
θ _w ^A	Stratum A Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	0.054	cm ³ /cm ³	Default value for sand
ρ _b ^B	Stratum B Soil Dry Bulk Density		NA	g/cm ³	Not Used
n ^B	Stratum B Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ _w ^B	Stratum B Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm ³ /cm ³	Not Used
ρ _b ^C	Stratum C Soil Dry Bulk Density		NA	g/cm ³	Not Used
n ^C	Stratum C Total Soil Porosity	Used with water-filled porosity to calculate air-filled porosity (see below)	NA	unitless	Not Used
θ _w ^C	Stratum C Soil Water-filled porosity	Used with total porosity to calculate air-filled porosity (see below)	NA	cm ³ /cm ³	Not Used
L _{crack}	Enclosed Space Floor Thickness		10	cm	Default
Δ _p	Soil-Building Pressure Differential		40	g/cm-s ²	Default
L _B	Enclosed Space Floor Length		1280	cm	Average length (42 feet) of small buildings (i.e., length <90') within 100' of plume(s).
W _B	Enclosed Space Floor Width		1189	cm	Average width (39 feet) of small buildings within 100' of plume(s).
H _B	Enclosed Space Height		335	cm	Average height (11 feet) of small buildings within 100' of plume(s).
w	Floor-Wall Seam Crack Width	Represents a gap assumed to exist at the junction between the floor and the foundation perimeter. This gap is due to building design or concrete shrinkage. It represents the only route for soil gas intrusion into a building	0.1	cm	Default
ER	Indoor air exchange rate	Building ventilation rate, expressed in units of air changes per hour (ACH)	0.76	(1/h)	Calculated - ANSI/ASHRAE Standard 62-2001 (see Table 3 Supplement A)
Q _{soil}	Average vapor flow rate into building		6	(L/m)	Calculated - NJDEP, 2007 (see Table 3 Supplement B)
AT _c	Averaging Time for Carcinogens		70	yrs	default
AT _{nc}	Averaging Time for Noncarcinogens		25	yrs	EPA, 1991
ED	Exposure Duration		25	yrs	EPA, 1991
EF	Exposure Frequency		250	days/yr	EPA, 1991
TR	Target Risk for Carcinogens	Used to calculate risk-based groundwater concentration	1 x 10 ⁻⁶	unitless	
THQ	Target Hazard Quotient for Noncarcinogens	Used to calculate risk-based groundwater concentration	1	days/yr	

ASHRAE. 2001. Standard 62-2001, Ventilation for Acceptable Indoor Air Quality

USEPA, 1991. U.S. Environmental Protection Agency. Risk Assessment Guidance for Superfund, Human Health Evaluation Manual, Part B, Development of Risk-based

USEPA, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings. Office of Emergency and Remedial Response. February 2004.

Table 3 Supplement A
 Site-Specific Air Exchange Rate - Small Building
 Calculations of Building Air Exchange Rate Per Hour
 OU1
 Cherry Point, North Carolina

Calculation of Air Changes Per Hour Indoors

$$ACH = \frac{Q_{building}}{V} = \frac{m^3/hr}{m^3} = 1/hr$$

Calculation of $Q_{building}$ (volumetric flow into indoor space)

Assumption	Value	Units	Source
Assumed volumetric airflow per person	20	ft ³ /min per person	ASHRAE, 2001, Table 2, minimum outside air requirement for an office
Number of persons per floorspace	7	persons/1,000 ft ²	ASHRAE, 2001, Table 2
Building floorspace (do not input value here)	1,638	ft ²	42 ft x 39 ft (Average size of small buildings within 100' of plume.)
Calculated volumetric flow into indoor space	229	ft ³ /min	Includes division by 1000 to account for persons per 1000 ft ²
	389	m ³ /hr	Includes conversion of 0.0283 ft ³ /m ³

Calculation of V (volume of indoor space)

Assumption	Value	Units	Source
Building floorspace (input value here)	1,638	ft ²	42 ft x 39 ft (Average size of small buildings within 100' of plume.)
Ceiling height	11	ft	Average height of buildings within 100' of plume.
Volume	18,018	ft ³	
	510	m ³	Includes conversion of 0.0283 ft ³ /m ³

Calculation of ACH

$Q_{building}$	389	m ³ /hr
Volume	510	m ³
ACH = Q/V	0.76	1/hr

Source:
 ASHRAE. 2001. ANSI/ASHRAE Standard 62-2001, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating and Air-Conditioning Engineers.

Table 3, Supplement B

Calculation of Soil Vapor Entry Rate for Johnson and Ettinger Modeling
Small Building

$$Q_{soil} (L/min) = 5 L/min \times \frac{Perimeter (cm)}{4,000 cm}$$

Length (cm) =	1280
Width (cm) =	1189
Perimeter (cm) = 2L + 2W	4938
Q _{soil} (L/min) =	6

This presents a method for calculating the soil vapor entry rate (Q_{soil}) into a building for purposes of performing vapor intrusion modeling using the Johnson and Ettinger model.

It scales up the default residential soil gas entry rate described in EPA's draft vapor intrusion guidance document (USEPA, 2002) to any other building footprint. This procedure and the accompanying rationale is discussed in detail in the NJDEP vapor intrusion guidance document (NJDEP, 2007). It is based on the following assumptions:

1. The residential default Q_{soil} value is 5 L/min.
2. The Q_{soil} value is proportional to the building perimeter.
3. The building is rectangular

Appendix C Field SOPs

Groundwater Sample Collection: Direct-Push Technology Method

Purpose and Scope

This SOP provides general guidelines for collecting groundwater grab samples using direct-push technology (DPT) (e.g., Geoprobe[®]) sampling methods. It does not discuss the collection of groundwater samples collected from permanent monitoring wells.

Equipment and Materials

- Field log book
- Clean DOT-approved 55-gallon steel drum with label
- Equipment/instrument decontamination materials (see SOP, Decontamination of Personnel and Equipment)
- Truck- or van-mounted hydraulic percussion hammer (to be supplied by the subcontractor) equipped with drill rods and at least one protected stainless steel well screen (two protected well screens are preferred)
- Polyethylene sample tubing and a foot valve (optional)
- Water level meter
- Peristaltic pump with portable battery
- Disposable polyethylene tubing
- Disposable silicone tubing
- Groundwater quality meter capable of collecting groundwater quality parameters either within the well riser or using a flow-through cell (Horiba or YSI Water Quality Multiprobe; capable of measuring temperature, specific conductance, dissolved oxygen, turbidity, pH, and oxygen-reduction potential)
- Laboratory-supplied analytical sample containers
- Clean latex or nitrile gloves

Procedures and Guidelines

- Set up and calibrate instruments in accordance with manufacturer's instructions.
- Decontaminate protected well screen in accordance with the SOP, Decontamination of Drill Rigs and Equipment.

- Drive protected well screen to the maximum desired sampling depth using the hydraulic percussion hammer.
- Retract the drill rod to expose well screen to formation. Ensure that the bottom of the well screen is set at the desired depth and has not been inadvertently pulled up to a shallower depth.
- Using a peristaltic pump, purge the well using low-flow sampling techniques (See the SOP, Low-Flow Groundwater Sampling).
- If possible, measure depth to water with water level meter and record in the field log book.
- Fill analytical sample containers beginning with the volatile organic compound (VOC) containers. See the SOP, Volatile Organic Compound Water Sample Collection, for more details regarding VOC sample handling.
- If sufficient groundwater is not available to fill each analytical sample containers, leave the protected screen in place and proceed to another soil boring location. Periodically check the well screen and attempt to sample more groundwater throughout the day until analytical sample containers have been filled. This is only a viable option if the driller has a sufficient number of drill rods and more than one protected well screen.
- Following collection of the groundwater sample, pull the protected well screen to the next shallow depth interval to be sampled. Purge and sample the next interval in the same manner as prescribed in this SOP.
- Backfill the boring with grout or hydrated bentonite chips and repair the surface with like material (i.e., asphalt patch, concrete, etc.), as required.
- Decontaminate protected well screen and rods in accordance with the SOP, Decontamination of Drill Rigs and Equipment.

Key Checks

- Verify that the hydraulic percussion hammer is clean and in proper working order.
- Ensure that the driller thoroughly decontaminates the protected well screen between sample intervals and soil boring locations.
- Ensure that the borehole has been backfilled and ground surface restored.
- Mark soil boring location with a labeled survey flag.

Attachments

None.

MiniRAE 2000

Portable VOC Monitor
PGM-7600



OPERATION AND MAINTENANCE MANUAL

(Document No.: 011-4001-000)
Revision E, May 2005



ATTENTION!

For European Applications

- A. CE 0575 II 1G/2G
DEMKO 03 ATEX 0204759X
Eex ia IIC T4**
- B. Recharge batteries only in non-hazardous locations.**
- C. Do not connect external cable to serial interface jack in hazardous locations.**
- D. Use RAE Systems Adapter P/N 500-0072 for connection to communication port and charging jack only in a non-hazardous area.**

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 **WARNING** 

- Do NOT proceed before reading -

This manual must be carefully read by all individuals who have or will have the responsibility for using, maintaining, or servicing this product.

The product will perform as designed only if it is used, maintained, and serviced in accordance with the manufacturer's instructions.

CAUTION!!

To reduce the risk of electric shock, turn off power before removing the monitor cover. Disconnect the battery before removing sensor module for service. Never operate the monitor while the cover is removed. Remove monitor cover and sensor module only in an area known to be non-hazardous.

The model PGM-7600 equipment is classified as to intrinsic safety for use in class I, division 1, groups A, B, C, D, or non-hazardous locations only.

Special Notes

-1-

When the MiniRAE 2000 Monitor is taken out from the transport case and turned on for the first time, there may be some residual organic or inorganic vapor trapped inside the detector chamber. The initial PID sensor reading may indicate a few ppm. Enter an area known to be free of any organic vapor and turn on the monitor. After running for several minutes, the residual vapor in the detector chamber will be cleared and the reading should return to zero.

-2-

The battery of the MiniRAE 2000 monitor will discharge slowly even if it is turned off. If the monitor has not been charged for 5-7 days, the battery voltage will be low. Therefore, it is a good practice to always charge the monitor before using it. It is also recommended to fully charge the monitor FOR AT LEAST 10 HOURS before first use. See Section 7 for more information on battery charging and replacement.

WARNINGS

STATIC HAZARD: Clean only with damp cloth.

For safety reasons this equipment must be operated and serviced by qualified personnel only. Read and understand instruction manual completely before operating or servicing.

Use only RAE Systems battery packs, part nos. 012-3050, 012-3051 or 012-3052. This instrument has not been tested in an explosive gas/air atmosphere having an oxygen concentration greater than 21%. Substitution of components may impair intrinsic safety. Recharge batteries only in non-hazardous locations.

The calibration of all newly purchased RAE Systems instruments should be tested by exposing the sensor(s) to known concentration calibration gas before the instrument is put into service.

For maximum safety, the accuracy of the MiniRAE 2000 should be checked by exposing it to a known concentration calibration gas before each day's use.

AVERTISSEMENTS

**DANGER RISQUE D'ORIGINE ELECTROSTATIQUE:
Nettoyer uniquement avec un chiffon humide.**

Pour des raisons de sécurité, cet équipement doit être utilisé, entretenu et réparé uniquement par un personnel qualifié. Étudier le manuel d'instructions en entier avant d'utiliser, d'entretenir ou de réparer l'équipement.

Utiliser seulement l'ensemble de batterie RAE Systems, la référence 012-3050, 012-3051 au 012-3052. Cet instrument n'a pas été essayé dans une atmosphère de gaz/air explosive ayant une concentration d'oxygène plus élevée que 21%. La substitution de composants peut compromettre la sécurité intrinsèque. Ne charger les batteries que dans emplacements désignés non-dangereuse.

La calibration de toute instruments de RAE Systems doivent être testé en exposant l'instrument a une concentration de gaz connue par une procédure diétalonnage avant de mettre en service l'instrument pour la première fois.

Pour une securite maximale, la sensibilité du MiniRAE 2000 doit être verifier en exposant l'instrument a une concentration de gaz connue par une procédure diétalonnage avant chaque utilisation journalière.

1. GENERAL INFORMATION

MiniRAE 2000 Portable VOC Monitor (Model PGM 7600) is a compact monitor designed as a broadband VOC gas monitor and datalogger for work in hazardous environments. It monitors Volatile Organic Compounds (VOC) using a Photo-Ionization Detector (PID) with a 9.8 eV, 10.6 eV, or 11.7 eV gas discharge lamp. Features are:

- **Lightweight and Compact**
 - Compact, light weight (19 oz.) and rugged design
 - Built-in sample draw pump

- **Dependable and Accurate**
 - Up to 10 hours of continuous monitoring with rechargeable battery pack
 - Designed to continuously monitor VOC vapor at ppm levels

- **User Friendly**
 - Preset alarm thresholds for STEL, TWA, low and high level peak values. Audio buzzer and flashing LED display are activated when the limits are exceeded.

- **Datalogging Capabilities**
 - 15,000 point datalogging storage capacity for data download to PC

MiniRAE 2000 consists of a PID with associated microcomputer and electronic circuit. The unit is housed in a rugged ABS + PC case with a backlit 1 line by 8 character dot matrix LCD and 3 keys to provide easy user interface.

GENERAL INFORMATION

1.1 General Specifications

Table 1.1

Portable VOC Monitor Specification	
Size:	8.2"L x 3.0"W x 2.0"H
Weight:	19.5 oz with battery pack
Detector:	Photo-ionization sensor with 9.8, 10.6, or 11.7 eV UV lamp
Battery:	A 4.8V /1250 mAH Rechargeable Nickel Metal Hydride battery pack (snap in, field replaceable)
Battery Charging:	10 hours charge through built-in charger
Operating Hours:	Up to 10 hours continuous operation
Display:	1 line by 8 characters 5x7 dot matrix LCD (0.4" character height) with LED back light automatically in dim light
Range, Resolution & Response time (t ₉₀):	
Isobutylene (calibration gas)	
	0-99 ppm 0.1 ppm 2 sec
	100-1,999 ppm 1.0 ppm 2 sec
	2000-10,000 ppm 1.0 ppm 2 sec
Measurement Accuracy (Isobutylene):	
	0 – 2000 ppm: ± 2 ppm or 10% of reading.
	> 2000 ppm: ± 20% of reading
PID Detector:	Easy access to lamp and sensor for cleaning and replacement
Correction Factors:	Built-in 102 VOC gases
Calibration:	Two-point field calibration of zero and standard reference gas
Calibration Memory:	Store up to 8 separate calibration, alarm limits and span value
Inlet Probe:	Flexible 5" tubing
Keypad:	1 operation key and 2 programming keys

GENERAL INFORMATION

Direct Readout:	Instantaneous, average, STEL and peak value, battery voltage and elapsed time
Intrinsic Safety:	UL & cUL Class I, Division I, Group A,B,C,D, Temperature Code T3C (US & Canada); CE 0575  II 1G DEMKO 02 ATEX 0204759 Eex ia IIC T4 (Europe)
EM Interference:	No effect when exposed to 0.43 W/cm ² RF interference (5 watt transmitter at 12 inches)
Alarm Setting:	Separate alarm limit settings for Low, High, STEL and TWA alarm
Operating Mode:	Survey or Hygiene mode
Alarm:	90 dB buzzer and flashing red LEDs to indicate exceeded preset limits, low battery voltage, or sensor failure.
External Alarm:	Optional plug-in pen-size vibration alarm or remote alarm
Alarm Mode:	Latching or automatic reset
Real-time Clock:	Automatic date and time stamps on data logged information
Datalogging:	15,000 points with time stamp, serial number, user ID, site ID, etc.
Communication:	Upload data to PC and download instrument setup from PC through RS-232 port
Sampling Pump:	Internally integrated. Flow rate: 450-550 cc/min.
Temperature:	0° to 45°C (32° to 113°F)
Humidity:	0 % to 95 % relative humidity (non-condensing)
Housing:	ABS + PC, conductive coating, splash and dust proof, will withstand 1 meter drop test with rubber boot
Attachment:	Wrist strap, rubber boot and belt clip

2. OPERATION OF MINIRAE 2000

The MiniRAE 2000 Portable VOC Monitor is a compact Monitor designed as a broadband VOC gas monitor and datalogger for work in hazardous environments. It gives real time measurements and activates alarm signals whenever the exposure exceeds preset limits. Prior to factory shipment the MiniRAE 2000 is preset with default alarm limits and the sensor is pre-calibrated with standard calibration gas. However, the user should test the instrument and verify the calibration before the first use. After the monitor is fully charged and calibrated, it is ready for immediate operation.

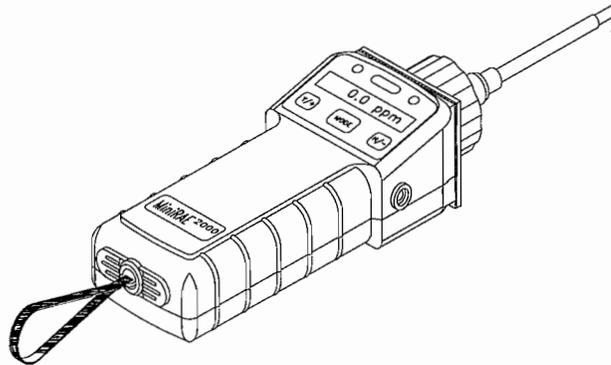


Figure 2-1 MiniRAE 2000

2.1 Physical Description

The main components of the MiniRAE 2000 Portable VOC monitor include:

- Three keys for user to interact with the monitor: 1 operation key and 2 programming keys for normal operation or programming of the monitor
- LCD display with back light for direct readout and calculated measurements
- Buzzer and red LED's for alarm signaling whenever the exposures exceed preset limits
- Wrist strap
- Charge contact for plugging directly to the charging station
- Gas entry and exit ports
- Serial communication port for PC interface
- External alarm and analog output port
- Protective rubber cover

2.2 Keys and Display

Figure 2.2 shows the LCD display and the keypad on the front panel of the monitor. The function of the 3 keys during normal operation are summarized below:

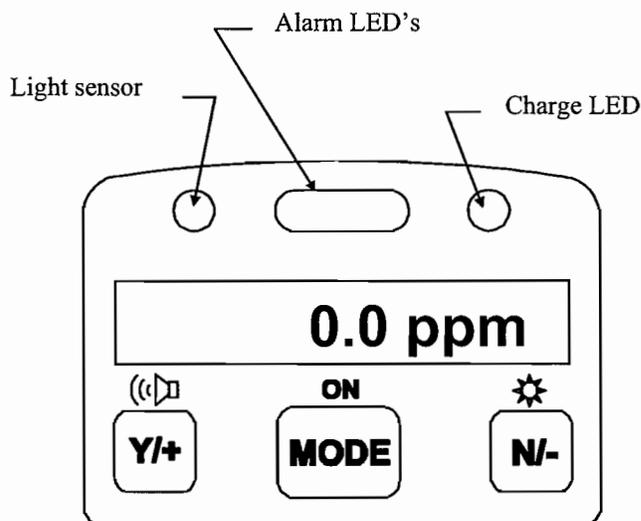


Figure 2-2 LCD Display and Keypad

Key Function in Normal Operation

<p>[MODE] -Turn on/off the power* and step through menu items</p> <p>[N/-] -Toggle on/off the back light, negative acknowledge, decrease value</p> <p>[Y/+] -Start measurement, positive acknowledge, increase value</p>

* Pressing and holding [**MODE**] key for 5 seconds turns off the power to the monitor. Monitor will beep once per second and display countdown timer during power-down sequence. Press [**MODE**] key momentarily to step through menu items. To save time, press any key during message scrolling to skip to the end of the message.

2.3 Power On/Off

To turn on the MiniRAE 2000 portable VOC monitor, press [MODE] key for one second and release. The audio buzzer will beep once and the air pump will turn on. The display will show “ON!..” and then “Ver n.nn” to indicate the unit’s current firmware version number. Next displayed are the serial number, the model number, Operating mode, current date and time, unit internal temperature, gas selected, high low, STEL, TWA/AVG alarm limits, battery voltage, and shut off voltage. Also displayed are internal mode settings such as User mode, Alarm mode, datalog time remaining and log periods in the respective order.

To turn off the MiniRAE 2000 portable VOC monitor, press and hold the [MODE] key for 5 seconds. The monitor will beep once per second during the power-down sequence with a count down timer showing the number of remaining seconds. The message “Off!..” flashes on the LCD display and the display will go blank indicating that the monitor is turned off.

Data protection during power off

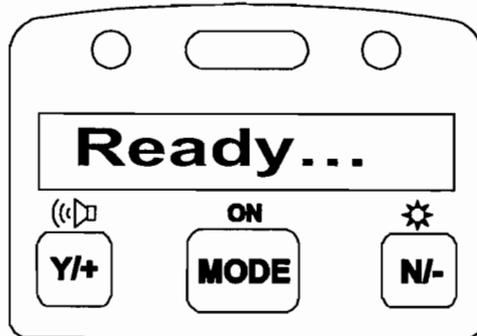
When the monitor is turned off, all the current real time data including last measured value are erased. However, the datalog data is preserved in non-volatile memory. Even if the battery is disconnected, the datalog data will not be lost. While the power is off, the real time clock will continue to operate until the battery is completely drained (usually in 4-5 days without any charging). If the battery is completely drained or is disconnected from the monitor for more than 30 minutes, the real time clock will be lost. In this case, the user needs to enter the real time clock information again, as described in Section 4, or send the PC clock during configuration through the PC communication.

2.4 Operation

The **MiniRAE 2000** VOC monitor has two operation modes: **Survey** and **Hygiene** mode. The **Survey mode** allows the user to manually start and stop the monitoring/measuring operation and display certain exposure values. In the **Hygiene mode**, the monitor runs continuously after the monitor is turned on. Refer to Section 4.7.1 for switching between the two modes.

2.4.1 Survey Mode

After the monitor is turned on, it runs through the start up menu. Then the message “**Ready...**” is displayed (see figure below).



At this point, the user has two options:

1. Step through the Main Menu.
2. Take a measurement.

Press the [**MODE**] button to step through the Main Menu. Press the [**Y/+**] button to proceed to take a measurement.

OPERATION

The Main Menu

Press the [MODE] button to enter the Main Menu. Press the [Y/+] , [MODE] or [N/-] as indicated in the flow chart below to step through the Main Menu. The PID sensor and pump are turned off during this time.

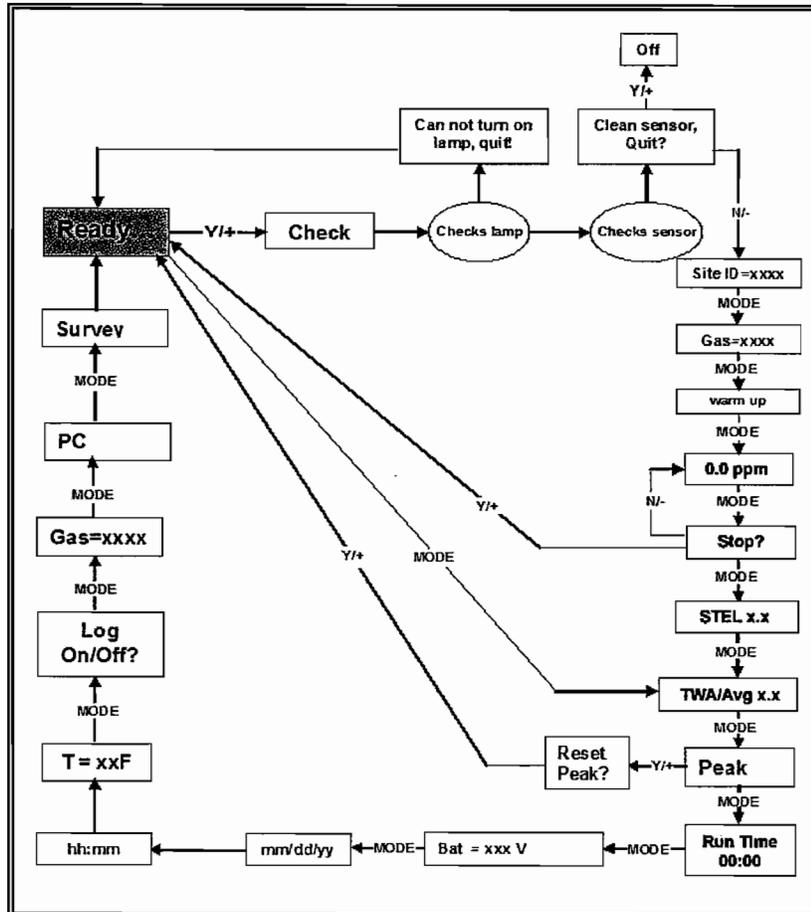
The Main Menu functions are:

- **Ready...**
- **Check**
- **Site ID = xxxx**
- **Gas = xxxx**
- **Warm up**
- **X.x ppm**
- **Stop?**
- **TWA/Avg x.x ppm**
- **STEL x.x ppm**
- **Peak x.x ppm**
- **Run time hh:mm**
- **Bat = X.XV**
- **Mm/dd/yy**
- **hh:mm**
- **T = xxxF [date, time and temperature (°C or °F)]**
- **Log On/Off?**
- **PC Comm?**
- **Survey**

OPERATION

These functions are arranged in a “round robin” order. To select a specific function, press the button as shown below until the desired function appears.

Main Menu



The Main Menu Functions

- **Ready...:** Indicates that the monitor is ready to take a measurement or to step through the Main Menu. Press the [Y/+] button to advance to taking a measurement (read “Taking a Measurement” on Page 2-12 for details).

Note: The **Ready...** screen is skipped if the menu is cycled through while a measurement is running.

- **Check...:** This message displays while the system is checking the lamp and the sensor. If the lamp test succeeds, the system will progress to checking the sensor. If the lamp test does not succeed, the display will read **Can not turn on lamp, quit!**

- **Can not turn on lamp, quit!:** This message displays when the lamp does not turn on. The system will automatically return to **Ready...** allowing the user to test the lamp again. If the lamp fails a second time, turn the monitor off and refer to Section 7.2 “**PID Sensor & Lamp Cleaning / Replacement**”.

- **Clean Sensor, Quit?:** This message displays when the sensor requires cleaning. Press the [Y/+] button to turn the monitor off and clean the sensor. Press the [N/-] button and the system will progress to the **Site ID = xx**

- **Site ID = xxxx:** This display shows the Site ID and indicates that the monitor is about to start taking measurements (read “Taking a Measurement” for details)

Note: This display appears only after a measurement has been started. It does not appear when the user is cycling through the Main Menu and the monitor is idling.

- **Gas = xxxx:** This display identifies the gas to be measured and indicates that the monitor is about to take a measurement (read “Taking a Measurement” for details)

OPERATION

Note: This display appears only after a measurement has been started. It does not appear when the user is cycling through the Main Menu and the monitor is idling.

- **x.x ppm:** (read “Taking a Measurement” for details)

Note: This display appears only after a measurement has been started. It does not appear when the user is cycling through the Main Menu and the monitor is idling.

- **TWA/Avg:** Displays (in ppm) the Time Weighted Average (TWA) or the Average since the start of the measurement. The average is recalculated every minute.
- **STEL:** Displays the Short Term Exposure Limit.
- **PEAK:** Displays (in ppm) the highest instantaneous reading since the start of the measurement. If [Y/+] is pressed while the peak reading is displayed, the unit will ask **Reset Peak?**. If [Y/+] is pressed again, the peak value will be cleared and the display will return to the **Ready...** message or instantaneous reading. The peak reading is automatically reset when a new measurement is started by pressing [Y/+] from the **Ready...** screen.
- **Run time hh:mm:** The duration of the current measurement period.
- **Bat = X.XV:** The current battery voltage.

Note: A fully charged battery pack should show 4.8 volts or higher. When the battery voltage falls below 4.4 volts, a flashing “**Bat**” will appear as a warning message. At that point, you have 20-30 minutes of run time remaining. When the battery voltage falls below 4.2 volts the monitor turns off automatically.
- **Mm/dd/yy:** The current date.
- **hh:mm:** The current time (24-hour format)

OPERATION

- **T = xxxF:** The internal unit temperature in degrees Fahrenheit. (see Section 4.7.13 to change temperature units)
- **Log on/Off?:** Allows the user to start datalogging of the current measurement. A superscript “L” flashes in the ppm measurement display when datalogging is on. This screen is not shown when datalogging is disabled or when the monitor is not operating in manual start/stop mode.
- **PC Comm?:** This function enables the user to upload data from the MiniRAE 2000 to a Personal Computer (PC) or send/receive configuration information between a PC and the MiniRAE 2000. Press [MODE] to return to **Ready...** .

To communicate with a PC, connect the monitor to the serial port of a PC and start the MiniRAE 2000 application software. Press the [Y/+] button and the LCD displays “**pause monitor, ok?**” Press the [Y/+] button one more time, and the display shows “**Comm...**” The monitor is now ready to receive commands from the PC.

- **Survey:** This function displays the Current Operating Mode (Survey or Hygiene).

Taking a Measurement

There are two ways to start a measurement.

1. Operating in Hygiene mode.
2. Manually start and stop measurement in Survey mode.

To start a measurement in Hygiene mode, please refer to Section 4.7.1, “**Change Operation Mode**”. To start a measurement in Survey Mode, the MiniRAE 2000 monitor must first be in the “Ready...” mode. This is the mode to which the monitor normally powers up.

OPERATION

Measurement phases

1. Ready
2. Start measurement
3. Measurement display and datalogging
4. Stop measurement

Ready

The display reads **Ready...** indicating the unit is ready to start a measurement.

Start Measurement

Press the [Y/+] button to start the check cycle (see above), and then the measurement cycle.

After completing the **Check** cycle, the display will show the **Site ID** and then the **Gas** selected for measurement. The pump will start and the reading will be displayed. The **Peak** and **Average** values will be automatically reset to zero.

Measurement Display and Datalog

Instantaneous readings of the gas concentration in parts per million (ppm) are updated every second. A flashing superscript **L** is displayed when datalogging is on. Datalog information is saved only after one full datalog period is completed.

OPERATION

Stop Measurement

Press the [MODE] button and the display shows Stop? Press [N/-] to continue measurement and [Y/+] to stop the measurement and datalog event. The pump stops automatically when measurement is stopped. Peak and average values for the current measurement can be read in idle mode until a new measurement is started.

Automatic Increment of Site ID

Every time a measurement is taken, the site ID will be incremented by one automatically in Survey mode.

Variable Alarm Signal

In Survey Mode, if the measurement exceeds the low alarm limit, the buzzer and flashing alarm are activated and will beep/flash once per second. The alarms will increase in frequency as the gas concentration approaches the high alarm limit reaching 8 times per second when the high alarm has been exceeded.

Press [Y/+] key to clear if latching alarm.

2.4.2 Hygiene Mode

In Hygiene Mode, the unit will continuously taking measurements, once the power is turned on. After the initial start-up sequence displaying the current monitor settings, the LCD displays the instantaneous readings.

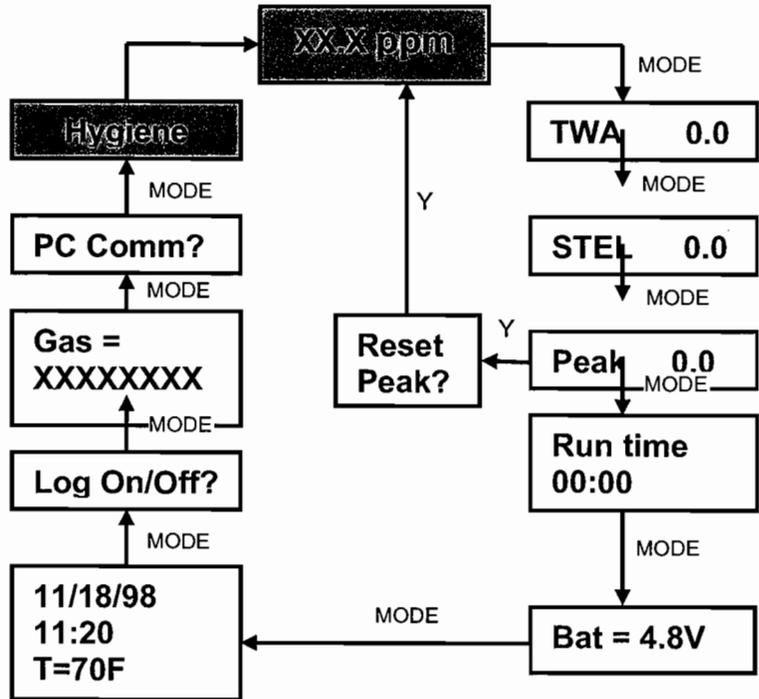
The Hygiene operation menu displays include:

- **Real time readings in ppm**
- **Current TWA/Avg, STEL and Peak values (see Section 4.6.6)**
- **Run time**
- **Current battery voltage**
- **Date, time and temperature**
- **Log on/off?**
- **Gas name**
- **PC communication?**
- **Hygiene**

Detailed description of most of these displays are the same as Section 2.4.1.

OPERATION

HYGIENE MODE MAIN MENU



To choose a specific display, press the [MODE] key one or more times until the desired display appears, or the [Y/+] key where indicated with a Y.

Note: To get back to instantaneous reading from any of the above display, press [MODE] key repeatedly until the "XX.X ppm" display appears.

2.5 Alarm Signals

During each measurement period, the gas concentration is compared with the programmed alarm limits (gas concentration alarm limit settings: Low, High, TWA and STEL). If the concentration exceeds any of the preset limits, the loud buzzer and red flashing LED are activated immediately to warn the user of the alarm condition.

In addition, the MiniRAE 2000 will alarm if one of the following conditions occurs: battery voltage falls below a pre-set voltage level (4.4 V), failure of UV lamp, pump stall, or when the datalog memory is full. When the low battery alarm occurs, there will be approximately 20-30 minutes of operating time remaining. When the battery voltage falls below 4.2 V, the monitor will turn off automatically.

OPERATION

Alarm Signal Summary:

Condition	Alarm Signal
Gas exceeds "High Alarm" limit	3 beeps/flashes per second
Gas exceeds "Low Alarm" limit	2 beeps/flashes per second
Gas exceeds "TWA" limit	1 Beeps/flashes per seconds
Gas exceeds "STEL" limit	1 Beeps/flashes per seconds
Pump failure	3 beeps/flashes per second plus "Pump" message on LCD
PID lamp failure	3 beeps/flashes per second plus "Lamp" message on LCD
Low battery	1 flash per second, 1 beep per minute plus "Bat" message on LCD
Memory full	1 flash per second plus "Mem" message on LCD

Alarm Signal Testing:

Under normal non-alarm conditions, it is possible to test the MiniRAE 2000 LED and buzzer in Special Diagnostic Mode (see Section 8 for details).

2.6 Preset Alarm Limits and Calibration

The MiniRAE 2000 portable VOC monitor is factory calibrated with standard calibration gas, and is programmed with default alarm limits. There are 102 gas settings stored in the library. Some examples of calibration and alarm limits are shown below. Refer to Section 4 on programming procedures for selecting a different gas, perform a calibration or set new alarm limits.

Factory Calibration and Preset Alarm Limits

Cal Gas	Cal Span	unit	Low	High	TWA	STEL
Isobutylene	100	ppm	50	100	100	250
Hexane, n-	100	ppm	500	750	500	750
Xylene, m-	100	ppm	100	150	100	150
Benzene	5	ppm	2	5	5	2
Styrene	50	ppm	20	40	20	40
Toluene	100	ppm	50	100	50	100
Vinyl Chloride	10	ppm	5	10	5	10
Custom	100	ppm	50	100	50	100

2.7 Integrated Sampling Pump

The MiniRAE 2000 portable VOC monitor includes an integrated sampling pump. This is a diaphragm type pump that provides a 500-600 cc per minute flow rate. Connecting a Teflon or metal tubing with 1/8 inch inside diameter to the gas inlet port of the MiniRAE 2000, this pump can pull in air samples from 200 feet away horizontally, or 90 feet vertically, at about 3 feet per second flow speed.

The pump turns on when a measurement is started, and turns off when the sample is manually stopped in Survey mode or when the unit is turned off from Hygiene Mode.

If liquid or other objects are pulled into the inlet port filter, the monitor will detect the obstruction and shut down the pump immediately. The alarm will be activated and a flashing error message "Pump" will be also displayed on the LCD display.

The user should acknowledge the pump shut off condition by clearing the obstruction and pressing the [Y/+] key to re-start the pump.

The pump stall threshold is set in the special Diagnostic Mode (Section 8).

2.8 Back Light

The LCD display is equipped with an LED back light to assist in reading the display under poor lighting conditions. Pressing and holding the [N/-] key for one second in normal operation can turn on the backlight. The backlight can be turned off by pressing [N/-] a second time. If the [N/-] key is not pressed, the back light will be turned off automatically after a pre-programmed time-out period to save power.

In addition, the ambient light is sensed and the back light will be turned on automatically if the ambient light is below a threshold level. The back light is turned off automatically when the ambient light exceeds the threshold level.

See Section 8 for instructions on how to set the light threshold level.

Note: The LED backlight consumes about 20-30% of the total average current, when the instrument is idle or not taking a measurement.

2.9 Datalogging

During datalogging, the MiniRAE 2000 Portable VOC monitor flashes a superscript “L”, on the display to indicate that datalogging is enabled. The monitor stores the time stamp, sample number, and measured gas concentration at the end of every sample period (when data logging is enabled). In addition, the following information are stored: user ID, site ID, serial number, last calibration date, and alarm limits. All data are retained (even after the unit is turned off) in non-volatile memory so that it can be down loaded at a later time to a PC.

Datalogging event

When Datalogging is enabled, measurement readings are being saved. These data are stored in “groups” or “events. A new event is created and stored each time the monitor is turned on, or a configuration parameter is changed, or datalogging is interrupted (e.g. Communication with PC during Hygiene mode). Information, such as start time, user ID, site ID, gas name, serial number, last calibration date, and alarm limits will be recorded.

Datalogging sample

After an event is recorded, the unit records a shorter form of the data. This data contains: the sample number, time (hour/minute) and gas concentration.

3. OPERATION OF ACCESSORIES

The accessories for the MiniRAE 2000 include:

- An AC Adapter (Battery Charger)
- Alkaline battery holder
- Water Trap Filter

Optional Accessories:

- Dilution Fitting
- Calibration adapter
- Calibration regulator and Flow controller
- Organic Vapor Zeroing kit

3.1 Standard Kit and Accessories

1) AC Adapter (Battery Charger)

WARNING

To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in area known to be non-hazardous.

Ne charger les batteries que dans emplacements designés non-dangereuses.

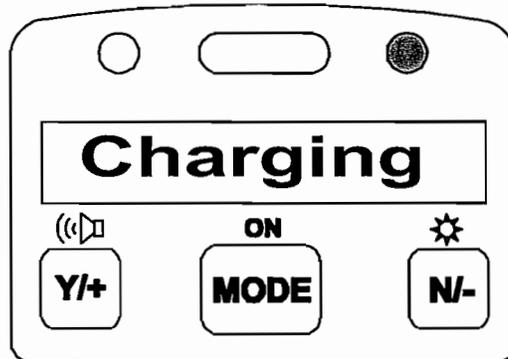
A **battery charging circuit** is built into the MiniRAE 2000 monitor. It only needs a regular AC to 12 V DC adapter (wall mount transformer) to charge the monitor.

To charge the battery inside the MiniRAE 2000 monitor:

1. Power off the Monitor.
2. Connect the AC adapter (or the optional automotive charging adapter) to the DC jack on the MiniRAE 2000 monitor. If the unit was off, it will automatically turn on.
3. The first message displayed will be “Deep discharge?” The unit will ask this question for three times. If the user wants to discharge the battery pack, affirm this query with the [Y/+] key, otherwise the unit will move on to the charge mode directly.

OPERATION OF ACCESSORIES

4. While charging, the display message will alternate between “Charging” and “Bat=x.xV” (x.x is the present battery voltage). The LED should be red in color when charging.



5. When the battery is fully charged, the LED will change from red to green and the message “Fully charged” will appear on the display. After the battery is fully charged, the unit will enter the “trickle charge” mode. In which, the red LED will turn on for several seconds every minute, to maintain the full charge.

A completely discharged MiniRAE 2000 monitor will be charged to full capacity within 10 hours. The battery will be drained slowly even if the monitor is turned off. If the monitor has not been charged for 7-10 days, the battery voltage will be low.

The factory-supplied battery is designed to last for 10 hours of normal operation (no alarm, no back light condition), for a new battery under the best condition. As the battery becomes older or is subject to adverse conditions (such as cold ambient temperature), the battery capacity will be reduced significantly.

2) Alkaline Battery Holder

An alkaline battery holder is supplied with each MiniRAE 2000. It accepts four AA size alkaline batteries and can be used in place of the Ni-MH or Ni-Cd battery pack to provide approximately 12-14 hours of operation. The adapter is intended to be used in emergency situations when there is no time to charge the Ni-Cd or Ni-MH battery pack.

To install the adapter, remove the cover of the battery compartment. Remove the Ni-Cd or Ni-MH battery pack from the battery compartment and replace with the alkaline battery adapter. Replace the battery compartment cover.

The internal charging circuit is designed to prevent damage to alkaline batteries and the charging circuit when alkaline batteries are installed inside the monitor.

Note: The AA Alkaline battery adapter supplied by RAE Systems Inc. is intrinsically safe!

3) Water Trap Filter

The water trap filter is made of PTFE (Teflon[®]) membrane with a 0.45 micron pore size to prevent water from being sucked into the sensor manifold, which would cause extensive damage to the monitor. It will also remove any dust and other particles from entering the monitor and prolong the operating life of the sensor. To install the water trap, simply insert it to the front of the inlet tube of the MiniRAE 2000 monitor.

3.2 Optional Accessories

1) Dilution Fitting

The user may wish to install a dilution fitting on the inlet to dilute the gas samples. One application for a dilution fitting is to measure organic gas when the concentration exceeds the upper limit of the sensor range.

Make sure to set the dilution ratio in the programming mode (see Section 4.7.9) so that the correct gas reading will be displayed when the dilution fitting is used.

WARNING: To use a dilution fitting, the user must have the monitor located in a clean atmosphere outside the confined space and use a remote access probe or Tygon tubing to measure the gas concentration inside the confined space.

2) Calibration Adapter

The calibration adapter for the MiniRAE 2000 is a simple 6-inch Tygon tubing with a metal adapter on one end. During calibration, simply insert the metal adapter into the regular gas inlet probe of the MiniRAE 2000 and the tubing to the gas regulator on the gas bottle.

OPERATION OF ACCESSORIES

3) Calibration Regulator and Flow Controller

The Calibration Regulator and Flow controller is used in the calibration process. It regulates the gas flow rate from the Span gas cylinder into the gas inlet of the MiniRAE 2000 monitor during calibration process. The maximum flow rate allowed by the flow controller is about 0.5L/min (500 cc per min.). Alternatively, a Demand-flow Regulator or a Tedlar gas bag may be used to match the pump flow precisely.

4) Organic Vapor Zeroing kit (Charcoal filter)

The Organic Vapor Zeroing Kit is used for filtering organic air contaminants that may affect the zero calibration reading. To use the Organic Vapor Zeroing Kit, simply connect the filter to the inlet port of the MiniRAE 2000.

4. PROGRAMMING OF MINIRAE 2000

The MiniRAE 2000 Monitor is built with a microcomputer to provide programming flexibility. Authorized users can recalibrate the monitor, change the alarm limits, change site ID, user ID, lamp type, and real time clock, etc.

Programming is menu-driven to provide intuitive end-user operation. The display shows the menu options and the key pad used for menu selection and data entry.

4.1 Programming Mode

The programming mode allows the users to change the setups in the monitor, calibrate the monitor, modify the sensor configuration and enter user information, etc. The programming mode has four menu items. Each menu item includes several sub-menus to perform additional programming functions. Appendix A shows a more detailed menu tree structure.

Programming Menu

- Calibrate/Select Gas?
- Change Alarm Limits?
- Change Datalog?
- Change Monitor Setup?

Once inside the programming mode, the LCD will display the first menu. Each subsequent menu item can be viewed by pressing the [N/-] repeatedly until the desired menu is displayed. To enter the sub-menu of a particular menu, press [Y/+] key, the sub-menu will be displayed.

Return to Operation mode: To exit the programming mode and return to operation, press the [MODE] key once at any of the programming menu displays.

4.2 Keys for Programming Mode

The three keys perform a different set of functions during the programming mode as summarized below.

Key	Function in Programming Mode
[MODE]:	Exit menu when pressed momentarily or exit data entry mode when pressed and held for 1 second
[Y/+]:	Increase alphanumerical value for data entry or confirm (yes) for a question
[N/-]:	Decrease alphanumerical value for data entry or deny (no) for a question

4.3 Entering into Programming Mode

1. Turn on the MiniRAE 2000 monitor and wait for the “**Ready..**” message or the instantaneous reading display “**0.0 ppm**” message displayed.
2. Press and hold down both [N/-] and [MODE] keys for three seconds to enter programming mode. This delay is to prevent the user from entering programming mode by accident.
3. The first menu item “Calibrate/select Gas?” will be displayed.
4. Release both [MODE] and [N/-] keys simultaneously to start the programming mode
5. Press [N/-] key to scroll to the next menu item of the programming menu. Press [Y/+] key to select the displayed menu item.

The following Sections 4.4 - 4.7 describe the details of each menu options.

4.4 Calibrate and Select Gas

WARNINGS

The calibration of all newly purchased RAE Systems instruments should be tested by exposing the sensor(s) to known concentration calibration gas before the instrument is put into service for the first time.

For maximum safety, the accuracy of the MiniRAE 2000 should be checked by exposing it to known concentration calibration gas before each day's use.

In the first menu of the programming mode, the user can perform functions such as calibration of the MiniRAE 2000 Monitor, select default cal memories, and modify cal memories (see Table 4.4).

Table 4.4

Calibrate/Select Gas Sub-Menu
Fresh Air Cal?
Span Cal?
Select Cal Memory?
Change Span Value?
Modify Cal Memory?
Change Correction Factor?

Calibrating the MiniRAE 2000 monitor is a two-point process using “fresh air “ and the standard reference gas (also known as span gas). First a “Fresh air” calibration, which contains no detectable VOC (0.0 ppm), is used to set the zero point for the sensor. Then a standard reference gas that contains a known concentration of a given gas is used to set the second point of reference.

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Note: The span value must be set prior to calibrating for fresh air or span.

The user can store calibrations for up to 8 different measurement gases. The default gas selections are as follows:

- Cal Memory #0.....Isobutylene
- Cal Memory #1.....Hexane
- Cal Memory #2.....Xylene
- Cal Memory #3.....Benzene
- Cal Memory #4.....Styrene
- Cal Memory #5.....Toluene
- Cal Memory #6.....Vinyl Chloride
- Cal Memory #7.....Custom?

Memory #0 functions differently than the other 7 memories. For Memory #0, isobutylene is always the calibration gas. When the gas is changed in Memory #0 to one of 100 other preprogrammed chemicals or to a user-defined custom gas, a correction factor is applied to all the readings. During calibration, the unit requests isobutylene gas and displays the isobutylene concentration immediately following calibration, but when the unit is returned to the normal reading mode, it displays the selected gas and applies the correction factor.

The other 7 cal memories require the same calibration gas as the measurement gas. These memories may also be modified to a preprogrammed chemical or to a user-defined custom gas. In the gas library, only the gases that can be detected by the installed UV lamp will actually be displayed. Note that although the correction factor for the new gas will be displayed and can be modified, this factor is not applied when Memories #1-7 are

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used. Therefore the factor will not affect the readings in these memories.

Once each of the memories has been calibrated, the user can switch between the calibrated gases by changing the cal memory without the need to recalibrate. Or the user can switch the measurement gas in Memory #0 and the appropriate correction factor will automatically be applied without the need to recalibrate. If the gas is changed in Memories #1-7, it is necessary to recalibrate.

To change a default gas from the list above to a library or custom gas, first go to Select Cal Memory (Section 4.4.3) and then proceed to Modify Cal Memory (Section 4.4.5) to enter the desired gas. If the desired compound does not appear in the preprogrammed library, the user can use the Custom_VOC entry in the library, or the name and correction factor of any of the existing compounds can be changed as described in Section 4.4.5. A list of some 300 correction factors is given in Technical Note 106, available at the website www.raesystems.com.

4.4.1 Fresh Air Calibration

This procedure determines the zero point of the sensor calibration curve. To perform a fresh air calibration, use the calibration adapter to connect the MiniRAE 2000 to a “fresh” air source such as from a cylinder or Tedlar bag (option accessory). The “fresh” air is clean dry air without any organic impurities. If such an air cylinder is not available, any clean ambient air without detectable contaminant or a charcoal filter can be used.

1. The first sub-menu shows: “Fresh air Cal?”
2. Make sure that the MiniRAE 2000 is connected to one of the “fresh” air sources described above.
3. Press the [Y/+] key, the display shows “zero in progress” followed by “wait..” and a countdown timer.

After about 15 seconds pause, the display will show the message “update data...zeroed... reading = X.X ppm...” Press any key or wait about 20 seconds, the monitor will return back to “Fresh air Calibration?” submenu.

4.4.2 Span Calibration

This procedure determines the second point of the sensor calibration curve for the sensor. A cylinder of standard reference gas (span gas) fitted with a 500 cc/min. flow-limiting regulator or a flow-matching regulator is the simplest way to perform this procedure. Choose the 500 cc/min. regulator only if the flow rate matches or slightly exceeds the flow rate of the instrument pump. Alternatively, the span gas can first be filled into a Tedlar Bag, or delivered through a demand-flow regulator. Connect the calibration adapter to the inlet port of the MiniRAE 2000 Monitor, and connect the tubing to the regulator or Tedlar bag.

Another alternative is to use a regulator with >500 cc/min flow but allow the excess flow to escape through a T or an open tube. In the latter method, the span gas flows out through an open tube slightly wider than the probe, and the probe is inserted into the calibration tube.

Before executing a span calibration, make sure the span value has been set correctly (see next sub-menu).

1. Make sure the monitor is connected to one of the span gas sources described above.
2. Press the [Y/+] key at the "Span Cal?" to start the calibration. The display shows the gas name and the span value of the corresponding gas.
3. The display shows "Apply gas now!" Turn on the valve of the span gas supply.

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4. Display shows “wait.... 30” with a count down timer showing the number of remaining seconds while the monitor performs the calibration.
5. To abort the calibration, press any key during the count down. The display shows “Aborted!” and return to “Span Cal?” sub-menu.
6. When the count down timer reaches 0, the display shows the calibrated value.
Note: The reading should be very close to the span gas value.
7. During calibration, the monitor waits for an increased signal before starting the countdown timer. If a minimal response is not obtained after 35 seconds, the monitor displays “No Gas!” Check the span gas valve is on and for lamp or sensor failure before trying again.
8. The calibration can be started manually by pressing any key while the “Apply gas now!” is displayed.
9. After a span calibration is completed, the display will show the message “Update Data Span Cal Done! Turn Off Gas.”
10. Turn off the flow of gas. Disconnect the calibration adapter or Tedlar bag from the MiniRAE 2000 Monitor.
11. Press any key and it returns back to “Span Gas Cal?”

4.4.3 Select Cal Memory

This function allows the user to select one of eight different memories for gas calibration and measurement. For Memories #1-7, the calibration and measurement gas is the same and no correction factor is applied. For Memory #0, the calibration gas is always isobutylene and the measurement gas may be different, in which case the correction factor for that gas is automatically applied. The default gas selections are listed in Section 4.4

1. "Select Cal Memory?" is the third sub-menu item in the Calibration sub-menu. Pressing the [Y/+] key, the display will show "Gas =" gas name followed by "Mem # x?"
2. Press [N/-] to scroll through all the memory numbers and the gas selections respectively. Press [Y/+] to accept the displayed Cal Memory number.
3. After the [Y/+] key is pressed, the display shows "Save?" Press [Y/+] key to save and proceed. Press [N/-] to discard the entry and advance to the next sub-menu.
4. If the gas in a newly selected Cal Memory number is not calibrated, the display shows "CF= x.xx". A correction factor with the value "x.xx" will be applied.
5. If the gas of a newly selected cal memory number has been calibrated previously, the display shows "Last calibrated xx/xx/xx".

4.4.4 Change Span Value

This function allows the user to change the span values of the calibration gases.

1. "Change Span Value?" is the fourth sub-menu item in the Calibration sub-menu
2. Press [Y/+], display shows the gas name and the span value. A cursor will blink at the first digit of the Span value. To modify the span gas value, go to Step 3. Otherwise, press and hold the [MODE] key for 1 second to accept the previously stored span gas value and move to the next sub-menu.
3. Starting from the left-most digit of the span gas value, use the [Y/+] or [N/-] key to change the digit value and press [MODE] key momentarily to advance to next digit. Repeat this process until all digits are entered. Press and hold the [MODE] for 1 second to exit.
4. The display shows "Save?" To accept the new value, press the [Y/+] key. Press the [N/-] key or the [MODE] key to discard the change and move to the next sub-menu.

4.4.5 Modify Cal Memory

If the current cal memory number selected is not memory 0, users will be prompted whether to modify the settings of the selected cal memory. Press [Y/+] to modify the cal memory and [N/-] to go to the next sub-menu.

Once [Y/+] is pressed the LCD display will show the current memory number, current Gas selected and prompt user for acceptance of current gas selected.

1. Press [N/-] to modify the gas selection if desired. Or press [Y/+] key to skip the change of gas selection, and proceed to the next sub-menu.
2. After pressing [N/-], display shows “Copy gas from library?” Press [Y/+] to accept or [N/-] for the next sub-menu, “Enter Custom gas?”
3. In the “Copy gas from library” submenu, use [Y/+] and [N/-] keys to scroll through the selections in the library. Press [MODE] key momentarily to select the gas. The display shows “Save?” Press [Y/+] to save or [N/-] to discard the changes and proceed to next sub-menu.
4. In the Custom gas sub-menu, the user can enter the gas name. Press the [Y/+] or [N/-] key to cycle through all 26 letters and 10 numerals. Press the [MODE] key momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all digits (up to 8 digits) of the custom gas name is entered.

Press and hold the [MODE] key for 1 second to exit the name entry mode. The display will show “Save?” Press [Y/+] to save the entry, or [N/-] to discard the changes.

4.4.6 Change Correction Factor

This function allows the user to change the Correction Factor of the standard calibration gas (only for Cal Memory #0).

1. “Change Correction Factor?” is the sixth sub-menu in the Calibration sub-menu.
2. Press [Y/+] key. Display shows the gas name, then the correction factor.

A cursor blinks at the left-most digit of the correction factor. If user wants to modify the correction factor, go to Step 3. Otherwise, press and hold the [MODE] key for 1 second to accept the previously stored correction factor value and return to the first sub-menu of the calibrate/select gas menu.

3. Starting from the left-most digit of the correction factor, use [Y/+] or [N/-] key to change the digit value and press [MODE] key momentarily to advance to the next digit, the cursor will move to the next digit to the right. Repeat this process until all digits are entered. Press and hold the [MODE] for 1 second to exit.
4. The display shows “Save?” To confirm the new value, press [Y/+] to accept the change. Press [N/-] or [MODE] to discard the change and return to the first sub-menu, Calibrate and Select Gas.

4.5 Change Alarm Limits

In this menu, the user can change the high and low alarm limits, the STEL limit and the TWA limit (see Table 4.5 below). Press the [Y/+] key and the display shows the current gas selected followed by the first sub-menu item below.

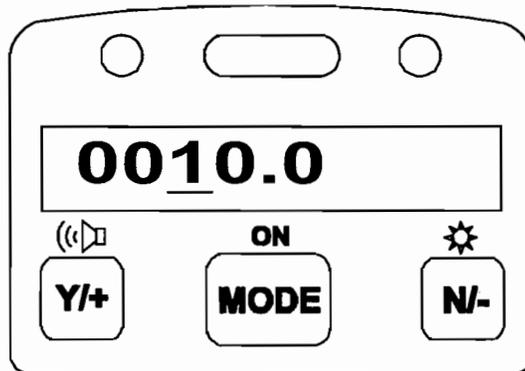
Table 4.5

Alarm Limit Sub-Menu
Change High Alarm limit?
Change Low Alarm limit?
Change STEL limit?
Change TWA limit?

1. Scroll through the Alarm Limit sub-menu using the [N/-] key until the display shows the desired limit to be changed, e.g., "High limit?", "STEL limit?", etc.

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2. Press the [Y/+] key to select the desired limit and the display shows a flashing cursor on the left-most digit of the previously stored alarm limit.



3. To modify this limit value, use the [Y/+] or [N/-] key to change the digit value and press the [MODE] key momentarily to advance to the next digit. The flashing digit will move to the next digit to its right. Repeat this process until the new limit value is entered. Press and hold the [MODE] key for 1 second to exit data entry mode.
4. If there is any change to the existing value, the display shows "Save?" Press [Y/+] to accept the new value and move to the next sub-menu. Press [N/-] to discard the changes and move to the next sub-menu.

4.5.1 Change Low Alarm Limit

The second sub-menu item in the Alarm Limit sub-menu allows the user to change the Low Alarm limit. The LCD displays “Low limit?” To change Low Alarm limit, press [Y/+] key, or Press [N/-] key advance to next sub-menu in Table 4.5.

1. Press [Y/+] and the display will show a flashing cursor on the left-most digit of the previously stored Low alarm limit.
2. To modify this limit value, use the [Y/+] or [N/-] key to change the digit value and press the [MODE] key momentarily to advance to the next digit. The flashing digit will move to the next digit to its right. Repeat this process until the new limit values is entered. Press and hold the [MODE] key for 1 second to exit data entry mode.
3. If there is any change to the existing value, the display shows “Save?” Press [Y/+] to accept the new value and move to the next sub-menu. Press [N/-] to discard the changes and move to the next sub-menu.

4.5.2 Change STEL Limit

This sub-menu item allows the user to change the STEL limit. The display shows “STEL limit?”

1. Press the **[Y/+]** key and the display will show a flashing cursor on the left-most digit of the previously stored STEL limit.
2. To modify this limit value, use the **[Y/+]** or **[N/-]** key to change the digit value and press the **[MODE]** key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new limit values is entered. Press and hold the **[MODE]** key for 1 second to exit data entry mode.
3. If there is any change to the existing value, the display shows “Save?” Press **[Y/+]** to accept the new value and move to the next sub-menu. Press **[N/-]** to discard the changes and move to the next sub-menu.

4.5.3 Change TWA Limit

This sub-menu item allows the user to change the TWA limit. The LCD displays “TWA limit?”

1. Press [Y/+] and the display will show a flashing cursor on the left-most digit of the previously stored TWA limit.
2. To modify this limit value, use the [Y/+] or [N/-] key to change the digit value and press the [MODE] key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new limit values is entered. Press and hold the [MODE] key for 1 second to exit data entry mode.
3. If there is any change to the existing value, the display shows “Save?” Press [Y/+] to accept the new value and move to the next sub-menu. Press [N/-] to discard the changes and move to the next sub-menu.

4.6 Change Datalog

The MiniRAE 2000 monitor calculates and stores the concentration and ID of each sample taken. In the datalog sub-menu, a user can perform the tasks and functions shown below.

Datalog Sub-Menu

Reset Peak/Minimum?

Clear Data?

Change Data Period?

Change Average Type?

4.6.1 Reset Peak

This function will reset the peak and minimum stored in the data memory. Note: this function will not clear the STEL or TWA data.

1. "Reset Peak?" is the first sub-menu item in the Datalog sub-menu (Table 4.6).
2. Press the [Y/+] key to reset the Peak/Minimum Values. The display shows "Are You Sure?"
3. Pressing the [Y/+] key again will reset the values. The display shows "Peak/Minimum Cleared" and moves to the next submenu.
4. Press the [N/-] or [MODE] key to exit without resetting the values and move to the next sub-menu.

4.6.2 Clear Data

This function will erase all data stored in the non-volatile datalog memory. Note: This function does not change STEL, TWA, Peak, Minimum and run time values, which are stored in the regular data memory.

1. "Clear Data?" is the third sub-menu item in the Datalog sub-menu.
2. Press the [Y/+] key to clear the datalog memory. The display shows "Are you sure?"
3. Press the [Y/+] key again to confirm erasure of all the datalog memory.
4. Press the [N/-] or [MODE] key to exit without clearing the datalog memory and move to the next datalog sub-menu.

4.6.3 Change Data Period

The datalog period can be programmed from 1 to 3,600 seconds (1 hour).

1. "Change Data Period?" is the fifth sub-menu item in the Datalog sub-menu.
2. Press the [Y/+] key and the display shows "Datalog Period = XXXX" with the left-most digit flashing, where "XXXX" is the previously stored data log period.
4. To modify this period, starting from the left-most digit, use the [Y/+] or [N/-] key to change the digit value and press the [MODE] key momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all 4 digits of the new period are entered. Press and hold the [MODE] key for 1 second to exit data entry mode.
5. If there is any change to the existing value, the display will show "Save?" Press [Y/+] to accept the new value or [N/-] to discard the changes and move to the next sub-menu.

4.6.4 Change Average Type

The user can select either an 8-hour Time Weighted Average (TWA) or a running Average. The running average is simply the average of all instantaneous (1-second) readings since the measurement was started. This average may increase or decrease with time depending on the readings. The TWA is a cumulative value used to estimate the fraction of the 8-hour limit to which the user has been exposed since the start of the measurement. This value can only increase or remain constant, never decrease. Refer to Technical Note 119 for more information on how TWA is calculated.

1. “Change Average Type?” is the sixth sub-menu in the Datalog sub-menu.
2. Press the [Y/+] key to enter the function.
3. The display will show “Running Average?” or “Time Weighted Average?” depending on the current average type.
4. Press [N/-] key to toggle between the average types. Press [Y/+] key to select the displayed average type.
5. If there is any change to the existing setting, the display shows “Save?” Press [Y/+] to save the change. Press [N/-] or [MODE] to discard the change and return to the first sub-menu.

4.7 Change Monitor Setup

Several monitor specific variables can be changed in this menu. The following is a list of configuration data that can be modified by the user.

Monitor Setup Sub-Menu	Diagnostic Mode
Change Operation Mode?	“
Change Site ID?	Change Unit ID?
Change User ID?	Change Host ID?
Change Alarm Mode?	“
Change User Mode?	“
Change Date?	“
Change Time?	“
Change Lamp?	“
Change Pump Duty Cycle?	“
Change Unit?	“
Change Dilution Ratio?	“
Change Output?	“
Change DAC Range?	“
Set Temperature Unit?	“

4.7.1 Change Operation Mode

MiniRAE 2000 supports two operation modes: Survey and Hygiene mode.

Survey mode: Manual start/stop of measurements and display of certain exposure values.

Hygiene mode: Automatic measurements, running and datalogging continuously and calculates additional exposure values.

1. “Change Op Mode?” is the first sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the [Y/+] key and the display shows the current user mode: “Op Mode = *current mode*?”
3. Press the [Y/+] key to accept the currently displayed operation (Op) mode. Press [N/-] to toggle to the other operation mode. Press [MODE] to exit this sub-menu and move to the next monitor setup sub-menu.
4. When changing Op mode from Hygiene to Survey, the display shows the additional message “Warning! Exit Hygiene?” to prevent accidental exit from Hygiene mode. Press the [Y/+] key to acknowledge.
5. If there is any change to the existing setting, the display will show “Save?” Press the [Y/+] key to accept or the [N/-] key to discard and move to the next sub-menu.

Note: If a new Op Mode is saved, the display shows “Op Mode changed!!” when exiting the programming mode.

4.7.2 Change Site ID

The user can enter an 8-digit alphanumeric site ID in the programming mode. This site ID will be included in the datalog report.

1. "Change Site ID?" is the second sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the [Y/+] key and the display shows the current site ID: "Site ID = xxxxxxx" with the left most digit flashing.
3. Press the [Y/+] or [N/-] key to cycle through all 26 letters and 10 numerals. Press [MODE] momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all 8 digits of the new site ID are entered.
4. Press and hold the [MODE] key for 1 second to exit the data entry mode.
5. If there is any change to the existing site ID, the display shows "Save?" Press the [Y/+] key to accept the new site ID. Press the [N/-] key to discard the change and move to the next sub-menu.

4.7.3 Change User ID

The user can enter an 8-digit alphanumeric user ID in the programming mode. This user ID will be included in the datalog report.

1. "Change User ID?" is the third sub-menu item the Monitor Setup menu.
2. Press the [Y/+] key and the display shows the current user ID: "User ID = xxxxxxxx" with the left most digit flashing.
3. Press the [Y/+] or [N/-] key to cycle through all 26 letters and 10 numerals. Press [MODE] momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until all 8 digits of the new user ID are entered.
4. Press and hold the [MODE] key for 1 second to exit the data entry mode.
5. If there is any change to the existing user ID, the display shows "Save?" Press the [Y/+] key to accept the new user ID. Or press the [N/-] key to discard the changes and move to the next sub-menu.

4.7.4 Change Alarm Mode?

There are two different alarm modes: **Latched** and **Automatic Reset** (Auto Reset) in the MiniRAE 2000 that can be selected from the programming menu.

1. “Change Alarm Mode?” is the fourth sub-menu item in the Monitor Setup menu.
2. Press the [Y/+] key; the display shows the current alarm mode.
3. Press the [Y/+] key to accept the currently displayed alarm mode. Press [N/-] key to toggle to the other alarm mode. Press [MODE] to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there is any change to the existing setting, the display will show “Save?” Press [Y/+] to save the change. Press [N/-] or [MODE] to discard the change and move to the next sub-menu.

4.7.5 Change User Mode

There are two different user modes: **Display** and **Program** that can be selected from the programming menu.

1. “Change User Mode?” is the fifth sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the [Y/+] key; the display shows the current user mode selected.
3. Press the [Y/+] key to accept the currently displayed user mode. Press [N/-] key to toggle to the alternate user modes. Press [MODE] to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there is any change to the existing selection, the display shows messages “Program change” and “Are you sure?” Press [Y/+] to confirm the change or press [N/-] or [MODE] to discard the changes and move to the next sub-menu.

CAUTION: If the user mode is changed to **Display** mode, the user can no longer enter the programming mode. Therefore, the user can not change the user mode back to **Program** mode in normal mode.

To restore the user mode back to **Program** mode, turn the unit off and back on in Diagnostic Mode. Next enter Program mode by holding the [MODE] and [N/-] keys for three seconds. Enter the password at the prompt (the default is 0000). Once program mode is entered, go to the “Change Monitor Setup” / “Change User Mode” and change the mode back to **Program**.

An alternative way to change Display mode back to Program mode is through the PC and the ProRAE-Suite software.

4.7.6 Change Date

The MiniRAE 2000 monitor is equipped with a real time clock (RTC). The user can enter the correct date and time (see 4.7.7) for the real time clock.

1. “Change Date?” is the sixth sub-menu item in the Monitor Setup menu.
2. Press [Y/+] and the display shows the current date “mm / dd / yy” with the left most digit of the date flashing.
5. To modify this value, use the [Y/+] or [N/-] key to change the digit value and press the [MODE] key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new date and time values are entered. Press and hold the [MODE] key for 1 second to exit data entry mode.
4. If there is any change to the existing value, the display shows “Save?” Press [Y/+] to confirm the new value or press [N/-] or [MODE] to discard the changes and move to the next sub-menu.

4.7.7 Change Time

To change the time in the RTC of the MiniRAE 2000:

1. "Change Time?" is the seventh sub-menu item in the Monitor Setup menu.
2. Press [Y/+] and the display shows the current time in the 24-hour format "hh : mm" with the left most digit of the time flashing.
3. To modify this value, use the [Y/+] or [N/-] key to change the digit value and press the [MODE] key momentarily to advance to the next digit. The flashing digit will move on to next digit to its right. Repeat this process until the new date and time values are entered. Press and hold the [MODE] key for 1 second to exit data entry mode.
4. If there is any change to the existing value, the display shows "Save?" Press [Y/+] to confirm the new value or press [N/-] or [MODE] to discard the changes and move to the next sub-menu.

4.7.8 Change Lamp

There are three UV lamps with different photon energies available for the PID sensor: **9.8 eV**, **10.6 eV** and **11.7 eV**. The user can select any one of the lamps from the programming mode.

1. “Change Lamp Type?” is the eighth sub-menu item in the Monitor Setup menu (Table 4.7).
2. Press the [Y/+] key; the display shows the current PID lamp selection.
3. Press the [Y/+] key to accept the currently displayed lamp. Press [N/-] key to scroll through the sub-menu for other lamp selections. Press [MODE] to exit this sub-menu and return to the next sub-menu in Table 4.7.
4. If there is any change to the existing selection, the display will show “Save?” Press [Y/+] to save the new selection or press [N/-] or [MODE] to discard the change and return to the next sub-menu in Table 4.7.

4.7.9 Change Unit

User can change the display and datalog unit from parts per million (ppm) to milli-gram per cubic meter (mg/m^3).

1. "Change Unit?" is the ninth sub-menu item in the Monitor Setup sub-menu.
2. Press the [Y/+] key, the display should show the current unit "Display Unit = ppm?" or "Display Unit = mg/m^3 ?"
3. Press [Y/+] key to accept the currently displayed unit. Press [N/-] key to toggle to the other unit. Press [MODE] key to exit this sub-menu.
4. If there is any change to the existing selection, press [Y/+] to confirm the new selection or press [N/-] or [MODE] to discard the changes and move to the next sub-menu.

Caution:

1. **The correction factor in the gas library is calculated based on "ppm" unit. If "mg" unit is selected, the built-in correction factor library is not valid.**
2. **No automatic conversion between "ppm" and " mg/m^3 " reading is performed by the monitor.**
3. **When the unit name is changed from "ppm" to "mg", the unit must be recalibrated with the span gas concentration entered in mg/m^3 . The converse rule applies when the unit is changed from "mg" to "ppm".**

4.7.10 Change Dilution Ratio

If a dilution system is used upstream of the MiniRAE 2000 inlet port, the user can enter the dilution ratio (from 1 to 10) to compensate the readings. The unit will then display the actual concentration of the gas before dilution. The dilution ratio should be 1 in normal operation where no dilution gas is applied to the sample gas. Dilution improves accuracy and linearity when the concentrations are above a few thousand ppm.

1. "Change Dilution Ratio?" is the tenth sub-menu item in the Monitor Setup menu.
2. Press the [Y/+] key; the display shows the current dilution ratio: "Dilution Ratio = xx" with the left most digit flashing.
3. Press the [Y/+] or [N/-] key to increase or decrease the value of the digit. Press [MODE] momentarily to advance to the next digit. The flashing digit will move to the next digit to the right. Repeat this process until both digits of the new dilution ratio are entered.
4. Press and hold the [MODE] key for 1 second to exit the data entry mode and move to the next sub-menu.
5. If there is any change to the existing dilution ratio, the display shows "Save?" Press [Y/+] to confirm the new value or press [N/-] or [MODE] to discard the changes and move to the next sub-menu.

4.7.11 Change Output?

There are two different external output options: DAC (Analog output) and Alarm in the MiniRAE 2000 that can be selected from the programming menu. The alarm output can be used to connect to the optional vibration alarm (vibrator) only. The analog output, which is proportional to the gas concentration, can be connected a chart recorder or can be queried by a computer to download data in real time (see Technical Note 141).

1. "Change External Output?" is the eleventh sub-menu item in the Monitor Setup menu.
2. Press the [Y/+] key and the display shows the current output option selection: "Output = DAC?"
3. Press the [Y/+] key to accept the currently displayed output option. Press [N/-] to change to the other external option: "Output = Alarm?" Press [MODE] to exit this sub-menu and move to the next monitor setup sub-menu.
4. If there is any change to the existing selection the display will show "Save?" Then, press [Y/+] to save the change, press [N/-] to go back to Step 2, or press [MODE] to exit this sub-menu and move to the next monitor setup sub-menu.

4.7.12 Change DAC Range?

There are four different DAC (Digital-to-Analog Conversion) range values available in the **MiniRAE 2000: 20, 200, 2000** and **10K ppm**. The maximum 2.5V DC analog signal output from the unit will represent the range value chosen. (See for analog signal output connection.)

1. “Change DAC Range?” is the twelfth sub-menu item in the Monitor Setup menu.
2. Press the [Y/+] key, the display shows the current DAC Range value: “DAC Range = 2000 ppm?”
3. Press the [Y/+] key to accept the currently displayed value. Press [N/-] to scroll through the sub-menu for other range values. Press [MODE] to exit this sub-menu and return to the first sub-menu in Table 4.7.
4. If there is any change to the existing selection, press the [Y/+] key and the display will show “Save?” Press the [Y/+] key to save the change or press the [N/-] key to discard and return to the first sub-menu in Table 4.7.

4.7.13 Set Temperature Unit?

The temperature display can be switched between Fahrenheit and Celsius units.

1. "Set Temperature Unit?" is the thirteenth sub-menu item in the Monitor Setup menu.
2. Press the [Y/+] key, and the display shows the current setting: "Temperature Unit = Fahrenheit?"
3. Press the [Y/+] key to accept the currently displayed value. Press [N/-] to select the sub-menu "Temperature Unit = Celsius?" Press [MODE] to exit this sub-menu and return to the first sub-menu in Table 4.7.
4. If there is any change to the existing selection, press the [Y/+] key and the display will show "Save?" Press the [Y/+] key to save the change and return to the first sub-menu in Table 4.7 or press the [N/-] key to discard and return to Step 3..

4.8 Exit Programming Mode

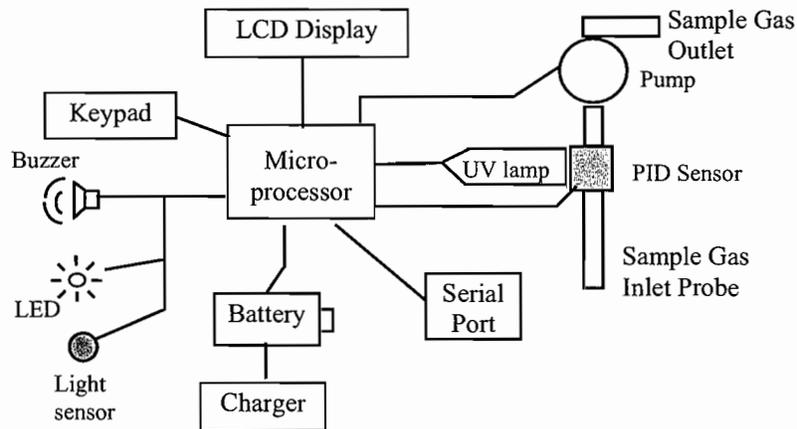
1. To exit programming mode from the first tier menu level, press the [MODE] key once.
2. To exit programming mode from 2nd tier sub-menu, press the [MODE] key twice.
3. To return to programming mode, press and hold down both the [MODE] and [N/-] keys for 3 seconds.

5. THEORY OF OPERATION

The MiniRAE 2000 monitor uses a newly developed electrodeless discharge UV lamp as the high-energy photon source for the PID. As organic vapors pass by the lamp, they are photo-ionized and the ejected electrons are detected as a current. The PID sensor with a standard 10.6 eV lamp detects a broad range of organic vapors. A lamp with high photon energy (e.g. 11.7 eV) will measure the more kinds of compounds, whereas low photon energies (e.g. 9.8 eV) are selective for easily ionizable compounds such as aromatics. In principle, any compound with an ionization energy lower than that of the lamp photons can be measured.

The PID sensor for the MiniRAE 2000 monitor is constructed as a small cavity in front of the UV lamp. A diaphragm pump draws the gas sample into the sensor and then pumps it out through the side of the instrument.

Figure 5-1 MiniRAE 2000 Block Diagram



THEORY OF OPERATION

A single chip microcomputer is used to control the operation of the alarm buzzer, LED, pump and light sensor. It measures the sensor readings and calculates the gas concentrations based on calibration to known standard gases. The data are stored in non-volatile memory so that they can be sent to a PC for record keeping. RS-232 transceivers provide a serial interface between the monitor and the serial port of a PC. An LCD display consisting of a single row of eight alpha/numeric characters is used to display the readings. The user interacts with the monitor through three keys on the front panel keypad.

A rechargeable NiMH, NiCd battery, or an alkaline battery pack powers the monitor.

6. MAINTENANCE

The major maintenance items of the MiniRAE 2000 are:

- Battery pack
- Sensor module
- PID lamp
- Sampling pump
- Inlet connectors and filters

Note: Maintenance should be performed by qualified personnel only.

NOTE: The printed circuit board of the monitor is connected to the battery pack even if the power is turned off. Therefore, it is very important to disconnect the battery pack before servicing or replacing any components inside the monitor. Severe damage to the printed circuit board or battery may occur if the battery pack is not disconnected before servicing the unit.

6.1 Battery Charging and Replacement

When the display shows a flashing message “Bat”, the battery requires recharging (see Section 3.1 for Battery charging). It is recommended to recharge the MiniRAE 2000 monitor upon returning from fieldwork. A fully charged battery runs a MiniRAE 2000 monitor for 10 hours continuously. The charging time is less than 10 hours for a fully discharged battery. The built-in charging circuit is controlled by the micro-controller to prevent over-charging. The battery may be replaced in the field (in area known to be non-hazardous) if required.

WARNING

To reduce the risk of ignition of hazardous atmospheres, recharge battery only in area known to be non-hazardous. Remove and replace battery only in area known to be non-hazardous.

Replacing Battery Pack

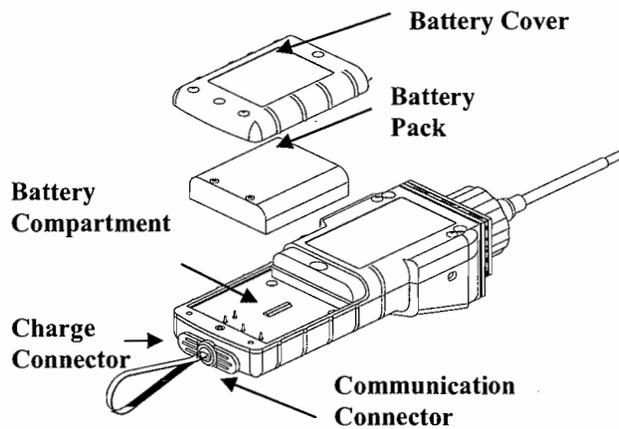


Figure 6-1 Battery Replacement

1.

MAINTENANCE

Turn off the power of the MiniRAE 2000.

2. Unscrew the two battery compartment screws, located on the bottom of the monitor, and remove the cover.
3. Remove the battery pack from the battery compartment.
4. Replace a fully charged spare battery pack inside the battery compartment. Make sure the battery pack is oriented properly inside the compartment
5. Close the battery cover and tighten the two screws.

Replacing Alkaline Battery Adapter

1. Insert four fresh AA size alkaline batteries into the alkaline battery holder. Make sure that the polarity of the batteries is correct.
2. Follow the same procedure as described above to replace the battery holder.

Note: The internal charging circuit is designed to prevent charging to alkaline batteries.

6.2 PID Sensor & Lamp Cleaning/Replacement

The sensor module is made of several components and is attached to the lamp-housing unit as shown in Figure 7-2.

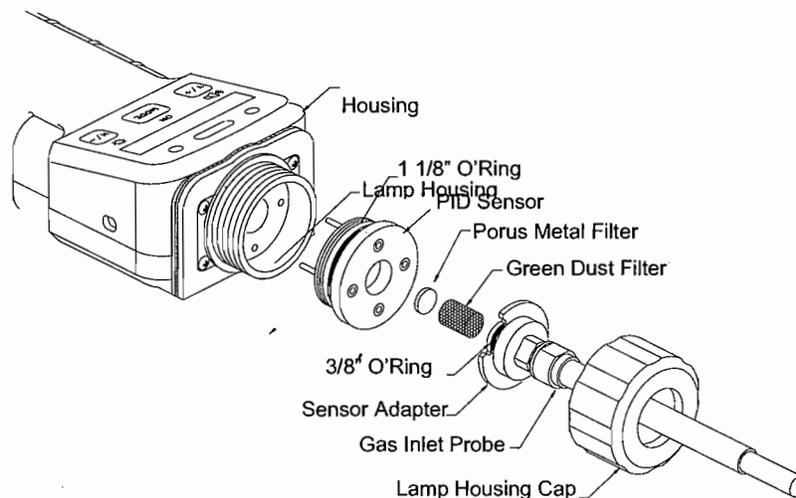


Figure 7-2 Sensor Components

Note: Normally the cleaning procedure is not needed. Clean the PID sensor module, the lamp and the lamp housing only when one of the following happened:

1. The reading is inaccurate even after calibration.
2. The reading is very sensitive to air moisture.
3. A chemical liquid has been sucked into the unit and damaged the unit.

Use of the water trap filter will help prevent contamination and accidentally drawing liquid into the sensor.

MAINTENANCE

To access the sensor components and lamp, gently unscrew the lamp-housing cap, remove the sensor adapter with the gas inlet probe and the metal filter all together. Then hold the PID sensor and pull straight out to avoid bending the electrical pins on the sensor (see Figure 7-2). A slight, gentle rocking motion helps release the sensor.

To clean the PID sensor:

Place the entire PID sensor module into GC grade methanol. It is highly recommended that an ultrasound bath to be used to clean the sensor for at least 15 minutes. Then dry the sensor thoroughly. Never touch the electrodes of the sensor by hand.

Also use a methanol-soaked cotton swab to wipe off the lamp housing where it contacts the sensor when the sensor is installed.

Turn over the sensor so that the pins point up and the sensor cavity is visible. Examine the sensor electrodes for any corrosion, damage, or bending out of alignment. The metal sensor electrode “fingers” should be flat and straight. If necessary, carefully bend the sensor fingers to ensure that they do not touch the Teflon portions and that they are parallel to each other. Make sure that the nuts on the sensor pins are snug but not overtight. If the sensor is corroded or otherwise damaged, it should be replaced.

MAINTENANCE

To clean lamp housing or change the lamp:

To clean lamp housing or change the lamp:

If the lamp does not turn on, the monitor will display an error message to indicate replacement of the lamp may be required.

1. If the lamp is operational, clean the lamp window surface and the lamp housing by wiping it with GC grade methanol using a cotton swab using moderate pressure. After cleaning, hold the lamp up to the light at an angle to detect any remaining film. Repeat the process until the lamp window is clean. Never use water solutions to clean the lamp. Dry the lamp and the lamp housing thoroughly after cleaning.

CAUTION: Never touch the window surface with the fingers or anything else that may leave a film. Never use acetone or aqueous solutions.

2. If the lamp does not turn on, remove the lamp from the lamp housing. Place the lamp O-ring onto the new lamp. Insert the new lamp, avoiding contact with the flat window surface.
3. Reinstall the PID sensor module.
4. Tighten the Lamp Housing Cap.
5. If the lamp type has been changed, adjust the lamp type setting in the programming mode (Section 4.7.8).

6.3 Sampling Pump

When approaching the end of the specified lifetime of the pump, it will consume higher amount of energy and reduce its sample draw capability significantly. When this occurs, it is necessary to replace or rebuild the pump. When checking the pump flow, make sure that the inlet connector is tight and the inlet tubing is in good condition. Connect a flow meter to the gas inlet probe. The flow rate should be above 450 cc/min when there is no air leakage.

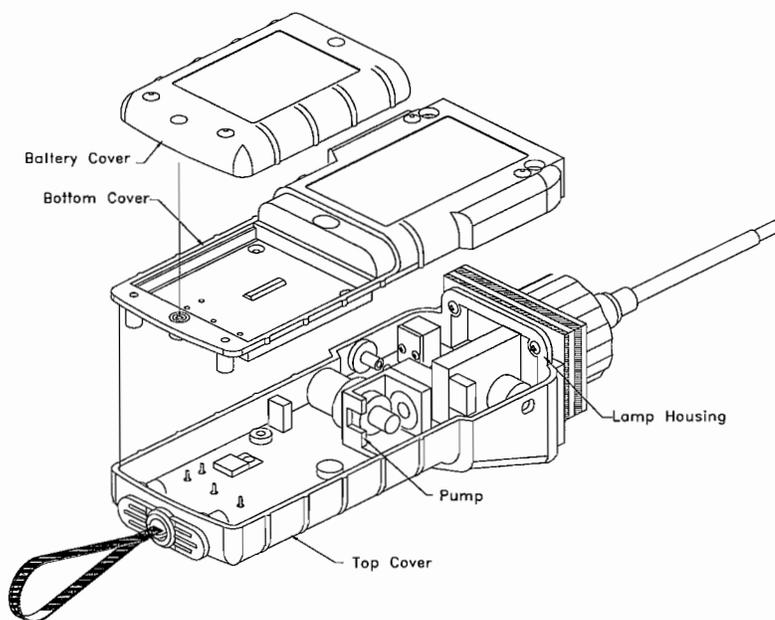


Figure 7-3 Sampling Pump

Pump Replacement

1. Turn off the MiniRAE 2000 power.
2. Open the battery cover, remove the battery pack, and carefully unscrew the six screws to open the bottom cover.
3. Unplug the pump from the PCB. Unscrew the two screws that hold the pump assembly to the PCB. Disconnect the Tygon tubing that connects the pump to the gas inlet port and gas outlet port.
4. Insert a new pump assembly. Connect the Tygon tubing to the gas inlet port. Plug the pump connector back into the PCB and screw down the pump assembly to the board.
5. Replace the bottom cover and tighten the six screws. Reconnect the battery pack. Replace the battery pack and its cover.

6.4 Turning on the UV Lamp

The UV lamp is made of a glass envelope and a UV window (salt crystal) on one end of the envelope. The inside of the lamp is filled with low pressure gases. To turn on the lamp, a high voltage electric field is applied from the outside of the glass envelope. The molecules inside the lamp are ionized and produce a glow discharge that generates the UV light. The MiniRAE 2000 has a built-in sensing mechanism to monitor the status of the UV lamp and display a “Lamp” error message if it is not on.

If the UV lamp has not been used for a long period of time (> 1 month) or is cold, it may become slightly harder to turn on. If such a condition occurs, the “Lamp” message will appear in the monitor display during the power on sequence. This phenomenon is more significant in 0.25” UV lamps used in ToxiRAE and MultiRAE Plus products, because of the relatively small lamp size. To solve this problem, simply turn on and off the monitor a few times and the lamp should turn on. After the UV lamp is turned on for the first time, it should be easier to turn on the UV lamp next time.

It is possible that the UV lamp is actually on when the lamp error message appears. This is because when the lamp becomes old, the internal threshold level to detect lamp failure may have shifted and cause a false alarm. To eliminate such possibility, simply check to see the UV lamp is actually on. This can be done easily by removing the sensor cap and observing the glow light of the UV lamp in a dark place. The user can also feed the monitor with calibration gas and observe if the sensor reading changes. If the reading changes significantly with the gas, the UV lamp is actually on.

A possible failure mechanism for the UV lamp is a leak developed along the seal of the glass envelope. When such condition occurs, the lamp will become very hard or impossible to turn on and will need to be replaced.

7. TROUBLESHOOTING

To aid the user in diagnosing the monitor, a special diagnostic mode can be used displays critical, low level parameters. Section 7.1 describes the operation of the diagnostic mode. Section 7.2 summarizes the frequently encountered problems and suggested solutions. By turning on the MiniRAE 2000 monitor in diagnostic mode and by using the troubleshooting table in Section 7.2, the user can usually correct the problem without having to return the monitor for repair.

WARNING

This function should be used by qualified personnel only! The diagnostic mode allows the user to set several low-level parameters that are very critical to the operation of the monitor. Extra care should be taken when setting these parameters. If the user is not familiar with the function of these parameters and sets them incorrectly, it may cause the monitor to shut down or malfunction.

TROUBLESHOOTING

7.1 Troubleshooting Table

Problem	Possible Reasons & Solutions
Cannot turn on power after charging the battery	<p>Reasons: Discharged battery. Defective battery. Microcomputer hang-up.</p> <p>Solutions: Charge or replace battery. Disconnect, then connect battery to reset computer.</p>
No LCD back light	<p>Reasons: Trigger level too low, the current mode is not user mode, and the mode does not support automatic turn on back light.</p> <p>Solutions: Adjust trigger level. Verify the back light can be turned on in user mode. Call authorized service center.</p>
Lost password	<p>Solutions: Call Technical Support at +1.408 .752 .0723 or +1. 888 .723 .4800</p>
Reading abnormally High	<p>Reasons: Dirty sensor module. Dirty water trap filter. Excessive moisture and water condensation.</p> <p>Solutions: Clean sensor module and lamp housing. Replace water trap filter. Blow dry the sensor module.</p>
Buzzer Inoperative	<p>Reasons: Bad buzzer.</p> <p>Solutions: Call authorized service center.</p>

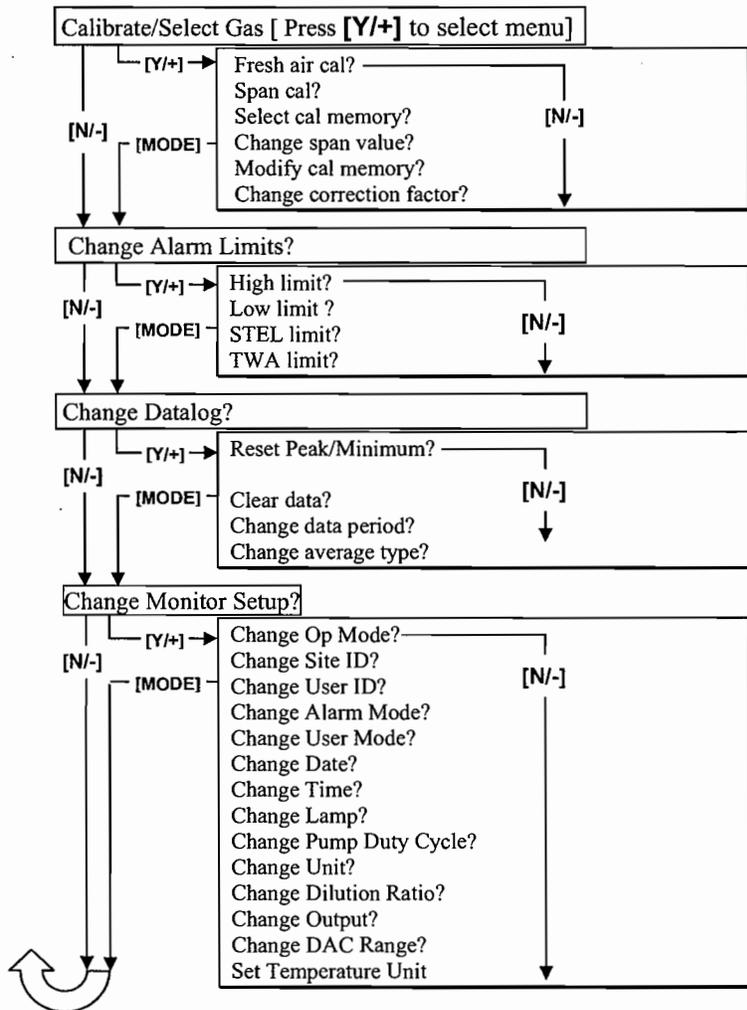
TROUBLESHOOTING

Inlet flow too low	<p>Reasons: Pump diaphragm damaged or has debris. Flow path leaks.</p> <p>Solutions: Check flow path for leaks; sensor module O-ring, tube connectors, Teflon tube compression fitting. Replace pump or diaphragm.</p>
"Lamp" message during operation	<p>Reasons: Lamp drive circuit. Weak or defective PID lamp, defective.</p> <p>Solutions: Turn the unit off and back on Replace UV lamp</p>
Full scale measurement in humid environment	<p>Reasons: Dirty or wet sensor.</p> <p>Solutions: Clean and dry sensor and lamp housing. Adjust sensor fingers to ensure not touching Teflon. Use water trap filter.</p>
Reading abnormally low	<p>Reasons: Incorrect calibration. Low sensitivity to the specific gas. Weak or dirty lamp. Air leakage.</p> <p>Solutions: Calibrate the monitor. Replace sensor. Clean or replace lamp. Check air leakage.</p>

APPENDIX A. QUICK REFERENCE GUIDE

Press [N/-] and [MODE], simultaneously, for 3 seconds, to enter Programming Mode. Press [MODE] to return to Survey Mode.

PROGRAMMING MODE



RAE Systems, Inc. Contact Information

Main Office: 3775 N. First St.
San Jose, CA 95134-1708
USA

Telephone: 408-952-8200

Fax: 408-952-8480

Instrument Sales: 877-723-2878

Email: RaeSales@raesystems.com

Website: www.raesystems.com

Technical Service: 888-723-4800

Tech@raesystems.com

Special Note

If the monitor needs to be serviced, contact either:

1. The RAE Systems distributor from whom the monitor was purchased; they will return the monitor on your behalf.
2. The RAE Systems Technical Service Department. Before returning the monitor for service or repair, obtain a Returned Material Authorization (RMA) number for proper tracking of your equipment. This number needs to be on all documentation and posted on the outside of the box in which the monitor is returned for service or upgrade. Packages without RMA Numbers will be refused at the factory.

Decontamination of Personnel and Equipment

Purpose and Scope

This SOP provides general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments. This is a general description of decontamination procedures for personnel and equipment used for environmental sampling purposes. This SOP does not cover the decontamination of drill rigs or other large equipment. That topic is discussed in the SOP for Decontamination of Drill Rigs and Equipment.

Equipment and Materials

- Distilled, organic-free water
- Clean plastic sheet
- Phosphate-free detergent such as Liquinox® or Alconox®
- Clean DOT-approved 55-gallon steel drum and label
- Five-gallon buckets
- Brushes
- Garden spray bottles for equipment wash and rinse
- Paper towels or drying cloths
- Clean latex or nitrile gloves
- Decontamination pad lined with plastic to catch wash and rinse water

Decontamination of Personnel

Decontamination of field personnel shall be performed after the completion of tasks with the potential of contamination and before leaving the exclusion zone. Personnel working in Level D personal protective equipment (PPE) must properly dispose of sampling gloves. Hands and other skin exposure points to contamination shall be washed in a detergent solution and rinsed. Boots or clothing that become grossly contaminated shall also be washed in a detergent solution. In the event that Modified Level D PPE is required, the following decontamination procedures shall be performed:

- Wash boots in detergent solution, then rinse with water. If disposable latex booties are worn over boots in the work area, rinse with detergent solution, remove, and discard into a drum.
- Wash outer gloves in detergent solution, rinse, remove, and discard into the drum.
- Remove disposable coveralls (e.g. Tyvek suits) and discard into the drum.
- Remove inner gloves and discard.
- At the end of the work day, shower the entire body, including hair.

Decontamination of Sample Equipment

This section includes the decontamination of sample equipment (e.g., stainless steel soil sampling tools, water level meter, and groundwater quality equipment).

- Spread plastic on the ground surface to keep clean sample equipment from touching the ground surface.
- Equipment may be decontaminated in 5-gallon buckets.
- Thoroughly scrub the sample equipment in a detergent wash solution. Do not immerse nonwaterproof electronic equipment in the wash solution as this may damage electronic components. These types of equipment should be wiped down with a soapy paper towel. Avoid damaging any sensors on water quality meters while washing these units.
- Provide a second and third rinse of the sample equipment to remove all detergent from the equipment. Care must be taken to ensure that no detergent is left on sample equipment, particularly equipment placed in monitoring well risers, as this may affect future sampling.
- For groundwater pumps, submerge the pump in the decontamination liquids as to allow the detergent solution and rinse water to pass through interior components of the pump.
- Allow the equipment to air dry in a clean, non-dusty, environment.
- Wash and rinse decontamination buckets at the end of the field work.
- Decontamination water will be containerized in a polyethylene storage tank and emptied at the oil-water separator located at the south portion of the active terminal facility. The volume emptied into the separator will be recorded in the field book.

Key Checks

- Make sure equipment is thoroughly cleaned and rinsed prior to use at another sample location or site.
- Properly store equipment as to maintain cleanliness when not in use.
- Refill decontamination buckets with clean water and detergent solution at the start of each day.

Attachments

None.

Standard Operating Procedure for the Collection of Soil Gas Samples from Soil Gas Probes (GeoProbe System - PRT) using SUMMA Canisters and a Helium Leak Check

1. Scope and Application

This procedure offers a practical approach for the collection of soil gas samples from GeoProbe Systems (or equal) direct push soil gas probes with post-run tubing (PRT) adapters into SUMMA canisters. Soil gas sample integrity is verified by using a real time helium leak checking procedure. This standard operating procedure (SOP) should be used in conjunction with CH2M HILL's SOP: "Standard Operating Procedure for the Installation of Shallow Soil Gas Sampling Probes," and when its application is consistent with the project's data quality objectives. It is the responsibility of the project team to make sure this procedure meets all applicable regulatory standards and receives approval/concurrence from the leading regulatory agency for the project. Only persons trained in the collection of soil gas samples should attempt this procedure.

2. Site-Specific Considerations

2.1. Prior to attempting soil gas sampling there should be an understanding of subsurface conditions at the site.

2.1.1. Depth to Groundwater - soil gas samples should be collected in the vadose zone (and above the capillary fringe). Generally, soil gas samples should not be collected at a depth above 5 feet below ground surface (bgs).

2.1.2. Soil permeability - It may not be feasible to collect soil gas from soils with little pore volume, such as clays; if there are clay layers present in the subsurface, these intervals should be avoided.

3. Other Considerations

3.1. A utility clearance should be performed prior to mobilization, as with all intrusive site work.

3.2. Soil gas sampling should not be performed until 48 hours after a significant rain event (>1 inch of rainfall).

4. Apparatus and Materials

4.1. The GeoProbe and direct push soil gas probes should be obtained from and operated by a licensed driller.

4.2. Teflon tubing, 1/4-inch outer diameter, for post-run sample tubing.

4.3. Swagelok® 1/4-inch nut and ferrule sets for connecting the probe tubing to the sampling manifold.

4.4. The helium leak check equipment, including the enclosure, helium canister, and helium detector. The enclosure may be provided by the driller or can be constructed from polyvinyl chloride (PVC) pipe. The helium detector can be rented from an equipment rental company.

4.5. MultiRae five gas meter. (Optional if onsite atmospheric gas analysis is required)

4.6. Air pump for purging and electric supply for the pump (either generator or power inverter with adapter for car battery).

4.7. Sampling manifold consisting of Swagelok® gas tight fittings with three valves and one pressure gauge to attach the probe to the air pump and the sample canister. This manifold must be clean, free of oils, and flushed free of volatile organic compounds (VOCs) prior to use.

- 4.8. Canister, SUMMA polished, certified clean and evacuated. (Canisters are typically provided by the laboratory.)
- 4.9. Flow controller or critical orifice, certified clean and set at desired sampling rate. These are typically provided and set by the laboratory.
- 4.10. Negative pressure gauge, oil-free and clean, to check canister pressure. The pressure gauges are typically provided by the laboratory. The laboratory may either provide one pressure gauge to be used with all of the canisters, or a pressure gauge for each canister to be left on during sample collection. Sometimes the canisters are fitted with built-in pressure gauges that are not removable.
- 4.11. Shipping container, suitable for protection of canister during shipping. Typically, strong cardboard boxes are used for canister shipment. The canisters should be shipped back to the laboratory in the same shipping container in which they were received.
- 4.12. Wrenches and screw driver (clean and free of contaminants), various sizes as needed for connecting fittings and making adjustment to the flow controller. A 9/16-inch wrench fits the 1/4-inch Swagelok® fittings, which most canisters and flow controllers have.

5. System Set-up

- 5.1. Acquire all the necessary hardware and sampling equipment shown in Figure 1. Be sure to use 1/4-inch outside diameter Teflon sample tubing. **Do not connect the canister at this time.**
- 5.2. Assemble or obtain the necessary fittings and vacuum gauge to create a soil gas probe and sampling manifold as shown in Figure 1. This manifold must be clean, free of oils, and flushed free of VOCs prior to use. Note: use only gas tight fittings such as Swagelok® or equivalent. Be sure to place the helium leak check enclosure over the probe, and push the sample tubing through the hole in the cap before attaching the sampling manifold.
- 5.3. Adjust the purge system evacuation pump sampling rate to achieve the desired flow rate of 200 milliliters/min. This should be performed at the outlet of the vacuum pump prior to purging, either by using a suitable flow meter, or determining the amount of time required to fill a 1-liter Tedlar bag.
- 5.4. Summa canisters are pre-evacuated by the laboratory. The vacuum will need to be verified in the field prior to use with a pressure gauge.
- 5.5. Flow controllers (if used) should come pre-set by the laboratory to sample at a pre-determined rate based on specific project requirements (see Table 1 for the most common options). In some cases [that is, project-specific quality assurance (QA)], the flow rate will need to be verified in the field prior to use. This is accomplished with a bubble meter, vacuum source, and instructions supplied by the laboratory.

6. System Leak Checking and Purging

- 6.1. **Physical Leak Check** - Perform a leak check of the sample manifold system by:
 - 6.1.1. Make sure the gas probe valve (valve #1) is closed and the sample valve (valve #2) is open.
 - 6.1.2. Open the purge valve (valve #3) and start the purge pump. Verify that the flow is set to 200 milliliters per minute (ml/min).
 - 6.1.3. Close the sample valve (valve #2) and achieve a vacuum gauge reading of 10 inches of mercury (Hg) or to a vacuum that will be encountered during sampling, whichever is greater.
 - 6.1.4. A leak-free system will be evident by closing off the purge valve (valve #3), turning off the purge pump, and observing no loss of vacuum within the sampling manifold system for a period of 30 seconds. Repair any leaks prior to use.
 - 6.1.5. Record the leak check date and time on the field sampling log.

- 6.2. System Purge and Helium Leak Check** -A purge of the soil gas probe and sampling manifold system is required. The helium leak check procedure is also performed during this step. This leak check will verify the integrity of the PRT adapter seal as well as the probe and ground interface. This is accomplished by:
- 6.2.1.** Where the ground surface is soft, the helium leak check enclosure is pressed down slightly into the ground surface. In situations where the ground surface is hard (for example, asphalt), apply a slight downward pressure to achieve a buildup of helium in the leak check enclosure.
 - 6.2.2.** Start the flow of helium under the leak check enclosure at 200 ml/min. Try and position the tube so the helium is directed at the interface of the probe and the ground. Let the helium fill the enclosure for a couple of minutes.
 - 6.2.3.** Turn the helium leak detector on and make sure that the detector is not giving a helium reading before starting the purge. Place the probe of the helium detector in the exhaust port of the flow meter.
 - 6.2.4.** Purging is carried out by pulling soil gas through the system at a rate of 200 ml /min for a time period sufficient to achieve a purge volume that equals at least 3-5 dead volumes (internal volume of the in-ground annular space, sample line, and sampling manifold system). When calculating the dead volume, be sure to take into account the inside diameter and length of the Teflon sample tubing, as well as the probe outside diameter and retract distance for the annular space.
 - 6.2.5.** Open the sample valve (valve #2) and the purge valve (valve #3) and start the purge pump. Verify that the flow rate is still 200 ml/min.
 - 6.2.6.** To start the soil gas probe purge, open the gas probe valve (valve #1) and close the sample valve (valve #2) at the same time, and start timing.
 - 6.2.7.** During the purge, observe the helium detector for indication of soil gas probe leakage (for example, infiltration of ambient air into the probe). If a helium reading of >1% (verify that this limit is consistent with appropriate project-specific agency guidance) is observed, then the probe leak check has failed and corrective action should be taken. This includes first checking the fittings and connections and trying another purge and leak check. It may also be necessary to remove the soil gas probe and re-install it in a nearby location.
 - 6.2.8.** If the vacuum gauge reads >15 inches during the purge, then close the purge valve (valve #3) and monitor the vacuum in the manifold and probe. If there is no significant change after a minute, then there is an insignificant amount of soil gas and the vacuum is too great to take a soil gas sample. Several things can cause this. Consult with the project manager and take corrective action.
 - 6.2.8.1.** The soil formation is too 'tight' (that is, high clay or moisture content). Try a different depth or location.
 - 6.2.8.2.** With a GeoProbe style probe system, the expendable tip may not have released when the probe was retracted. Try retracting the probe a little further, or use a long thin rod to poke the tip loose.
 - 6.2.8.3.** If water is visible in the flexible soil gas tubing, stop the purging immediately. It is not possible to take a soil gas sample at that depth or location.
 - 6.2.9.** At the end of the pre-determined purge time (usually around a couple of minutes) and after the system is verified to be leak free, close the purge valve (valve #3). Do not open it again. Doing so will result in loss of the purge integrity and will require re-purging. Turn off the helium leak detector.

6.2.10. Record the purge date, time, purge rate, leak check result, and purge volume on the field sampling log.

6.2.11. Immediately move on to the sampling phase. Little to no delay should occur between purging and sampling.

7. Sample Collection

7.1. 'Clean' sampling protocols must be followed when handling and collecting samples. This requires care in the shipping, storage, and use of sampling equipment. Cleanliness of personnel who come in contact with the sampling equipment is also important: no smoking, no eating, no drinking, no perfumes, no deodorants, no dry cleaned clothing, etc. Canisters should not be transported in vehicles with gas-powered equipment or gasoline cans. Sharpie markers should not be used for labeling or note-taking during sampling.

7.2. The SUMMA canisters are certified clean and evacuated by the laboratory to near absolute zero pressure. Care should be used at all times to prevent inadvertent loss of canister vacuum. *Never open the canister's valve unless the intent is to collect a sample or check the canister pressure.*

7.3. Verify that the vacuum pressure of the canister is between 28 - 30 inches Hg. Do not use a canister that has an initial pressure less than 28 inches Hg because that canister likely leaked during shipment.

7.3.1. Remove the protective cap from the valve on the canister.

7.3.2. If using an external gauge, attach the gauge to the canister and open the valve. If the pressure gauge has two openings, make sure that the other opening is closed; the canister cap can be used for this. After taking the reading, close the canister and remove the gauge.

7.3.3. If using assigned pressure gauges, attach the pressure gauge to the canister, then attach the flow controller. When sample collection begins, record the initial pressure.

7.4. Attach the canister to the flow controller and then connect the flow controller to the sample valve (valve #2) on the sampling manifold. Open the sample valve (valve #2)

7.5. Before taking the sample, confirm that the sampling system valves are set as follows: 1) the purge valve (valve #3) is confirmed to be closed, gas probe valve (valve #1) is open, and 2) the sample valve (valve #2) is open.

7.6. Slowly open the canister's valve approximately one full turn.

7.7. After sampling for the appropriate amount of time (determined from project instructions, see Table 1), close the sample valve (valve #2) and the canister's valve. If the canister has a built-in or assigned pressure gauge, allow the canister to fill until the vacuum pressure reaches 0 - 10 inches Hg. Remove the canister from the sampling manifold.

7.8. If using an external vacuum gauge, re-attach it, open the canister valve, and record the final pressure. Close the valve, remove the gauge, and replace and tighten the cap on the canister. Ideal pressure in the canister is between 0-10 inches Hg. More than 10 inches Hg can greatly increase reporting limits. Consult with the project team if this condition is encountered.

7.9. Record the sampling date, time, canister identification (ID), flow controller ID, and any other observation pertinent to the sampling event on the field sampling log. The indoor and outdoor temperature and barometric pressure should be recorded.

7.10. Fill out all appropriate documentation (sampling forms, sample labels, chain of custody, sample tags, etc.).

7.11. Disassemble the sampling system.

8. Sample Handling and Shipping

- 8.1. Fill out all appropriate documentation (chain of custody, sample tags) and return canisters and equipment to the laboratory
- 8.2. The canisters should be shipped back to the laboratory in the same shipping container in which they were received. The samples do not need to be cooled during shipment. **DO NOT** put ice in the shipping container.
- 8.3. When packing the canisters for shipment, verify that the valve (just past finger tight) and valve caps are snug (1/4 turn past finger tight), and use sufficient clean packing to prevent the valves from rubbing against any hard surfaces. Never pack the cans with other objects or materials that could cause them to be punctured or damaged.
- 8.4. **Do not place sticky labels or tape on any surface of the canister!**
- 8.5. Place a custody seal over the openings to the shipping container.
- 8.6. Make sure to insure the package for the value of the sample containers and flow controllers.
- 8.7. Ship canisters for overnight delivery.

9. Quality Control

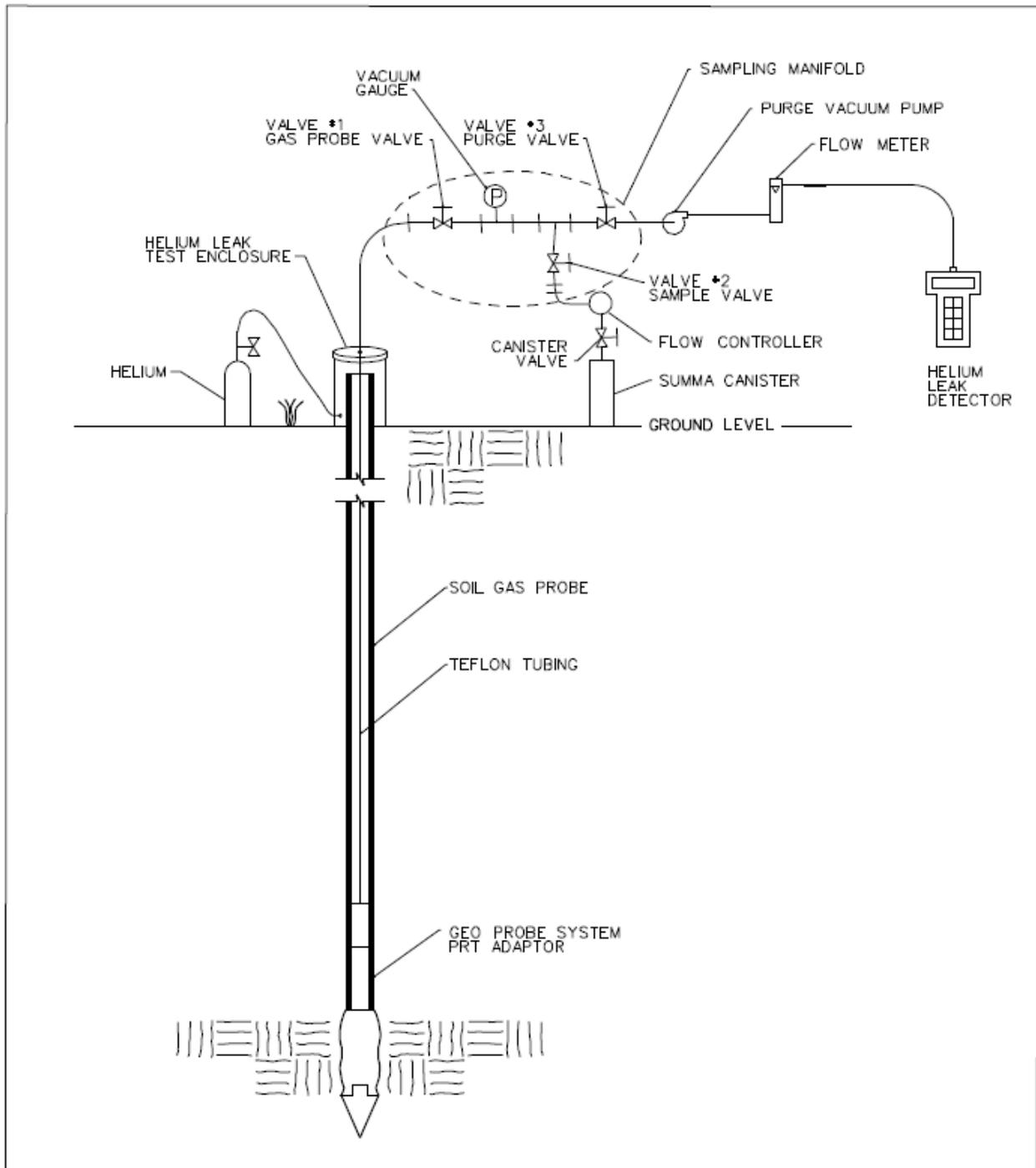
- 9.1. Canister supplied by the laboratory must follow the performance criteria and quality assurance prescribed in U.S. Environmental Protection Agency (EPA) Method TO-14/15 for canister cleaning, certification of cleanliness, and leak checking. SOPs are required.
- 9.2. Flow controllers supplied by the laboratory must follow the performance criteria and QA prescribed in EPA Method TO-14/15 for flow controller cleaning and adjustment. SOPs are required.

Table 1 - Common Sampling Rates for Soil Gas Sampling

Can Size	Length of sampling time	Sampling Flow Rate (ml/min)
6 Liter	1 hour	90
6 Liter	8 hours	11.25
6 Liter	24 hours	3.75
1 Liter	5 minutes	180
1 Liter	1 hour	15
850 ml	5 minutes	150
850 ml	1 hour	12

Figure 1

Soil Gas Sampling System



**Indoor Vapor Intrusion Assessment
Soil Gas Sampling Field Log**

Project Info	
Project Name:	Project #:
By:	Date:

Structure
Identification:
Address:
Sample Location type:
<input type="checkbox"/> concrete slab on grade <input type="checkbox"/> Yard or Driveway
<input type="checkbox"/> concrete footing w/crawl space <input type="checkbox"/> other (describe)
<input type="checkbox"/> basement

Soil Gas Sampling System
Probe type (describe):
.....
Probe to sample interface system (describe):
.....
Sample collection type: <input type="checkbox"/> Syringe <input type="checkbox"/> Tedlar bag <input type="checkbox"/> Summa canister
Other info (describe other aspects)
.....

Soil Gas Probe Purging & Sampling Log		1	2	3	4
Sample location (show in diagram)					
Sample Identification (field ID)					
Time Installed					
Depth of installed probe (feet bgs)					
Leak check, vacuum (probe/sampling interface)					
Calculated dead volume (1 purge volume), cc					
Calculated purge volume (3 purge volume), cc					
Purge rate, cc/min.					
Purge duration, min.					
Purge started (time of day)					
Purge vacuum, " Hg					
Max Helium Leak Check Reading					
Purge completed (time of day)					
Sampling period started (time of day)					
Sampling rate, cc/min					
Sampling vacuum, " Hg					
Sampling period ended (time of day)					

Observations and Comments:

.....

.....

**Indoor Vapor Intrusion Assessment
Soil Gas Sampling Field Log**

Project Info

Project Name: Project #:
 By: Date:

Structure

Identification:
 Address:
 Sample Location type:
 concrete slab on grade Yard or Driveway
 concrete footing w/crawl space other (describe)
 basement

Soil Gas Sampling System

Probe type (describe):
 Probe to sample interface system (describe):
 Sample collection type: Syringe Tedlar bag Summa canister
 Other info (describe other aspects)

Soil Gas Probe Purging & Sampling Log

Sample location (show in diagram)	1	2	3	4
Sample Identification (field ID)				
Time Installed				
Depth of installed probe (feet bgs)				
Leak check, vacuum (probe/sampling interface)				
Calculated dead volume (1 purge volume), cc				
Calculated purge volume (3 purge volume), cc				
Purge rate, cc/min.				
Purge duration, min.				
Purge started (time of day)				
Purge vacuum, " Hg				
Max Helium Leak Check Reading				
Purge completed (time of day)				
Sampling period started (time of day)				
Sampling rate, cc/min				
Sampling vacuum, " Hg				
Sampling period ended (time of day)				

Observations and Comments:

1 STANDARD OPERATING PROCEDURE

2 Long-Term Measurement of Subslab/Indoor Air 3 Pressures for Vapor Intrusion Investigations

4 SOP No. : PRESSDIFF1

5 REVISION: 0.9 (QA REVIEW REQUIRED)

6 DATE: JUNE 2008

7 PAGES: 12

8 1. Background

9 Vapor intrusion is often driven by advective transport of air from soil to indoor air. The
10 movement of vapors located near a building foundation is often affected within an area
11 referred to as the “zone of influence” (a zone approximately within one meter within a
12 foundation). Chemicals in soil gas entering this zone are drawn into the building via
13 advection and convection resulting from building interiors that exhibit a negative pressure
14 relative to the outdoors and the surrounding soil.

15 According to regulatory guidance, this pressure differential can occur from one or more
16 factors:

- 17 • Operation of HVAC system including inadequate makeup air and unbalanced air
18 supply and exhaust systems;
- 19 • The use of fireplaces and other combustion sources, which results in venting of exhaust
20 gases to the exterior;
- 21 • Exhaust fans in bathrooms and kitchens that may not be adequately balanced
- 22 • Higher temperatures indoors relative to outdoors during the heating season or as a
23 result of solar radiation on rooftops (stack effect); and
- 24 • Pressure exerted on the wall of a building caused by wind movement over the building
25 (Bernoulli’s principle).

26 The combination of these actions/conditions results in a net convective flow of soil gas from
27 the subsurface through the building foundation to the building interior. Measurements can
28 be made to evaluate the potential for convective flow of soil gas, and hence evaluate the
29 potential for vapor intrusion into a building.

30 2. Purpose and Objectives

31 This Standard Operating Procedure (SOP) identifies procedures to provide data for
32 understanding pressures differences between building interior and beneath the building
33 slab (i.e. subslab). This SOP does not include procedures for building observation; these are
34 covered in the Building Survey SOP.

3. Materials

- 3.1. Install subslab probes in accordance with CH2M HILL's SOP *Standard Operating Procedure for the Installation of Sub-Slab Probes and the Collection of Vapor Samples Using Summa® Canisters*
- 3.2. Omniguard 4 differential pressure monitor with data logger (<http://www.engsolinc.com/docs/og/OG4broch.pdf>).
- 3.3. Barometric data logger (Solinst <http://www.solinst.com/Downloads/3001/3001Manual/Introduction/Barologger.html>)
- 3.4. Hand-held digital micromanometer (TEC DG500 or equivalent <http://www.energyconservatory.com/download/dg500brochure.pdf>) and Tygon tubing (optional)
- 3.5. Tools and hardware needed to connect instruments to gas-tight Swagelok fittings.

4. Field Procedures

- 4.1. Differential pressure data logging (using the Omniguard 4 instrument) is performed at one or more locations within the building (typically a single location).
- 4.2. An existing subslab probe can be used for these measurements; if needed, install and leak-test a subslab probe using the subslab probe installation SOP.
- 4.3. Set up the pressure monitor in accordance with the manufacturer's instructions. Set the positive and negative pressures triggering the alarms to their maximum and minimum values – this is to disable the alarms (the audible alarm also can be disabled manually – see the manufacturer's instructions).
- 4.4. Connect the #2 (Reference) port to the subslab probe. This assures that the pressure difference is relative to the subsurface. If the indoor space is depressurized, this will show as a negative pressure measurement.
- 4.5. Pressures should be reported in units of Pascals (Pa).
- 4.6. After startup, the pressure monitoring will record the minimum and maximum pressures every 15 minutes.
- 4.7. Allow the pressure monitor to operate for a minimum of three to five days with a recommended duration of seven days.
- 4.8. Indoor barometric pressure logging should also be performed during the same period as differential pressure logging. Follow the manufacturer's instructions for operation of the Solinst barometric pressure logger.
- 4.9. Note that with the Solinst barometric pressure logger, barometric pressures are reported in meters (39.37 inches)

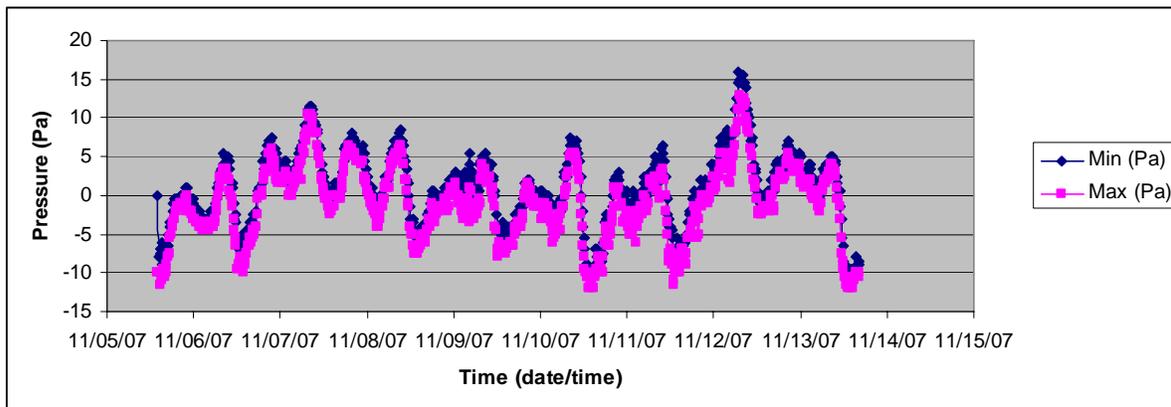
1 4.10. After pressure monitoring is complete, download the differential pressure
2 log and the barometric pressure log to a personal computer for data reduction. Data
3 reduction is discussed below.

4 4.11. (Optional). Due to cost and schedule constraints, long-term differential
5 pressure monitoring generally can be completed only at a limited number of
6 locations (typically, one location). If there is a concern about spatial variation in
7 pressure measurements in large buildings, and if multiple subslab probes have been
8 installed, "snapshot" pressure measurements can be made at these locations using a
9 hand-held digital micromanometer. The date, time and location of these
10 measurements should be recorded on a data form or field notebook, for comparison
11 with the integrated differential pressure measurements.

12 5. Data Reduction and Evaluation

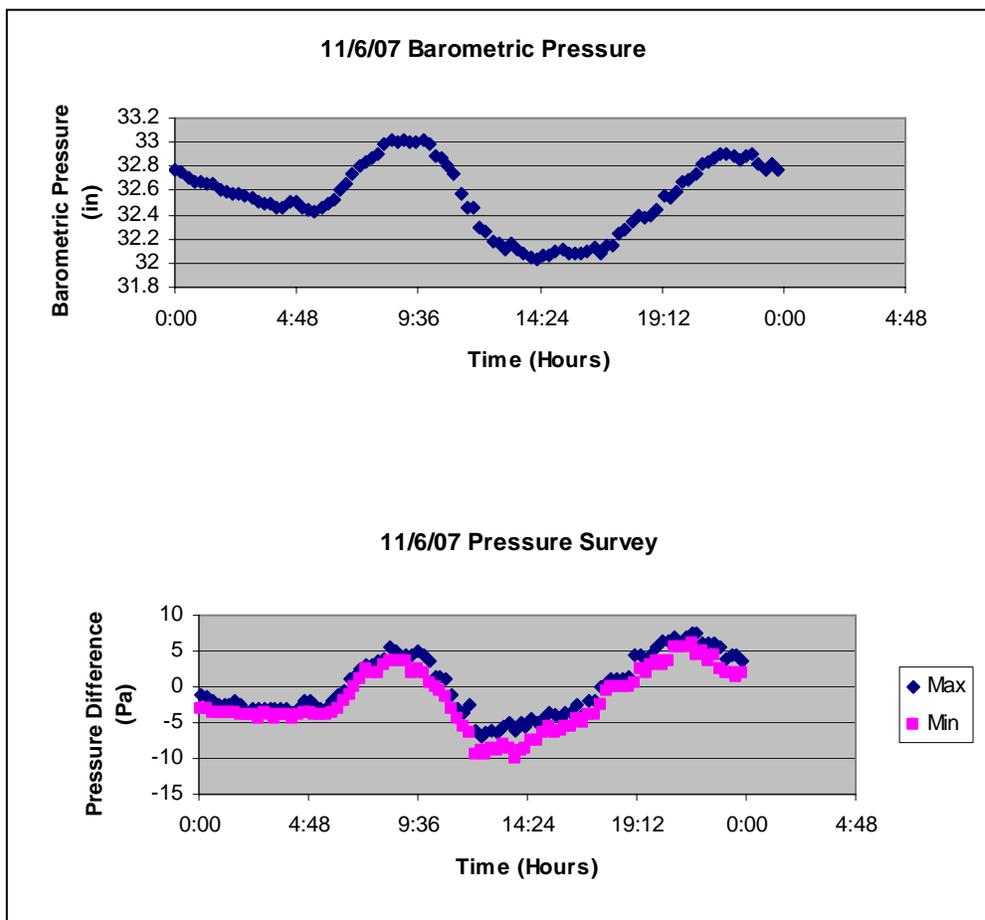
13 5.1. Differential pressure measurements and barometric pressure measurements should
14 be exported to Microsoft Excel for generating tables and plots. An Excel template is
15 available at [Vapor Intrusion VOC Share Point site/Key Documents/Best](#)
16 [Practices/SOPs](#).

17 5.2. Individual pressure measurements should be plotted against time. An example of a
18 data plot is presented below:



19
20 5.3. In addition, the individual measurements can be averaged over a specified time
21 period (for example, a 9-hour work shift) to estimate a longer-period average
22 pressure difference. The longer-term average value can then be used to determine
23 if, overall, a building is positively pressurized (hence vapor resistant) or negatively
24 pressurized (hence prone to vapor intrusion). These measurements can then be used
25 to identify "worst-case" time periods for collecting indoor air samples. It may be
26 useful to collect subslab samples for analysis of volatile organic compounds under
27 rising or falling pressure conditions, in order to better understand spatial and
28 temporal variability in subslab concentrations.

1 5.4. The plot of pressure differences also can be overlain on barometric pressure
2 measurements as shown below, to observe the effects of atmospheric conditions on
3 potential vapor intrusion pathways:



4
5 5.5. There are no regulatory screening levels for interpreting differential pressure
6 measurements. However, long-term average pressure differences between indoor
7 air and subslab can be interpreted using EPA guidance for radon mitigation.¹
8 Subslab depressurization systems for radon mitigation are designed to achieve a 6
9 to 9 Pa pressure difference between the subsurface and indoors. This represents the
10 pressure difference needed to prevent soil gas intrusion into a structure where
11 indoor pressures are governed by heating and the operation of appliances or fans. A
12 matrix outlining the levels used to interpret pressure measurements is presented in
13 Table 1. The need for further investigation of the potential vapor intrusion pathway
14 can be assessed based on the magnitude and direction of the pressure
15 measurements (i.e. positive relative to outdoors, or negative relative to outdoors).

¹ U.S. Environmental Protection Agency (USEPA). 1993. *Radon Reduction Techniques for Existing Detached Houses. Technical Guidance (Third Edition) for Active Soil Depressurization Systems.* EPA/625/R-03/011.

1 **6. Quality Management**

2

3 Version: 0.5 (06/18/2008)

4 File Name: SOP_VI_DifferentialPressureMonitoring_Date.doc

5

6 Location: [Vapor Intrusion VOC Share Point site/Key Documents/Best Practices/SOPs](#)

7 Primary Contact(s): Dave MacPhaul/GNV; Karen Centafonti/PHL

8 QA/QC Review: Dave MacPhaul/GNV; Mike Bedan/DEN; Loren Lund/DEN...

Table 1
Suggested Interpretation of Pressure Level Measurements

Condition	Description	Comments	Possible Outcome
Positively Pressurized	Consistent pressure measurements of > 6 to 9 Pa relative to outdoors or subsurface.	Based on the pressure difference needed to prevent soil gas intrusion in a structure with combined heating and appliance or fan operation effects (0.025 to 0.035 in water, based on USEPA, 1993).	No apparent driver for vapor intrusion pathway. Further investigation may not be needed
Neutral to Positively Pressurized	Consistent pressure measurements of <2 to 5 Pa relative to outdoors or subsurface. OR Highly variable pressure measurements typically greater than zero.	Minimum acceptable pressure difference needed to prevent in a structure with either heating effects OR appliance/fan effects (0.01 to 0.02 in water, based on USEPA, 1993).	Potential transient (intermittent) driver for vapor intrusion pathway may be present. Further investigation may be warranted to identify a potential source for vapor intrusion (i.e. groundwater sampling).
Neutral to Negatively Pressurized	Consistent pressure measurements of -5 to <2 Pa relative to outdoors or subsurface. OR Highly variable pressure measurements <5 Pa	Range of depressurization that could occur either from heating effects OR appliance/fan effects (0.01 to 0.02 in water, based on USEPA, 1993).	Potential transient (intermittent) driver for vapor intrusion pathway may be present. Further investigation may be warranted to identify a potential source and transport pathways for vapor intrusion (i.e. groundwater and near slab sampling).
Negatively Pressurized	Consistent pressure measurements of > -6 to -9 Pa relative to outdoors or subsurface.	Range of depressurization that could occur from heating effects and appliance/fan effects (0.025 to 0.035 in water, based on USEPA, 1993).	Potential driver for vapor intrusion pathway. Further investigation may be warranted. Consideration may need to be given to sub slab and/or indoor air sampling.

Note: 1 Pa = 0.004 inches of water

Table Adapted from U.S. Environmental Protection Agency (USEPA). 1993. *Radon Reduction Techniques for Existing Detached Houses. Technical Guidance (Third Edition) for Active Soil Depressurization Systems.* EPA/625/R-03/011.

Standard Operating Procedure for the Collection of Sub-Slab Vapor Samples Using Summa™ Canisters (Temporary Probe)

This procedure describes the approach for the collection of sub slab soil vapor samples in Summa canisters using a temporary probe. It includes instruction on probe installation, leak checking, gas sampling, and probe abandonment. This SOP should be used in conjunction with project data quality objectives. Only persons trained in the collection of soil gas samples should attempt this procedure.

1.0 Materials

1.1 Probe Installation

- Hammer drill and 7/8" or 1" and 5/16" or 3/8" bits
- Vacuum cleaner ('shop vac' type or hand held)
- Nuts and ferrules (1/4" stainless steel Swagelock or equivalent)
- 1/4" outside diameter Teflon tubing (Probe)
- Bees Wax (Unscented and low in target VOCs)
- VOA vial or small glass container
- Large Q-tips or paper towels and water
- Tape measure

1.2 Leak check

- Leak check enclosure
- Compressed helium tank (balloon grade), helium regulator, flow meter (200 ml/min)
- Helium detector, or equal

1.3 Sampling

- Vacuum pump and sampling assembly (pressure gauge, tubing, and fittings)
- Sampling valve
- 1/4" Teflon tubing, rubber tubing
- Flow controller
- Summa canister (sized appropriately for sampling requirements)

1.4 Probe Abandonment

- Mortar consisting of Portland Cement mix or similar

1.5 Miscellaneous

- Teflon tape
- 9/16", 1/2", crescent wrench, screw driver
- Extension cord
- Timer/watch
- Tools required to cut carpet, and/or tools needed for removal of other floor coverings

2.0 Probe Installation

- 2.1 Locate the sampling locations in accordance with the work plan. Check with local utility companies to identify utilities coming into the building from outside. If possible, look for known or suspected utility conduits and note their location on a map or in the field log. Be sure to confirm that the sample locations will not interfere with the known underground utilities. Also note the location of the probe, locations of significant features (walls, cracks, sumps, drains, etc), and conditions of the slab and soil.
- 2.2 If needed, expose the concrete by cutting the carpet or other loose floor coverings (Note: Carpet need not be removed, but rather a 'L' shape cut to expose the concrete for drilling and the leak check enclosure). Drill a 7/8" or 1" diameter hole to a depth of 3/4" (measured to the center of the hole) to create a well for the Bees wax to pool in (See Figure 2). Remove the cuttings using a vacuum cleaner. Be careful to not compromise the integrity of the slab during drilling (i.e., cracking it), although note if this occurs. It is

important that the slab and the probe hole remain air tight for sampling and that cracks are noted.

- 2.3 Drill a 5/16" or 3/8" diameter hole through the remainder of the slab and approx. 3" down into the sub-slab material (See Figure 3). Drilling into the sub slab material creates a void that is free of obstructions that might plug the probe during sampling. Record the total depth of the slab and the depth drilled into the sub slab material.
- 2.4 Once the total depth of the slab is known, mark the probe, a piece of 1/4" OD Teflon tubing, at a distance from the end that is no more than the depth of the slab. This will serve as a reference point when the tube is inserted into the hole. The tube will be inserted far enough into the slab when the mark is even with the surface of the slab.
- 2.5 Then wrap the tube with Teflon tape approx 1 inch from the end. This will serve as a dam to stop the melted wax from plugging the tip of the probe. Make sure the tape is thick enough to contact the sides of the wall, but not so thick that the tube can not be inserted to the appropriate depth. (See figure 4).
- 2.6 Wipe the walls of the hole using the Q-tip. This removes any remaining dust allowing the wax to make a better seal with the wall. Insert the sample tube to the appropriate depth.
- 2.7 Put some bees wax in a VOA vial or other glass vessel. Using a lighter, heat the glass to melt the wax and then pour the wax into the hole. Be sure to get wax on all sides of the smaller diameter hole by moving the sample tube away from the walls. Continue to add wax until the small diameter is completely full and there is about 1/4" in the larger diameter well. (See figure 5 and 6).
- 2.8 Let the wax cool for 10 minutes.
- 2.9 Be sure to never leave the probe hole open to atmosphere for extended periods to minimize the effects of surface infiltration.
- 2.10 Be careful to never put too much force on the sampling tube. The wax is only a temporary seal, and its sealing integrity can be compromised easily

3.0 Sampling Assembly

- 3.1 Thread the sample probe coming out of the probe hole through the rubber grommet in the leak check enclosure and slide the enclosure carefully down the tube (see figure 7) so that the weather stripping is in contact with the ground. Be sure to do this before attaching the nut and ferrule set to the end of the sample tube.
- 3.2 Attach the sample probe to the sampling valve and pressure gauge. Do not connect the flow controller or canister at this time.
- 3.3 Attach one end of a Teflon tube to the inlet of the vacuum pump and turn the pump on (the other end should be open to the atmosphere.) Make sure that the flow meter on the vacuum pump exhaust is reading 200 ml/min. Turn the pump off.
- 3.4 Attach the tube from the pump to the sampling valve and pressure gauge. Attach a Tedlar bag to the exhaust port of the pump and open the bag's valve.

4.0 Probe Purging and helium leak check

- 4.1.1 Attach a piece of tubing to the helium tank regulator and the other end to the enclosure. Attach the exhaust tube to the enclosure and position the other end as far away as possible. (See figure 8).
- 4.1.2 Make sure the entire sampling system is now assembled as in Figure 1.
- 4.1.3 Open the helium tank and start the helium flow at 200 ml/min. Allow it to flow for 1 minute to fill the leak check enclosure before starting the purge.

- 4.1.4 Two liters of sub slab gas need to be purged before sampling. The purge time is 10 minutes at a flow rate of 200 ml/min. Open the sampling valve, turn on the vacuum pump, and start timing for the purge volume.
- 4.1.5 During the purge time, be sure to watch and record the pressure on the vacuum gauge. A large vacuum could indicate a plugged probe or a tight or saturated formation. Either could invalidate the sampling. If water is present in the tube, stop purging immediately. If either is encountered, contact the project manager.
- 4.1.6 At the end of the purge time turn close the sampling valve and turn the pump off.
- 4.1.7 Turn the helium off.
- 4.1.8 Close the valve on the Tedlar bag and remove it from the pump.
- 4.1.9 Turn the helium detector on and be sure that it is calibrated properly.
- 4.1.10 Open the Tedlar bag, and using a piece of flexible tubing, attach the Tedlar bag to the helium detector. Be sure to record the helium leak check value on the field sheet.
- 4.1.11 If a reading of >5% is observed, then the probe leak check has failed, and corrective action is required. There are 2 options:
 - 4.1.11.1 Try fortifying the probe seal by adding more wax and repeating the purge and leak check procedure
 - 4.1.11.2 If that fails, abandon the hole, drill a new one, and repeat the whole procedure.
- 4.1.12 Remove the gauge and tubing from the sampling valve.

5.0 Sampling

- 5.1 The Summa canister has been evacuated to near absolute zero pressure. Care should be used at all times to prevent inadvertent loss of canister vacuum. Never open the valve affixed to the canister unless the intent is to collect sample or check the pressure. Use only a canister that has been certified to be clean.
- 5.2 Remove the canister valve cap, attach the vacuum gauge to the canister, and open the canister valve. Record the pressure reading and close and remove the valve. The pressure in the canister should be between 28" and 30" of mercury. If not, then the canister has leaked and should not be used for sampling.
- 5.3 Connect the flow controller to the sampling valve and the Summa canister to the flow controller. The port on the flow controller that reads 'HP' or 'In' should be attached to the sampling valve. The port that reads 'LP' or 'Out' should be attached to the canister. Use only a flow controller that has been cleaned and properly adjusted.
- 5.4 To take the sample, first open the sampling valve. Then, slowly open the canister valve approximately one (1) full turn, and start timing. Record the start time on the field sampling log.
- 5.5 There are different sample time and flow rate protocols. These are subject to project requirements.
 - 5.5.1 5 minute sample period, 850 ml canister: The flow controller is set for 150 ml/min. For an 850 cc Summa canister, it will take 5 minutes to collect a sample.
 - 5.5.2 24 hour sample period, 6 liter canister: The flow controller is set for 3.75 ml/min. For a 6 liter Summa canister, it will take 24 hours to collect a sample.
- 5.6 At the end of the time, close the sampling valve and the valve affixed to the canister. Remove the canister from the apparatus.
- 5.7 Re-attach the vacuum gauge and record the final pressure. The flow controllers are set so that there should be some remaining vacuum in the canister. If everything worked properly, there should be between 2" and 5" final pressure in the canister. Record the

- sampling date, time, canister ID, flow controller ID, and any other observation pertinent to the sampling event on the field sampling log.
- 5.8 Remove the gauge from the can and tighten the cap back on with a wrench. Verify that canister valve is closed.
 - 5.9 Fill out all appropriate documentation (sampling forms, sample labels, chain of custody, sample tags, etc.).
- 6.0 Probe Abandonment
- 6.1 After sampling, remove the sampling probe and any remaining wax.
 - 6.2 Fill the hole with cement mix.

Figure 1 – Sub slab Sampling

Figure 2 – Drilling 1” mortar hole to a depth of 1 ¾”



Figure 3 – Drilling 3/8” probe hole

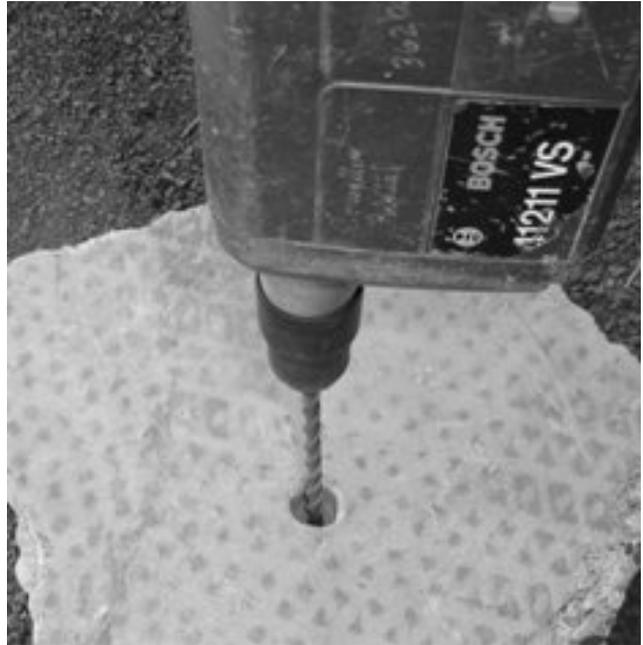


Figure 4 – Wrapping Probe with Teflon tape

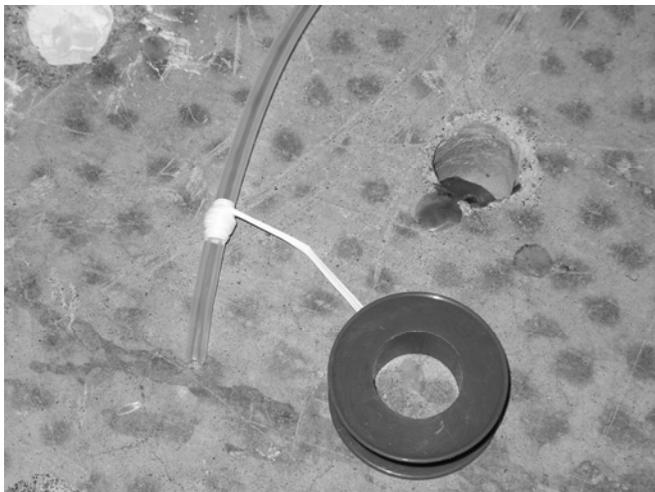


Figure 5 – Melting wax



Figure 6 – Probe waxed in hole

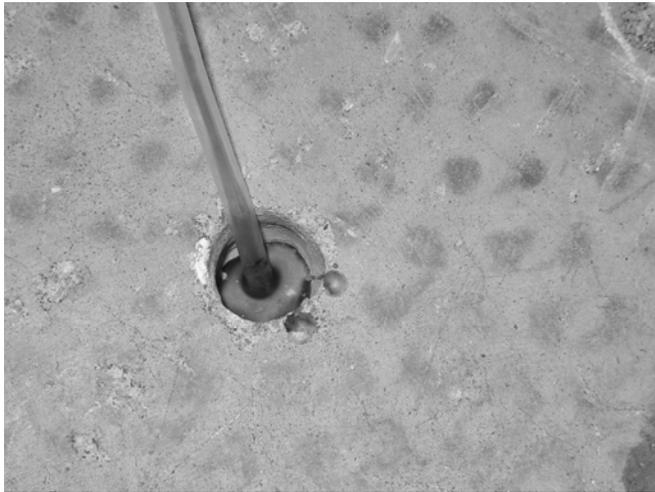


Figure 7 - Installing the helium leak check assembly

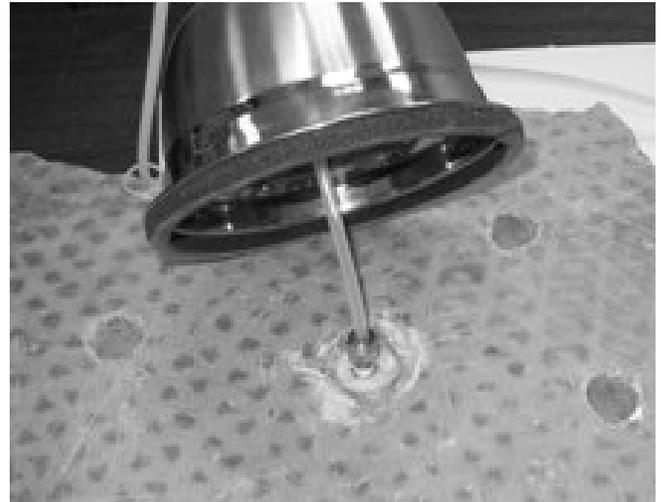
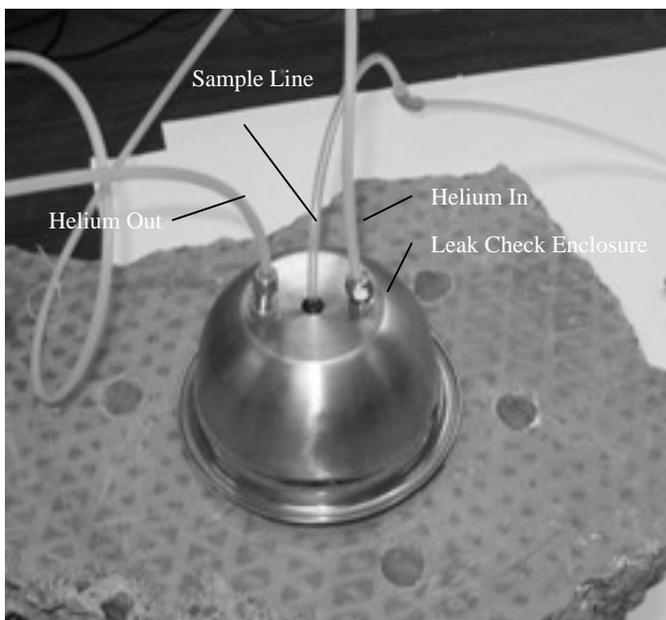


Figure 8 –Helium Leak Check Assembly



Volatile Organic Compound Water Sample Collection

Unison Remediation System O&M Activities

Purpose and Scope

This SOP provides general guidelines for sampling aqueous volatile organic compounds (VOCs). The standard techniques for collecting representative samples are summarized.

Equipment and Materials

- Field log book
- Clean DOT-approved 55-gallon steel drum with label
- Equipment/instrument decontamination materials (see SOP, Decontamination of Personnel and Equipment)
- Dedicated polyethylene and silicone sample tubing
- Water level meter
- Peristaltic pump with portable battery
- Groundwater quality meter capable of collecting groundwater quality parameters using a flow-through cell (Horiba U-22 Water Quality Multiprobe; capable of measuring temperature, specific conductance, dissolved oxygen, turbidity, pH, and oxygen-reduction potential)
- Laboratory-supplied analytical sample containers
- Clean latex or nitrile gloves

Procedure and Guidelines

- Set up and calibrate instruments in accordance with manufacturer's instructions.
- Purge the well in accordance with the SOP for Low Flow Groundwater Sampling.
- Sample VOCs before sampling other analyte groups.
- When sampling for VOCs, evaluate the area around the sampling point for possible sources of air contamination by VOCs. Products that may give off VOCs and possibly contaminate a sample include perfumes and cosmetics, skin applied pharmaceuticals, automotive products (gasoline, starting fluid, windshield deicers, carburetor cleaners, etc.) and household paint products (paint strippers, thinners, turpentine, etc.).

- Keep the caps off the sample vials for as short a time as possible.
- Wear clean latex or surgical gloves.
- Fill the sample vial immediately, allowing the water stream to strike the inner wall of the vial to minimize formation of air bubbles. **DO NOT RINSE THE SAMPLE VIALS BEFORE FILLING.**
- Fill the sample vial with a minimum of turbulence, until the water forms a positive meniscus at the brim.
- Replace the cap by gently setting it on the water meniscus. Tighten firmly, but **DO NOT OVERTIGHTEN.**
- Invert the vial and tap it lightly. If you see air bubbles in the sample, do not add more sample. Use another vial to collect another sample. Repeat if necessary until you obtain a proper sample.

Key Checks

- Check sample area for possible sources of contamination. Do not sample down wind of vehicle exhaust or gasoline containers.
- Fill sample bottles slowly, minimize turbulence.
- Check sample bottles for air bubbles.

Attachments

None.

Appendix D

Laboratory SOPs

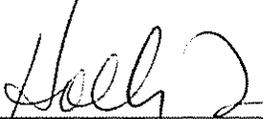


TestAmerica Knoxville SOP Cover Page

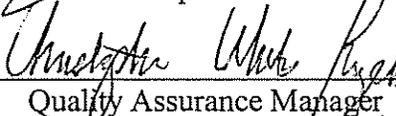
Any reference within this document to Severn Trent Laboratories, Inc. or STL, should be understood to refer to TestAmerica Laboratories, Inc. (formerly known as Severn Trent Laboratories, Inc.)

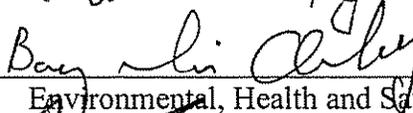
STL KNOXVILLE
STANDARD OPERATING PROCEDURE
TITLE: VOA CANISTER ANALYSIS

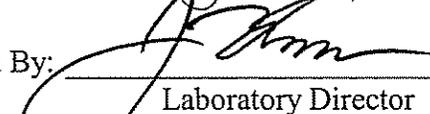
(SUPERSEDES: KNOX-MS-0001, Revision 8)

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TESTAMERICA KNOXVILLE
SOP CHANGE FORM

SOP NUMBER: KNOX-MS-0001

TITLE: VOA CANISTER ANALYSIS

SOP TITLE: (SUPERSEDES: KNOX-MS-0001, Revision 8)

SOP SECTIONS AFFECTED BY CHANGE: 7.4, 7.4.3, 11.2.10, appdx IV

REASON FOR ADDITION OR CHANGE: remove surrogates toluene-d8 and 1,2-dichloroethane-d4; change the concentration of the stock and working level, change the injection volume.

CHANGE EFFECTIVE FROM: 10/23/08

CHANGE OR ADDITION (SPECIFY SECTION; USE ADDITIONAL SHEETS IF NECESSARY)

Section 7.4...change concentration from 100 ppb/v to 50 ppb/v. Remove surrogates 1,2-dichloroethane-d4 and toluene-d8.

7.4.3...change the injection volume to 40 mL. Change the concentration to 4 ppb/v.

Add 7.4.4: an expiration date of 5 years from the manufacturing date is assigned to the cylinder. This is due to no response factor requirements for any analyte, and no 2nd source requirements for internal standards and surrogates from the methods.

11.2.10...change the injection volume to 40 mL.

Appendix IV...remove toluene-d8 and 1,2-dichloroethane-d4

SUBMITTED BY/DATE:

David L. Niles 10/27/08

APPROVED BY:

[Signature]

Technical Reviewer Signature

10/28/08

Date

[Signature]

Environmental Health & Safety Signature

10-28-08

Date

[Signature]

QA Signature

10/29/08

Date

[Signature]

Management Signature

10/28/08

Date

1. Scope and Application

- 1.1. The purpose of this standard operating procedure is to define the procedures and quality control necessary to analyze samples collected in "SUMMA™ passivated" stainless steel canisters.
- 1.2. This procedure is applicable to the analysis of ambient air, indoor air, landfill gases, soil gases, vapor intrusion, and other gaseous samples. It is based on EPA Methods TO-14, TO14A and TO-15.
- 1.3. Responsibilities to perform this procedure in the lab are as follows:

Position	Responsibilities
Analyst	<ul style="list-style-type: none"> - Prepares and analyzes samples - Summarizes/assembles data package - Reviews the data package
Team/Group Leader	<ul style="list-style-type: none"> - Schedules/assigns analyses - Reviews data package

2. Summary of Method

- 2.1. Microscale Purge and Trap (MSPT): A precisely measured aliquot is removed from the canister or Tedlar bag and concentrated on a cryogenic trap. The cryogenic trap is desorbed. Polar and nonpolar compounds are quantitatively transferred to a subambient Tenax™ trap. Most of the water remains on the Cryotrap and CO₂ passes through the Tenax trap and is vented. The Tenax™ trap is thermally desorbed to the on-column cryofocuser. Sample components are separated by temperature programmed gas chromatography and detected with a quadrupole mass spectrometer.
- 2.2. The compounds analyzed by this method are listed in Tables 1, 2 and 3.

3. Definitions

- 3.1. Canister - a stainless steel container, typically 6-liter volume, equipped with a stainless steel shut-off valve, suitable for use from vacuum to 40 psig. 1-L cans are available for reduced volume analysis.
- 3.2. SUMMA™ Passivation - a proprietary treatment process used to deactivate stainless steel surfaces. It produces a pure chrome/nickel oxide surface that features a high level of inertness.

- 3.3. Absolute pressure - pressure measured with reference to absolute zero pressure, expressed as kpa, mmHg, or psia.
- 3.4. Gauge pressure - pressure above atmospheric pressure as measured by a standard gauge. Zero gauge pressure is equal to ambient atmospheric pressure, expressed as mmHg, inches Hg, or psig.
- 3.5. Polar compound - Oxygen-containing compound capable of forming hydrogen bonds in water; compound having significant solubility in water.
- 3.6. Batch – A batch is a set of up to 20 samples of the same matrix processed using the same procedures and reagents within the same 24 hour time period. The Quality Control batch must contain a blank and a Laboratory Control Sample (LCS). Refer to the QC Program document (QA-003, current revision) for further details of the batch definition.
- 3.7. Additional definitions can be found in the STL Knoxville LQM glossary and in the STL Quality Management Plan.
- 3.8. Tedlar bag - Tedlar bags are manufactured from PVF (Tedlar) film with a polypropylene valve and septum. Various volume capacities available.

4. Interferences

- 4.1. Only compounds having both a similar mass spectrum and GC retention time would be expected to interfere in the method. The most common occurrence of this would be with structural isomers.
- 4.2. Large concentrations of water, methane, or carbon dioxide may limit the size of the aliquot that can be effectively cryotrapped. This may elevate the quantitation limits obtainable for samples of this type.
- 4.3. Matrix interferences may be caused by non-target contaminants that are present in the sample. The extent of matrix interferences will vary considerably from source to source depending upon the nature and diversity of the site being sampled.
- 4.4. Cross-contamination can occur whenever high-level and low-level samples are analyzed sequentially or in the same purge position on an autosampler. Whenever an unusually concentrated sample is analyzed, it should be followed by one or more blanks to check for cross-contamination, or evaluate the next sample for blank acceptance criteria. The autosampler and concentrator may require extensive bake-out and cleaning after a high-level sample.

5. Safety

- 5.1. Employees must abide by the policies and procedures in the Corporate Safety Manual, Radiation Safety Manual and this document.
- 5.2. Procedures shall be carried out in a manner that protects the health and safety of all associates. Exposure to chemicals and samples will be maintained as low as reasonably achievable, therefore, unless they are known to be non-hazardous, all samples must be opened, transferred and prepared in a fume hood, or under other means of mechanical ventilation. Solvent and waste containers will be kept closed unless transfers are being made. The preparation of all standards, reagents and glassware cleaning procedures that involve solvents will be conducted in a fume hood with the sash closed as far as the operations will permit.
- 5.3. All work must be stopped in the event of a known or potential compromise to the health and safety of any associate. The situation must be reported **immediately** to a laboratory supervisor.
- 5.4. Specific Safety Concerns or Requirements
 - 5.4.1. The effluents of sample splitters for the gas chromatograph and roughing pumps on the mass spectrometer must be vented to the laboratory hood exhaust system or must pass through an activated charcoal filter.
 - 5.4.2. The gas chromatograph and mass spectrometer contain zones that have elevated temperatures. The analyst needs to be aware of the locations of those zones, and must cool them to room temperature prior to working on them.
 - 5.4.3. The mass spectrometer is under deep vacuum. The mass spectrometer must be brought to atmospheric pressure prior to working on the source.
 - 5.4.4. There are areas of high voltage in both the gas chromatograph and the mass spectrometer. Depending on the type of work involved, either turn the power to the instrument off, or disconnect it from its source of power
- 5.5. Primary Materials Used: The following is a list of the materials used in this method, which have a serious or significant hazard rating. **NOTE: This list does not include all materials used in the method. The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material	Hazards	Exposure Limit (1)	Signs and symptoms of exposure
Methanol	Flammable Poison Irritant	200 ppm-TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.
Methylene Chloride	Carcinogen Irritant	25 ppm-TWA 125 ppm-STEL	Causes irritation to respiratory tract. Has a strong narcotic effect with symptoms of mental confusion, light-headedness, fatigue, nausea, vomiting and headache. Causes irritation, redness and pain to the skin and eyes. Prolonged contact can cause burns. Liquid degreases the skin. May be absorbed through skin.
Acetonitrile	Flammable Poison	40 ppm-TWA	Early symptoms may include nose and throat irritation, flushing of the face, and chest tightness. Prolonged exposure to high levels of vapors may cause formation of cyanide anions in the body.
Hexane	Flammable Irritant	500 ppm-TWA	Inhalation of vapors irritates the respiratory tract. Overexposure may cause lightheadedness, nausea, headache, and blurred vision. Vapors may cause irritation to the skin and eyes.
Acetone	Flammable	1000 ppm (TWA)	Inhalation may cause coughing, dizziness, dullness, and headache. Contact causes redness, pain, drying and cracking of the skin. Vapors cause eye irritation. Eye splashes may cause severe irritation, with stinging, tearing, redness and pain.
Benzene	Carcinogen Flammable Poison	1 ppm-TWA 5 ppm-STEL	Toxic by ingestion, inhalation and absorption. Causes headache, nausea, dizziness, weakness and breathing difficulties. This material is irritating on contact with the skin and eyes and may cause permanent eye damage.
Carbon Tetrachloride	Carcinogen Poison	10 ppm-TWA 200 ppm-STEL	Toxic by ingestion, inhalation and absorption. Causes headache, nausea, dizziness and narcosis. Contact with skin or eyes may cause irritation. Consumption of alcohol may increase toxic effects
Chloroform	Carcinogen Irritant	50 ppm Ceiling	Acts as a relatively potent anesthetic. Irritates respiratory tract and causes central nervous system effects, including headache, drowsiness, dizziness. Causes skin irritation resulting in redness and pain. Removes natural oils. May be absorbed through skin. Vapors cause pain and irritation to eyes. Splashes may cause severe irritation and possible eye damage.
1,4-Dichlorobenzene	Irritant	75 ppm-TWA	Can cause irritation by ingestion and inhalation. Causes nausea, vomiting and diarrhea. Contact with material or vapors can cause irritation to skin and eyes.
Vinyl Chloride	Carcinogen Flammable Poison	1 ppm TWA	Toxic by inhalation, ingestion and absorption. Can cause respiratory irritation, dizziness, weakness, fatigue, nausea and headache. Contact with the material can cause eye and skin irritation.

1 – Exposure limit refers to the OSHA regulatory exposure limit.

6. Equipment and Supplies

- 6.1. Canisters, 1, 6-, 15-, and 30-liter sizes, preferably equipped with two valves and integral vacuum/pressure gauge, Scientific Instrumentation Specialists or equivalent.
- 6.2. Static gas dilution bottles (SGDB), nominally 2000 ml, with mininert valves, Tekmar Co., or equivalent.
- 6.3. Syringes, gas-tight, 10 uL, 50 uL, 500 uL, 1000 uL, 2.5 mL, 50 mL, 500 mL, all side port needle, Hamilton, Inc., or equivalent.

- 6.4. Gas Chromatograph/Mass Spectrometer System, Agilent HP 6890 GC and 5973 MSD or equivalent.
- 6.5. Fused silica capillary column, 60 m x 0.32 x 1um film DB-5, J&W Scientific, or equivalent.
- 6.6. Vacuum pump, Model 726.3 TTP, KNF Newberger, or equivalent.
- 6.7. Canister concentrator system, Model 7100 or 7100A, Entech Co., with a Model 7016CA, 16-position auto sampler.
- 6.8. Gauges: The following gauges are certified annually
 - 6.8.1. Test gauge, 0 to 30 in. Hg vacuum, Ashcroft Co., or equivalent
 - 6.8.2. Test gauge, 0-60 psi, Ashcroft Co., or equivalent
 - 6.8.3. Test gauge, 0 to 100 in. Hg pressure, Ashcroft Co., or equivalent
 - 6.8.4. Digital gauge 0 to 30" Hg vacuum, Dwyer or equivalent
 - 6.8.5. Digital gauge 0 to -29.9" Hg vacuum, 0 to 99.9 psi, Dwyer or equivalent
- 6.9. Tedlar Bags: Variety of sizes. SKC or equivalent.

7. Reagents and Standards

- 7.1. Helium, ultra high purity, 99.999+%, Air Products, or equivalent.
- 7.2. Liquid nitrogen, Air Products, or equivalent.
- 7.3. Nitrogen, ultra high purity, Air Products or equivalent
- 7.4. Internal/Surrogate Standard (all at 100 ppb) in nitrogen, 2000 psig, Scott Specialty Gases, or equivalent:

CAS NUMBER	Internal Standards	MOLECULAR WEIGHT (ng/n mole)
74-97-5	bromochloromethane	129.4
540-36-3	1,4-difluorobenzene	114.1
3114-55-4	chlorobenzene-d5	117.6
	Surrogates	
17060-07-0	1,2-dichloroethane-d4	103.0
2037-26-5	toluene-d8	100.2
460-00-4	4-bromofluorobenzene	175.0

- 7.4.1. A sufficient volume from the internal/surrogate standard cylinder is transferred to the 15-liter summa canister to produce a positive pressure.
- 7.4.2. The working internal/surrogate standard may be used as long as the pressure in the canister remains above ambient pressure and is not past its expiration date.
- 7.4.3. The Entech is programmed to add 20 mL of the internal standard/surrogate can. This results in a concentration of 4 ppb/v of internal standard/surrogate (based on 500 mL volume).
- 7.5. Primary Target and Laboratory Control Sample Gaseous Standards: target compounds, 1000 ppb v/v, vendor-certified high-pressure aluminum cylinder.
 - 7.5.1. An expiration date of one year from the date of vendor certification is assigned to the standard cylinder. This expiration date may be extended through comparison against an unexpired standard that meets the second source standard criteria in Section 10.4.
- 7.6. Initial Calibration Verification Standard (2nd source) stock cylinders (ICV): Target compounds, 300 ppb v/v, vendor-certified high-pressure aluminum cylinders.
 - 7.6.1. These cylinders have been used for over 10 years and no significant degradation in response has been observed. Due to this stability, the calibration verification (second source) standard stock cylinders may be used for 20 years from date of certification or until the vendor supplied expiration date, whichever is earlier. It is also subject to ongoing monitoring of target analytes against the primary calibration standard.
- 7.7. Standard grade neat compounds of hexachlorobutadiene (HCBD) and naphthalene, 99+% or of known purity, Chem Service, or equivalent.
 - 7.7.1. Naphthalene/Hexachlorobutadiene (HCBD) Stock Standard:
Approximately 3.6 mg of naphthalene is weighed into a glass container small enough to be dropped into a SGDB. The glass container is introduced into the SGDB and the bottle is capped with a mininert valve. Approximately 4.4 uL of HCBD is added to the SGDB using a 10 uL syringe. The SGDB is placed in an oven at approximately 60°C. The exact weight/volume to be added is calculated from the volume of the SGDB such that adding 2.5 milliliters from the SGDB to a 15-L can (or 1

mL in a 6-L can) pressurized to 30 psig yields a concentration of 25 ppb (v/v) of HCB and Naphthalene in the working standard. See section 12.7 and 12.8 for calculations.

- 7.8. Prepared Standard, polar compounds, vendor certified mix containing methanol, ethyl ether, acetone, acrylonitrile, vinyl acetate, 2-butanone, 1-butanol, 4-methyl-2-pentanone, 2-hexanone, methyl-tert-butyl ether, acrolein, acetonitrile, 99+% or of known purity, Ultra Scientific or equivalent.
- 7.9. Polar stock standard and 1,2,3-trichloropropane, 99+% or of known purity, Chem Service or equivalent.
 - 7.9.1. SGDB stock method: Approximately 27 μ L of the polar standard mix (section 7.8) and approximately 1.3 μ L of 1,2,3-trichloropropane is injected into a SGDB. The exact volume to be added is calculated from the volume of the SGDB such that adding 5 mL from the SGDB to the working standard yields a concentration of 100 ppb (v/v) for methanol and 50 ppb (v/v) for the other polar compounds and 25 ppb (v/v) of 1,2,3-trichloropropane in the working standard.
 - 7.9.2. Water stock method: 67.5 μ L of the polar standard mix and 3.25 μ L of 1,2,3-trichloropropane are dissolved in water to a final volume of 10 mL.
- 7.10. Additional Standards: Neat materials, not contained in the certified cylinders, can be added to a SGDB either individually or as a mix.
 - 7.10.1. If the desired compound is a gas at room temperature, a measured volume is injected into an evacuated summa canister and pressurized. See section 12.9 and 12.10 for calculation. If the desired compound is a liquid or solid at room temperature, the volume of each compound to be added to the SGDB should be back calculated to the desired final concentration in the canister. See section 12.7 and 12.8 for calculation.
- 7.11. 50ppb v/v Canister Working Standard (for a 15-L can. For a 6-L can, reduce the volume of standards appropriately).
 - 7.11.1. 100ul of reagent water is injected through a septum (inserted into a ¼ in. nut) into a clean evacuated 15-L canister.
 - 7.11.2. The canister is then brought up to 0" gauge pressure with UHP nitrogen
 - 7.11.3. 3 in (Hg) of the 1000 ppb v/v high pressure gas standard from Section 7.5 is added to the 15-liter canister. The can is pressurized to 30 in (Hg) with

UHP nitrogen for a final volume of 30 L and final concentration of 50ppb v/v.

- 7.11.4. Alternate concentrations of the working standards may be made as long as the calculations, concentrations and volumes are adjusted appropriately and preparation is clearly documented in the standard preparation logbook.
- 7.12. Low Standard Preparation: Typically 1 ppb v/v or 2 ppb v/v calibration point
 - 7.12.1. 40 µL of reagent water is injected through a septum (inserted into a 1/4 inch nut) into a clean evacuated 6-liter canister. The canister is allowed to stand for at least 20 minutes to allow all the water to evaporate from the valve area.
 - 7.12.2. 240 mL (2.4" Hg) (for a 1 ppb v/v standard) or 480 mL (4.8" Hg) (for a 2 ppb v/v standard) of the 50 ppb (v/v) standard is transferred to a 6-liter canister.
 - 7.12.3. The canister is pressurized to 30 in. Hg with UHP nitrogen.
- 7.13. 50 ppb v/v Canister Second Source Standard (for a 15-L can. For a 6-L can, reduce the volume of the standards appropriately).
 - 7.13.1. 100 uL of reagent water is injected through a septum (inserted into a 1/4-in. nut) into a clean evacuated 15-liter canister. . The canister is allowed to stand for at least 20 minutes to allow all the water to evaporate from the valve area .
 - 7.13.2. 10 uL from the water standard in 7.9.2 (or 5 mL of the polar stock from the SGDB in 7.9.1) and 2.5 mL of the naphthalene/HCBD stock in 7.7.1 are injected through the septum. . This step should be done quickly and the syringe for the naphthalene/HCBD stock should be heated in the oven along with the SGDB. The canister is then brought up to exactly zero inches gauge pressure with UHP nitrogen
 - 7.13.3. 5 in. (Hg) of each 300 ppb v/v high-pressure gas standard from section 7.5 is added to the 15-liter canister. The can is pressurized to 30 in (Hg) with UHP nitrogen for a final volume of 30L and final concentration of 25 ppb v/v
 - 7.13.4. Alternate concentrations of the working standards may be made as long as the calculations, concentrations and volumes are adjusted appropriately and preparation is clearly documented in the standard preparation logbook

- 7.14. Approved SGDB and canister stock standards (section 7.7, 7.8, 7.9 and 7.10) may be used for 6 months from the date of preparation or the earliest expiration of parent standard, whichever comes first. Working canister standards (7.11 and 7.12 and 7.13) may be used for two months from the date of preparation or the earliest expiration of parent standard, whichever comes first.
- 7.15. The HCBd/naphthalene SGDB is stored at approximately 60°C. Other SGDB and canister standards are stored at room temperature. If the analytes prove to be plating/condensing in the SGDB at room temperature, then the SGDB should be stored at approximately 60°C. Mixes and neat compounds (that are not in SGDB, cans, or cylinders) are stored at the manufacturer's recommended storage conditions.
- 7.16. Approval of Stock and Working Standards
- 7.16.1. When a new stock is prepared, it can either be verified at the SGDB stage or at the working level stage.
- 7.16.1.1. To compare the SGDB standards, humidify two 6 liter canisters with 40 µL of water each, and spike with equal known volumes (typically 5 - 10 mL) from the SGDB, and bring to an equal final pressure of nominally 15 psig.
- 7.16.1.2. The two standards must agree to within 20 percent difference after taking into account nominal volume differences between the two bottles.
- 7.16.2. Working canister standards are approved for use by passing the daily standard acceptance criteria given in Section 10.5 or the initial calibration verification in section 10.4. The working LCS canister is approved for use by passing the LCS acceptance criteria in section 9.3.

8. Sample Collection, Preservation and Storage

- 8.1. Sampling is not performed for this method by STL Knoxville. For information regarding sample shipping, refer to SOP KNOX-SC-0003, Receipt and Log In of Commercial Samples, current revision.

Container Type	Preservative	Holding Time
SUMMA canister	None	30 days
Tedlar bag	None	72 hours from collection to analysis or transfer to a can. After transfer to a can, the holding time is 30 day from sample collection.

9. Quality Control

9.1. Internal/Surrogate Standards

- 9.1.1. Internal standards and surrogates are added to each analytical standard, blank and sample. The acceptance criteria for each internal standard's area for every analysis must be $\pm 40\%$ recovery of the internal standard area from the continuing calibration standard. The acceptance criteria for each internal standard's retention time in every analysis must be within ± 20 seconds (0.33 minutes) of the internal standard retention time from the continuing calibration standard.
- 9.1.2. Surrogate recoveries must fall within 70% to 130%, or within laboratory historical control limits if available.
- 9.1.3. If the internal standard areas or surrogate recoveries for a sample are outside their limits, the cause is determined. If it is a result of a system problem, then the problem must be corrected and the sample reanalyzed with acceptable results. If it is the result of a matrix effect, the sample must be reanalyzed to confirm this, unless the effect is caused by high levels of target or non-target compounds co-eluting with or interfering with the surrogates or internal standards.
- 9.1.4. If the sample surrogate recoveries are biased high outside acceptance limits and no target analytes are detected above the reporting limit, the sample data may be reported with qualification in the project narrative.

9.2. System Blanks

- 9.2.1. For each 24-hour tune in which samples are analyzed or every 20 samples, whichever is more frequent, an acceptable system blank must be analyzed before samples analysis may begin.
 - 9.2.1.1. A system blank is defined as a cleaned canister, humidified with reagent water and filled with UHP nitrogen.
 - 9.2.1.2. Typically, a 30L canister, humidified with 200 uL of reagent water and pressurized to 25-30 psi with nitrogen is used for the blank. A lot check from the can cleaning system can be used as a system blank (See section 9.5).
 - 9.2.1.3. An acceptable system blank is one with all target analytes less than 0.2 ppbv. The data may still be reported if the concentration of the analyte is less than the laboratory

reporting limit (see Tables 1, 2 and 3), and meets internal standard and surrogate requirements in section 9.1. Any samples associated with a method blank with results above 0.2 ppbv are flagged in the data report. If a blank has a reportable result between the RL and the MDL, the associated samples are also flagged.

9.2.2. If a system blank does not meet the above criteria, then the blank must be reanalyzed or a new blank prepared and analyzed with acceptable results.

9.3. Laboratory Control Standard (LCS)

9.3.1. The LCS is defined as a working standard made by the same method as analytical standards, using the same source materials. It is used to assess analytical control of this procedure. The LCS is analyzed every 24 hour tune or every 20 samples, whichever is more frequent.

9.3.1.1. The daily calibration verification may also serve as the LCS as long as it meets the criteria of both the LCS and the daily calibration verification.

9.3.2. All non-polar analytes in the LCS must be within 70-130% recovery with the allowance of up to two non-polar analytes having 60-140% recovery. All polar analytes in the LCS must be within 60-140% recovery with the allowance of up to two polar analytes having 45-155% recovery.

9.3.3. The internal standards and surrogates must pass criteria specified in section 9.1.

9.3.4. If the above criteria cannot be met, corrective action must take place. Corrective action may include: a reanalysis of the LCS, performing instrument maintenance, preparation of a new working standard, or recalibration of the instrument. Corrective action is followed by reanalysis of any samples associated with the LCS that failed acceptance criteria.

9.3.5. Note: If the LCS recovery for a target analyte is biased high outside acceptance limits and that target analyte is not detected in any of the associated samples above the reporting limit, the sample data may be reported with qualification in the project narrative.

9.4. Duplicate Analysis

9.4.1. A duplicate is analyzed with every 20 samples. It is not reported unless specifically requested.

- 9.4.2. The acceptance criteria for the duplicate analysis are $\leq 25\%$ RPD for target compounds that are greater than 5 times the RL. No criteria for methanol and n-butanol. The calculations are given in section 12.16.
- 9.4.3. If the RPD is outside acceptance criteria for the duplicate, the sample is rerun once. If upon reanalysis, the duplicate does not meet acceptance criteria, the original sample data is qualified in the project narrative.
- 9.4.4. Due to limited sample volume, duplicates are not performed for Tedlar bags unless otherwise specified in the project requirements.

9.5. Canister Blank Checking

- 9.5.1. From each cleaned lot of canisters, a canister is selected, humidified with 40 μL reagent water, and pressurized with UHP nitrogen. (See SOP KNOX-SC-0001, current revision, "Canister Cleaning and Preparation").
- 9.5.2. A blank check is analyzed within 24 hours of a valid tune check and calibration.
- 9.5.3. A blank check passes if there are no target analytes above the reporting limit, and the internal standards and surrogates pass criteria in section 9.1. Cans are considered certified "clean" if the result for all analytes are below 0.2 ppbv. However the can may still be used to collect samples if the concentration of the target analyte is less than the reporting limit. If analytes are detected in the can being certified as clean above 0.2 ppbv and below the reporting limit, this will be noted on the blank check quantitation report.
- 9.5.4. If a blank check canister does not pass, the can may be re-analyzed. If the acceptance criteria are still not met, the entire lot of canisters must be re-cleaned, and a blank check from the re-cleaned lot must pass.

9.6. Nitrogen check

- 9.6.1. Before a new nitrogen cylinder is used for pressurization of samples or standards, it must be analyzed as a blank and pass all the criteria in section 9.2.1.3.

- 9.7. Annual gauge calibration: The gauges that are used in calculations to measure cylinder and canister pressure or vacuum must be certified annually.

10. Calibration and Standardization

- 10.1. Instrument Conditions: The following steps are part of the software's automatic tuning procedure and are performed as needed.
 - 10.1.1. Mass assignments of the mass spectrometer are checked and adjusted using perfluorotributylamine (PFTBA FC43).
 - 10.1.2. The mass spectrometer is tuned to meet the criteria for BFB (see Figure 1).
 - 10.1.3. The mass spectrometer is adjusted to minimize noise (see instrument manufacturer instruction manuals).
 - 10.1.4. See Appendix III for examples of GC/MS and GC instrument parameters.
- 10.2. Daily Tune Check
 - 10.2.1. 50 ng or less of BFB is analyzed for each 24-hour time tune period; the 24-hour time period begins at the moment of injection of BFB. All abundance criteria for BFB in Figure 1 must be met before the analysis of standards, QC samples or client samples.
 - 10.2.2. The BFB must be acquired in the following manner: Three scans (the apex scan, and the scans immediately preceding and following the apex) are acquired and averaged. Background subtraction is conducted using a single scan prior to the elution of BFB.
 - 10.2.3. Once the BFB passes criteria, the same mass spectral conditions used for the BFB must be used to acquire the data in that 24-hour tune period, until the next BFB event.
- 10.3. Initial Calibration
 - 10.3.1. The GC/MS system must be calibrated with at least 5 concentrations that span the monitoring range of interest. The dynamic range of the curve is generally 0.2 ppb v/v to 30 ppb v/v based on 200 mL sample analysis for normal level reporting limits for most analytes, and 0.01 ppb v/v to 1 ppb v/v based on 500 mL sample analysis for low level reporting limits, for a limited set of analytes. The concentration of the low standard of the calibration must be at or below the reporting limit. If quadratic fit is required, there must be at least 6 points. See Appendix IV for the recommended calibration amounts.
 - 10.3.2. See chart below to obtain the typical desired levels of quantitation. This is a typical schematic of the calibration; however the standard can

concentration, calibration levels and calculated concentrations may be different, as long as the calibration rules in 10.3.1 and 10.3.11 are followed. See Appendix IV and V for the table of analytes. If the actual standard amount trapped is greater than 5% from the programmed volume, the actual volume trapped is documented and used in calculations.

Normal Level Reporting Limit (calculation based on 200ml sample analysis) Volumes (mls) taken from the working stock canisters to prepare the calibration series concentrations listed (ppbv/v)

50 ppb v/v can	240	160	80	40	20	-	-	-	-
1 ppb v/v can	-	-	-	-	-	160	80	40	20
Calculated concentration ppb v/v	60	40	20	10	5	0.8	0.4	0.2	0.1

Low Level Reporting Limit (calculation based on 500ml sample analysis) Volumes (mls) taken from stock canisters to prepare the calibration series concentrations listed (ppbv/v)

2 ppb v/v can	250	125	50	-	-	-	-
0.1 ppb v/v can	-	-	-	500	200	100	50
Calculated concentration ppb v/v	1.0	0.5	0.2	0.1	0.04	0.02	0.01

10.3.3. See Tables 1, 2 and 3 for suggested quantitation ions.

10.3.4. A calibration curve is valid for all target analytes if the relative standard deviation (RSD) of the relative response factors is $\leq 30\%$ for each target analyte, with the following allowance: up to two target analytes may have an RSD $\leq 40\%$.

10.3.5. The internal standard area response at each calibration level must be within 40% of the mean area response over the initial calibration range for each internal standard.

10.3.6. The retention time (RT) shift for each of the internal standards at each calibration level must be within 20 seconds of the retention time of the mean calibration for each internal standard.

10.3.7. Each analyte at each level must be within 0.06 RRT units of the mean RRT.

10.3.8. If the curve is acceptable and there is time remaining in the 24-hour tune, blanks, LCSs and samples may be analyzed.

10.3.9. The concentrations in the samples, LCSs and blanks are calculated using the response factors from the initial calibration curve.

10.3.10. Linear or quadratic curve fits may be used. Use of $1/\text{Concentration}^2$ weighting may be used to improve the accuracy of quantitation at the low end of the curve. The analyst should consider instrument maintenance to improve the linearity of response. The correlation coefficient (coefficient of determination for non-linear curves, r^2) must be ≥ 0.990 .

10.3.11. Analyst may elect to drop points from the calibration to improve subsequent quantitation. The rules for dropping points are:

- May drop points below the RL as long as there is a point remaining at or below the RL.
- May drop high points, decreasing linear range.
- May NOT drop a point between points.

For more guidance see “Selection of Calibration Points” Policy P-T-001, current revision.

Rules for curve use/acceptability:

- The Y intercept must be below the RL.
- The r^2 value obtained from Target must be ≥ 0.990 .
- At least 5 points must be used for average or linear curve.
- At least 6 points must be used for a quadratic curve.
- Do not include the origin or force the curve through the origin.
- For quadratic curves, the tangent line to the slope of the curve must be continuous and positive (i.e. no parabola's or breaks in the curve).

10.4. Initial Calibration Verification (ICV)

10.4.1. The ICV is a second source standard containing the TO-14 list compounds at 10 ppb (Table 1) and is analyzed after the initial calibration and before any samples are analyzed. For each analyte, a percent recovery (%R) is calculated using the response factor from the initial calibration.

10.4.2. A working standard from an independently prepared stock containing all analytes is also analyzed as the ICV for analytes not included in the TO-14 list.

10.4.3. The ICV is valid for all analytes if the %R is between 65% and 135% for each TO-14 list analyte in the ICV. Benzyl chloride ICV acceptance criteria is 20-180%.

10.5. Daily Calibration Verification

10.5.1. A mid-level standard is analyzed following the daily tune check (section 10.2) as the calibration verification standard. Typically, this is 80 mL of

the 25-ppb (v/v) can. For all target analytes, a percent difference (%D) or percent drift is calculated using the response from the calibration verification standard and compared to the current initial calibration curve.

10.5.2. A calibration verification standard is acceptable if the %D or % drift is $\leq 30\%$ for all target analytes. However, data may be reported from a calibration verification standard with up to four target analytes with % drift up to $\leq 40\%$. These analytes must be clearly noted in the data report.

10.5.2.1. For samples from New Jersey, the target analytes with drift $>30\%$ must be noted in the narrative.

10.5.3. The daily calibration verification may also serve as the LCS as long as it meets the criteria of both the LCS and the daily calibration verification (section 9).

10.5.4. If the calibration verification standard does not meet the above criteria, corrective action must be taken and/or a new initial calibration performed unless project specific analytes or client specified QC criteria are met. Corrective action may include a reanalysis of the calibration verification standard. If reanalysis of the standard does not meet acceptance criteria, further corrective action may include performing instrument maintenance, or preparation of a new working calibration verification standard. Either of these corrective actions must be followed by successful analysis of the calibration verification standard and reanalysis of any affected samples. If these corrective actions do not result in an acceptable calibration verification, a new initial calibration must be performed.

11. Procedure

11.1. Canister Preparation

11.1.1. Use the following guidelines when checking a sample upon receipt:

- Tedlar bags are inspected to ensure that the valve is closed and the bags are not leaking. Bags must be analyzed or transferred to a can within 72 hours of collection. Tedlar bags are analyzed directly from the bag or transferred to an evacuated SUMMA can within 72 hours of sampling. If the entire bag is transferred to a can, the bag is attached to a short line and the entire contents transferred to a 1-L or a 6-L evacuated can. If only a portion of the bag is to be transferred, a measured aliquot of the bag is transferred via syringe through a septa attached to the top of a 1-L or a 6-L humidified can. After transfer, the can is then pressurized to a positive pressure and the pressure is recorded. The lab default is to analyze tedlar bags at a 20x dilution. Based on a default dilution factor

at the bench, the RLs and MDLs will be 20 times higher for tedlar bag analysis. (If a client wants lower RLs than 20x the standard this will need to be communicated to the lab via special instructions.) If a client wants RLs lower than 20x and the client is supplying the tedlar bags, the PM should request that the client send an unused bag to be logged in and run along with their samples as a media blank check. If a client wants RLs lower than 20x and STL Knoxville is supplying the tedlar bags, the PM should have sample receiving set aside and log in a tedlar bag from the same lot as a media check.

- 1-L cans received between -10” Hg vacuum and a positive pressure are ready for a 20 mL analysis. If more volume is expected to be analyzed, the can will have to be pressurized in order to obtain more volume from the can.
- 6-liter cans received between -10” Hg vacuum and a positive pressure are ready for 200 mL analysis
- If any can is near zero psi (approximately -1” Hg to 1 psi), non-conformance the can as “suspect improper sampling event” and proceed with analysis. The project manager will discuss this with the client.
- Cans received –10” Hg or more vacuum should be pressurized to no more than approximately 5 psi.
- Cans below -20” Hg: non-conformance the can as “suspect improper volume sampled” and proceed with pressurizing the can to no more than approximately 5 psi for analysis. The project manager will discuss with the client that there may have not been enough sample collected for analysis and inform the analyst if sample analysis is to proceed or if the test is to be cancelled.
- Cans received at high vacuum (near -28” Hg or lower) should be inspected to determine if it is a trip blank. If the can is a trip blank, pressurize the can and use a dilution factor of one in analysis. If the sample cannot be determined to be a trip blank, non-conformance the can as “suspect improper sampling event” and proceed with pressurizing the can for analysis. The project manager will discuss with the client that there was not enough sample collected for analysis, and inform the analyst if sample analysis is to proceed or if the test is to be cancelled.

11.1.2. Measure the initial and final pressure/vacuum of the canister using an NIST traceable, certified vacuum or pressure gauge.

11.1.3. The barometric pressure, initial pressure/vacuum and final pressure/vacuum are recorded in a laboratory notebook, and used to calculate the dilution factor caused by pressurizing the can to working conditions

- 11.1.4. The canister is allowed to equilibrate for approximately one hour. If the canister was pressurized to greater than 15 psig, pressure should be released from the canister to bring the pressure below 15 psig. For autosampler volumes scheduled to be below 50 mL, the can pressure must be reduced to below 7 psig to more accurately measure the volume injected.
- 11.1.5. This canister may be further diluted, if necessary, by the dilution methods discussed in sections 11.3, 11.5 and 11.6.
- 11.2. Following a successful initial or calibration verification and prior to analysis of actual samples, an acceptable system blank and LCS must be analyzed (see sections 9.2 and 9.3). Following successful system blank and LCS analysis, actual sample analysis may begin. The LCS and blank are analyzed every 24 hour tune or every 20 samples, whichever is more frequent.
 - 11.2.1. The desired sample size of each sample to be analyzed is determined by screening the cans according to SOP KNOX-MS-0010, current revision, Volatile Analyte Screening By Purge and Trap. The standard aliquot size is 200 mL for standard reporting limit work or 500 mL for low-level work. Sample volume injected can range from 10 mL to 1000 mL. For sample volumes below 50 mL, the can pressure must be reduced to below 7 psig to more accurately measure the volume injected. Volumes larger than 1000 mL can cause trap freeze-up when high humidity samples are trapped. If samples have been adequately pressurized with nitrogen, have been diluted, or only a small amount of sample collected in the can, then volumes larger than 1000 mL may be trapped, and the internal standards and surrogates monitored closely for breakthrough or freeze-up problems.
 - 11.2.2. The pressure of each sample canister is checked. If the pressure is above 15 psig, the excess pressure is vented.
 - 11.2.3. Each sample name, volume (aliquot), method, and autosampler position are typed into the Entech sequence table.
 - 11.2.4. If necessary, the automated flush function is used to sweep each autosampler line in the name list with helium.
 - 11.2.5. The cans are then securely tightened onto the autosampler with the canister valves closed.
 - 11.2.6. An automated leak check is run on each position. A hard copy of the leak check results is included with the daily calibration package. This is only a

check to ensure that the valves are in proper working order and that the cans are attached securely to the autosampler.

- 11.2.7. If all positions pass the leak check, the canister valves are opened.
- 11.2.8. A name list similar to the Entech name list (section 11.2.3) is typed into the GC/MS sequence table. The sample volume programmed, the can number and a notation for in-can or serial dilution are noted in the analytical run log.
 - 11.2.8.1. If the actual sample amount trapped is greater than 5% from the programmed volume, the actual volume trapped is documented and used in calculating the results.
- 11.2.9. The Entech autosampler is started and the GC/MS acquisition program is started. (Note: The scan and GC parameters are controlled by the GC/MS method.)
- 11.2.10. 20 ml of the surrogate/internal standard is trapped on the Entech concentrator prior to sample introduction.
- 11.2.11. The analysis proceeds automatically for each name in the Entech autosampler program.
- 11.2.12. The internal standards and surrogates must pass all the criteria specified in section 9.1.

11.3. Autosampler Dilutions

- 11.3.1. Volumes of 10 to 1000 mL may be analyzed by the autosampler (see section 11.2.1). The standard aliquot is 200 mL for standard reporting limit work and 500 mL for low-level work.
- 11.3.2. If an analyte found in the sample is over the curve by less than a factor of twenty (based on 200 ml nominal volume) or fifty (based on 500 ml nominal volume), then the aliquot size of the sample may be reduced to a volume as low as 10 mL. This dilution factor is multiplied with all other dilution factors for this sample to obtain the final dilution factor.
- 11.3.3. If a dilution is performed to bring one or more analytes within the calibration range, the analyte having the highest concentration should not be diluted to less than 20% of the calibration range unless there are significant amounts of non-target compounds present.

- 11.3.4. If the sample is initially run at a dilution and the baseline rise is less than the height of the internal standards, or if individual non target peaks are less than five times the height of the internal standards, then the sample should be reanalyzed at a more concentrated dilution (up to the nominal volume). This requirement is approximate and subject to analyst judgment.
- 11.3.5. Only the most concentrated dilution with no target compounds above the calibration range will be reported. Other dilutions will only be reported at client request.
- 11.3.6. The internal standards and surrogates must pass all the criteria specified in section 9.1.

11.4. Water addition

- 11.4.1. The analyst should be aware that humidity plays an important role in the recovery of certain target compounds, particularly polar compounds, and should be prepared to add humidity to canisters where appropriate. The addition of water helps to stabilize the behavior of these compounds, which might otherwise interact with the interior surface of the summa canister or with the stainless-steel lines of the sample manifold.
- 11.4.2. Since it is not practical to know the relative humidity of all canisters received at the laboratory, the analyst should assume that canisters are received at approximately 80 percent relative humidity. When making canister dilutions (see Sections 11.5, and 11.6), the analyst should attempt to preserve the relative humidity of canisters at a level that will minimize recovery loss due to low canister relative humidity.
- 11.4.3. Under normal laboratory conditions, a 6 liter summa canister at ambient pressure will have a relative humidity of 100 percent if approximately 100 uL of water is in the canister.
 - 11.4.3.1. The minimum relative humidity at which canisters containing polar analytes can be analyzed before polar target recovery is negatively affected is approximately 20 - 30 percent.
 - 11.4.3.2. The minimum relative humidity at which canisters containing nonpolar analytes can be analyzed before nonpolar target recovery is negatively affected is approximately 10 percent.

11.5. Serial Dilution

- 11.5.1. High-level samples, for example, are those containing ppm levels of volatile organic compounds.
- 11.5.2. The original sample canister must have a positive pressure. If the pressure is less than 0 psig, then proceed to Section 11.1.
- 11.5.3. A septum cap is attached to the sample canister and a gas-tight syringe is purged with UHP nitrogen. A septum cap is attached to a clean evacuated 6-liter canister (the dilution canister).
- 11.5.4. 40 uL of deionized water is added to the canister through the septum of the evacuated can (See Section 11.4 for guidance on addition of water).
- 11.5.5. The syringe is inserted into the septum cap of the canister containing the sample and the canister valve is opened. The syringe is purged twice with sample and vented. The desired volume is then withdrawn and transferred into the dilution canister. The dilution canister is then pressurized using UHP nitrogen.
- 11.5.6. The final pressure is measured in the serial dilution canister using a NIST traceable, certified gauge.
- 11.5.7. If the canister was pressurized to greater than 15 psig, pressure should be released from the canister to bring the pressure below 15 psig.
- 11.5.8. The barometric pressure, the aliquot volume, final canister pressure and canister serial number are recorded in a laboratory notebook. The serial dilution factor is calculated.
- 11.5.9. If a high level dilution is performed to bring one or more analytes within the curve, the analyte having the highest concentration should not be diluted to less than 20% of the upper calibration range, unless there are significant amounts of non-target compounds present. It is imperative that high levels of target and non-target analytes not contaminate the analytical system.
- 11.5.10. This serial dilution canister may be further diluted, if necessary, by another serial dilution or in-can dilution (see section 11.6) or on the autosampler (see section 11.3). The final dilution factor is the product of all the dilution factors for the sample.

11.6. In-canister Dilutions

- 11.6.1. If an analyte found or suspected to be in the sample is over the calibration range, to a level that an autosampler dilution would be insufficient, an in-canister dilution may be performed.
- 11.6.2. The canister vacuum/pressure is checked. If the can is under vacuum, then record the vacuum reading and proceed to section 11.6.3. If the canister is under pressure, then the can is bled to ambient pressure, then proceed to section 11.6.3.
- 11.6.3. The canister is pressurized to the desired pressure. The pressure should be no more than 40 psig.
- 11.6.4. The final pressure is measured using an NIST traceable, certified gauge.
- 11.6.5. If the canister was pressurized to greater than 15 psig, pressure should be released from the canister to bring the pressure below 15 psig.
- 11.6.6. The barometric pressure and the final pressures are recorded in a laboratory notebook and the in-can dilution factor is calculated.
- 11.6.7. If an in-canister dilution is performed to bring one or more analytes within the curve, the analyte having the highest concentration should not be diluted to less than 20% of the upper calibration range, unless there are significant amounts of non-target compounds present. Care should be taken to avoid over-dilution for in-canister dilutions since the original sample is affected.
- 11.6.8. This in-can dilution canister may be further diluted, if necessary, by another in-can dilution or a serial dilution (see section 11.6) or on the autosampler (see section 11.3). This dilution factor is multiplied with all other dilution factors for this sample to obtain the final dilution factor.

11.7. Major Maintenance

- 11.7.1. A new initial calibration is necessary following major maintenance. Major maintenance includes changing the column, cleaning or repairing the source, replacing filaments, changing electronics, replacing the multiplier or changing moisture or Tenax traps.

11.8. Minor Maintenance

- 11.8.1. Minor maintenance includes cleaning the injector port, replacing filters, changing the pump oil, autotuning, switching filaments (instrument contains two filaments under vacuum), replacing valves or rotors,

change/refill the calibration vial, changing seals and o-rings, ballasting pump, replacing fuses, replacing roughing pumps or transfer lines.

- 11.9. One time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure, except those specified by project specific instructions, shall be completely documented using a Nonconformance Memo and approved by a Technical Specialist, Project Manager and QA Manager. If contractually required, the client shall be notified.
- 11.10. Any unauthorized deviations from this procedure must also be documented as a nonconformance, with a cause and corrective action described.

12. Data Analysis and Calculations

- 12.1. Refer to Figure 2 for an example data review checklists used to perform and document the review of the data. Using the data review checklist, the analyst also creates a narrative which includes any qualifications of the sample data.
- 12.2. Tentatively Identified Compounds (TICs): Library searches of peaks present in the chromatogram that are not target compounds (Tentatively Identified Compounds, TIC) may be performed if required by the client. They are evaluated using the STL Knoxville SOP KNOX-MS-0014, current revision, "Determination of Tentatively Identified Compounds (TICs)"
- 12.3. Calculation legend:
- | | | |
|----|---|--|
| A | = | amount of neat compound, uL |
| CB | = | concentration in SGDB, ug/mL |
| CC | = | concentration in canister, ppb v/v |
| CS | = | concentration in mix, ug/uL |
| Cx | = | the value determined by vendor certification analyses is used in the following calculations, ppb v/v (300 ppb nominal) |
| d | = | density of neat compound, g/mL |
| DF | = | dilution factor, unitless |
| FV | = | final volume in a pressurized canister, liters |
| GC | = | gas constant at 25°C and standard pressure, 24.45 nL/n mole |
| MW | = | molecular weight, ng/n mole |
| PB | = | barometric pressure |
| PF | = | final pressure, units specified |
| PI | = | initial pressure, units specified |
| PT | = | transfer pressure, units specified |
| Px | = | pressure in X = inches, psia or mmHg |
| TK | = | temperature in Kelvin |

TV = transfer volume, liters or uL
 V_{bottle} = volume of static gas dilution bottle, mL
 V_{mix} = volume of mix, μL

12.4. Calculations:

12.4.1. Final Canister Volume

$$FV = \frac{\text{Canister size (L)} \times P_F(\text{mm Hg Abs})}{P_B(\text{mm Hg Abs})}$$

$$\text{Pmm Hg} = \text{P inches} \times 25.4$$

$$\text{P inches} = \text{Ppsi} \times 2.036$$

$$\text{Pmm Hg} = \text{P}_{\text{psi}} \times 51.7149$$

12.5. Polar stock:

$$12.5.1. \quad CS \mu\text{g} / \text{uL} = \frac{A * d * 1000}{V_{\text{mix}}}$$

$$12.5.2. \quad CB \mu\text{g} / \text{mL} = \frac{CS * TV, \mu\text{L}}{V_{\text{bottle}}}$$

12.6. Polar concentration in target dilution standard

$$CC, \text{ppb } v/v = \frac{TV, \mu\text{L} * CB * GC}{MW * FV}$$

12.7. Stock standards in SGDB

$$CB_{\text{LIQUID}}, \mu\text{g}/\text{mL} = \frac{\# \mu\text{L} * d * 1000 * 0.8829}{V_{\text{bottle}}}$$

where 0.8829 is a temperature correction factor (from 21 °C to 60°C)—only used if the SGDB standard is in the oven at 60 C; = 294 °K / 333 °K.

12.7.1. Liquid formula

12.7.2. Solid formula

$$CB_{SOLID}, \mu\text{g}/\text{mL} = \frac{\# \text{ mg} * 1000 * 0.8829}{V_{\text{bottle}}}$$

where 0.8829 is a temperature correction factor (from 21 °C to 60°C)—only used if the SGDB standard is in the oven at 60 C; = 294 °K / 333 °K.

12.8. Concentration of standards in primary target standard made from SGDB

$$CC, \text{ ppb } v/v = \frac{TV, \text{ mL} * CB * 1000 * GC}{FV * MW}$$

12.9. Concentration of Cylinder Standards: Concentration of Analytes in Primary Target Standard

$$CC, \text{ ppb } v/v = \frac{(P_T - P_I, \text{ psi})(Cx)}{(P_F, \text{ psi} + P_B, \text{ psi})}$$

12.10. Target Dilution Standard (CC is the concentration of the Primary Target Standard).

$$CC, \text{ ppb } v/v = \frac{(P_T - P_I)(CC)}{(P_F + P_B, \text{ psi})}$$

12.11. Dilution Factors of original sample canisters

12.11.1. In Can Dilution Factor

$$DF = \frac{P_{f(mmAbs)}}{P_{i(mmAbs)}}$$

12.11.2. Serial Dilution Factor

$$DF = FV/TV$$

12.11.3. Instrument Dilution Factor

$$DF = \frac{\text{Nominal Sample Volume}}{\text{Sample Volume Injected}}$$

12.12. Response Factor (RF)

$$RF = \frac{A_x * C_{is}}{A_{is} * C_x}$$

where:

- x = area of the characteristic ion for the target compound.
 A_{is} = area of the characteristic ion for the internal standard.
 C_x = amount of the target compound.
 C_{is} = amount of the internal standard.

12.13. Average Response Factor (ARF)

$$ARF = \frac{RF_1 + RF_2 + \dots + RF_n}{n}$$

where:

- n = the number of calibration points

12.14. Standard deviation of the ARF:

$$S = \sqrt{\frac{\sum_i^n (ARF - RF_n)^2}{n - 1}}$$

12.15. Relative standard deviation (RSD) of the ARF:

$$RSD = \frac{S}{ARF} * 100\%$$

12.16. Calibration Verification : Percent deviation (% D) of the daily RF values as compared with the initial ARF values:

$$\% D = \frac{|RF - ARF|}{ARF} * 100\%$$

12.17. Laboratory Control Sample percent recovery (%R):

$$\% R = \frac{FoundAmount, ppb}{SpikeAmount, ppb} * 100\%$$

12.18. Duplicate relative percent difference (RPD):

$$RPD = \frac{|A_1 - A_2|}{A} * 100\%$$

where:

A₁ = amount determined in first analysis
 A₂ = amount determined in second analysis
 A = average determination, (A₁ + A₂)/2

12.19. Calibration verification percent drift and difference from the initial calibration:

$$\% \text{ Drift} = \frac{C_{\text{expected}} - C_{\text{found}}}{C_{\text{expected}}} \times 100$$

Where

C_{expected} = Known concentration in standard

C_{found} = Measured concentration using selected quantitation method

$$\% \text{ Difference} = \frac{\overline{RF} - RF}{\overline{RF}} \times 100$$

\overline{RF} = Average Analyte Response Factor from Initial Calibration

RF = Measured Analyte Response Factor from Calibration Verification

12.19.1. Target analyte concentrations in samples are typically calculated using the average response factor from the initial calibration. Quantitation may also be determined using linear or second order curves at the analyst's discretion to improve the quantitation of target analytes.

12.19.1.1. Calculation of concentration using Average Response Factors

$$C_{pv} = \frac{R_x C_{is}}{R_{is} RF}$$

12.19.1.2. Calculation of concentration using Linear fit

$$C_{pv} = A + B \frac{(R_x C_{is})}{R_{is}}$$

C_{pv} = Concentration, ppb (v/v)

R_x = Response for analyte (area of quantitation ion)

R_{is} = Response for internal standard (area of quantitation ion)

C_{is} = Concentration of internal standard

A = Intercept

B = Slope

The corresponding Target software calculation is as follows:

$$C_{pv} = C_{is} \left(b + \frac{1}{m1} \times \frac{R_x}{R_{is}} \right)$$

b = Concentration Ratio Intercept

m1 = Inverse of Slope

12.19.1.3. Calculation of concentration using Quadratic fit

$$C_{pv} = A + B \left(\frac{R_x C_{is}}{R_{is}} \right) + C \left(\frac{R_x C_{is}}{R_{is}} \right)^2$$

C = Curvature

The corresponding Target software calculation is as follows:

$$C_{pv} = C_{is} \left(b + m1 \times \frac{R_x}{R_{is}} + m2 \times \left(\frac{R_x}{R_{is}} \right)^2 \right)$$

m1 = First order coefficient

m2 = Curvature (Second order coefficient)

12.20. Sample Quantitation: The amount of target compound detected is determined using the average RF or calibration curve values from the initial calibration (not the continuing calibration):

$$\text{Amount} = C_{pv} * DF$$

12.21. Unit conversions

12.21.1.

$$\text{Amount, } \mu\text{g/ m}^3 = \frac{\text{Amount, ppb (v/v) * MW}}{\text{GC}}$$

12.21.2.

$$\text{Amount, ppm v/v} = \text{amount, } \frac{\text{ppb (v/v)}}{1000}$$

12.22. Quantitation of Unknowns

12.22.1. If required, nontarget peaks are reported with probable identifications as Tentatively Identified Compounds (TICs). These are quantitated using the nearest internal standard and assuming a response factor of 1; correction for dilution factor is also made. Search criteria are those in the STL Knoxville SOP KNOX-MS-0014, current revision, Tentatively Identified Compounds (TICs).

13. Method Performance

- 13.1. Method Detection Limit (MDL) - An MDL must be determined for each analyte in each routine matrix prior to the analysis of any samples. The procedure for determination of the method detection limit is given in the SOP S-Q-003 current revision based on 40 CFR Part 136 Appendix B. The result of the MDL determination must support the reporting limit. MDL summaries are stored on the local area network.
- 13.2. Initial Demonstration of Capability – Each analyst must perform an initial demonstration of capability (IDOC) for each target analyte prior to performing the analysis independently. The IDOC is determined by analyzing four replicate spikes (e.g., LCSs) as detailed in STL Knoxville SOP KNOX-QA-0009. Recovery limits must be 70-130% and RSD must be less than or equal to 25%. Recovery limits for Methanol are 60-140% and RSD must be less than or equal to 30%.
- 13.3. Training Qualification: The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience. Refer to SOP KNOX-QA-0009 current revision for further requirements for performing and documenting initial and on-going demonstrations of capability.

14. Pollution Prevention

- 14.1. All attempts will be made by laboratory personnel to minimize the use of solvents when performing this procedure.

15. Waste Management

- 15.1. All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the Corporate Safety Manual for “Waste Management and Pollution Prevention.”
- 15.2. The following waste streams are produced when this method is carried out.
 - Expired solid and liquid standards are stored in metal closed-top containers.

16. References

- 16.1. Compendium Method TO-14, “The Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using SUMMATM Passivated Canister Sampler and Gas Chromatographic Analysis,” U.S. EPA 600/4-89/017, June 1988.
- 16.2. Compendium Method TO-14A, “Determination of Volatile Organic Compounds (VOCs) in Ambient Air Using Specially Prepared Canisters With Subsequent Analysis by Gas Chromatography,” U.S. EPA 625/R-96/010b, January 1999.
- 16.3. Compendium Method TO-15, “Determination of Volatile Organic Compounds (VOCs) in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GCMS),” U.S. EPA 625/R-96/010b, January 1999.
- 16.4. STL Quality Management Plan (QMP), current revision.
- 16.5. STL Knoxville Laboratory Quality Manual (LQM), current revision.
- 16.6. Entech Instruments Inc. 7100 Operators Manual. Version 2.0 for the 7100 Preconcentrator and Accessories.

17. Miscellaneous

- 17.1. Other SOPs cross-referenced in this SOP: KNOX-SC-0001, “Canister Cleaning and Preparation”, latest revision.
- 17.2. Modification from the referenced methods

- 17.2.1. The TO-15 tune criteria were not used in this procedure. The tune criteria listed in TO-14 is tighter and thus was used in this procedure. This SOP also allows for 50 ng or less of BFB to verify tuning of the instrument.
- 17.2.2. The continuing calibration listed in this procedure allows up to 4 target analytes with a %D of $\leq 40\%$, with a narrative note (or data review checklist note for non-NJ DEP analysis) of those target analytes that are over 30% D, but $\leq 40\%$ D.
- 17.2.3. This procedure uses purified nitrogen in place of zero humid air specified in the reference methods.
- 17.2.4. TO-14 requires that the RT shift for the internal standards at each calibration level must be within 20 seconds of the RT of the mid-level calibration for each internal standard. TO-15 specifies that the comparison is made to the mean RT over the initial calibration range for each internal standard. This SOP uses the TO-15 criteria.
- 17.2.5. Section 7.13 Method TO-15 states that the working standard may be stored for 30 days. This laboratory experience has allowed the standard expiration date to be 2 months with no significant degradation of the standards.
- 17.2.6. Surrogates are not required by the methods. This SOP adds surrogates to every sample to help monitor for matrix effects and method performance.
- 17.2.7. The TO-15 method states that the scan time must give 10 scans per peak, not to exceed 1 second per scan. The GC/MS software is set for a sampling rate of 3, which corresponds to approximately 2 to 3 scans per second, depending on the instrument. See the GC/MS operator's manual or "help" on the software for more information about the sampling rate.
- 17.2.8. EPA Method TO-14A specifies that the relative accuracy of the field sampler or sample delivery system must meet 90-110% for a standard at 8 ppb v/v. The laboratory Control Sample (LCS) summary data is evaluated against alternate acceptance criteria based on this laboratory procedure for method TO-14A. When TO-14A work is performed, this must be noted in the case narrative.

17.3. List of Appendices

17.3.1. Appendix I: Target Analyte Tables

17.3.1.1. Table 1: Target Analytes - TO-14 and TO-15 Compounds

17.3.1.2. Table 2: Target Analytes - Other Nonpolar Compounds

17.3.1.3. Table 3: Target Analytes - Other Polar Compounds

17.3.2. Appendix II: Figures

17.3.2.1. Figure 1: BFB Tuning Criteria

17.3.2.2. Figure 2: Example of a Data Review Checklist

17.3.2.3. Figure 3: Flow Chart

17.3.3. Appendix III: Example Instrument Parameters

17.3.4. Appendix IV: Recommended Calibration Levels (normal reporting limits)

17.3.5. Appendix IV: Recommended Calibration Levels (low level reporting limits).

Appendix I: Target Analyte Tables**Table 1: Target Analytes – Method TO-14A Target Compounds**

CAS NUMBER	METHOD TO-14 COMPOUND	REPORTING LIMIT (ppb, v/v) (i)	REPORTING LIMIT (ug/m ³) (i)	Low Level Reporting Limit (ppb, v/v) (j)	MOLECULAR WEIGHT (ng/n mole)	SUGGESTED ION
75-71-8	Dichlorodifluoromethane (b)	0.2	0.99	0.020	120.9	85
76-14-2	1,2-Dichlorotetrafluoroethane (c)	0.2	1.40	0.020	170.9	135
74-87-3	Chloromethane	0.5	1.03	n/a	50.49	52
75-01-4	Vinyl Chloride	0.2	0.51	0.020	62.50	62
74-83-9	Bromomethane	0.2	0.78	0.060	94.94	94
75-00-3	Chloroethane	0.2	0.53	0.030	64.51	64
75-69-4	Trichlorofluoromethane (d)	0.2	1.12	0.030	137.4	101
75-35-4	1,1-Dichloroethene	0.2	0.79	0.090	96.94	96
76-13-1	1,1,2-Trichlorotrifluoroethane (e,f)	0.2	1.53	n/a	187.4	101
75-09-2	Methylene Chloride (f)	0.5	1.74	n/a	84.93	84
75-34-3	1,1-Dichloroethane	0.2	0.81	0.020	98.96	63
156-59-2	cis-1,2-Dichloroethene	0.2	0.79	0.050	96.94	96
67-66-3	Chloroform	0.2	0.98	0.020	119.4	83
71-55-6	1,1,1-Trichloroethane	0.2	1.09	0.020	133.4	97
56-23-5	Carbon Tetrachloride	0.2	1.26	0.020	153.8	117
71-43-2	Benzene	0.2	0.64	0.030	78.11	78
107-06-2	1,2-Dichloroethane	0.2	0.81	0.020	98.96	62
79-01-6	Trichloroethene	0.2	1.07	0.020	131.4	130
78-87-5	1,2-Dichloropropane	0.2	0.92	0.030	113.0	63
10061-01-5	cis-1,3-Dichloropropene	0.2	0.91	0.030	111.0	75
108-88-3	Toluene	0.2	0.75	0.10	92.14	91
10061-02-6	trans-1,3-Dichloropropene	0.2	0.91	0.050	111.0	75
79-00-5	1,1,2-Trichloroethane	0.2	1.09	0.040	133.4	97
127-18-4	Tetrachloroethene	0.2	1.36	0.020	165.8	129
106-93-4	1,2-Dibromoethane (EDB)	0.2	1.54	0.020	187.9	107
108-90-7	Chlorobenzene	0.2	0.92	0.020	112.6	112
100-41-4	Ethylbenzene	0.2	0.87	0.020	106.2	91
IT5-30-5	m/p-Xylene (g, h)	0.2	0.87	0.10	106.2	91
95-47-6	o-Xylene (h)	0.2	0.87	0.030	106.2	91
100-42-5	Styrene	0.2	0.85	0.020	104.2	104
79-34-5	1,1,2,2-Tetrachloroethane	0.2	1.37	0.020	167.8	83
108-67-8	1,3,5-Trimethylbenzene	0.2	0.98	0.020	120.2	120
95-63-6	1,2,4-Trimethylbenzene	0.2	0.98	n/a	120.2	105
541-73-1	1,3-Dichlorobenzene	0.2	1.2	n/a	147.0	146
106-46-7	1,4-Dichlorobenzene	0.2	1.2	n/a	147.0	146
100-44-7	Benzyl Chloride	0.4	2.07	n/a	126.6	91
95-50-1	1,2-Dichlorobenzene	0.2	1.2	n/a	147.0	146
120-82-1	1,2,4-Trichlorobenzene	1.0	7.42	n/a	181.4	180
87-68-3	Hexachlorobutadiene	1.0	10.67	n/a	260.8	225

b) Freon 12

c) Freon 114

d) Freon 11

e) Freon 113

f) This is a common laboratory solvent

g) m-xylene and p-xylene coelute

h) Total xylenes (CAS # 1330-20-7) is the sum of m/p-xylenes and o-xylene.

i) Normal reporting limits (RLs) based on 200 mL sample volume. The ug/m³ values are example RLs using the value listed in the table.

j) Low level reporting limits based on 500 mL sample volume

Table 2: Target Analytes - Other Nonpolar Compounds

CAS NUMBER	OTHER NON-POLAR COMPOUNDS	REPORTING LIMITS (ppb, v/v) (i)	REPORTING LIMIT (ug/m ³) (i)	Low Level Reporting Limit (ppb, v/v) (j)	MOLECULAR WEIGHT (ng/n mole)	SUGGESTED ION
75-45-6	Chlorodifluoromethane (b)	0.2	0.71	n/a	86.47	51
106-97-8	n-Butane	0.4	0.95	n/a	58.12	43
106-99-0	1,3-Butadiene	0.4	0.88	0.030	54.09	54
109-66-0	Pentane	1.0	2.95	n/a	72.15	57
75-15-0	Carbon Disulfide	0.5	1.56	n/a	76.14	76
107-05-1	3-Chloropropene	0.2	0.63	0.060	76.52	39
156-60-5	trans-1,2-Dichloroethene	0.2	0.79	0.10	96.94	96
110-54-3	n-Hexane	0.5	1.76	0.10	86.18	56
110-82-7	Cyclohexane	0.5	1.72	0.040	84.16	69
540-84-1	2,2,4-Trimethylpentane	0.5	2.34	0.020	114.2	57
142-82-5	n-Heptane	0.5	2.05	0.020	100.2	43
74-95-3	Dibromomethane	0.4	2.84	n/a	173.8	93
75-27-4	Bromodichloromethane	0.2	1.34	0.020	163.8	83
111-65-9	n-Octane	0.4	1.87	n/a	114.2	85
124-48-1	Dibromochloromethane	0.2	1.7	0.020	208.3	129
111-84-2	Nonane	0.5	2.62	n/a	128.3	57
75-25-2	Bromoform	0.2	2.07	0.020	252.7	173
98-82-8	Cumene	0.4	1.97	n/a	120.2	105
103-65-1	n-Propylbenzene	0.4	1.97	n/a	120.2	120
95-49-8	2-chlorotoluene	0.4	2.07	n/a	126.6	126
622-96-8	4-ethyltoluene	0.4	1.97	0.020	120.2	105
124-18-5	Decane	1.0	5.82	n/a	142.3	57
98-83-9	alpha-Methylstyrene	0.4	1.93	n/a	118.2	118
135-98-8	sec-butylbenzene	0.4	2.20	n/a	134.2	105
104-51-8	n-Butylbenzene	0.4	2.20	n/a	134.2	91
1120-21-4	n-Undecane	1.0	6.39	n/a	156.3	57
112-40-3	n-Dodecane	1.0	6.97	n/a	170.3	57
91-20-3	Naphthalene	0.5	2.62	n/a	128.2	128

b) Freon 22

i) Normal reporting limits (RLs) based on 200 mL sample volume. The ug/m³ values are example RLs using the value listed in the table.

j) Low level reporting limits based on 500 mL sample volume.

Table 3: Target Analytes – Other Polar Compounds

CAS NUMBER	OTHER POLAR COMPOUNDS	REPORTING LIMITS (ppb, v/v) (i)	REPORTING LIMIT (ug/m ³) (i)	Low Level Reporting Limit (ppb, v/v) (j)	MOLECULAR WEIGHT (ng/n mole)	SUGGESTED ION
67-56-1	Methanol	10	13.1	n/a	32.04	31
593-60-2	Vinyl Bromide	0.2	0.88	0.050	107.0	106
60-29-7	Ethyl Ether	2.0	6.06	n/a	74.12	31
67-64-1	Acetone	5.0	11.88	n/a	58.08	58
75-65-0	Tert-Butanol	2.0	6.06	n/a	74.12	59
107-13-1	Acrylonitrile	2.0	4.34	n/a	53.06	53
108-05-4	Vinyl Acetate	1.0	3.52	n/a	86.09	43
78-93-3	2-Butanone	1.0	2.95	n/a	72.11	72
71-36-3	1-Butanol	2.0	6.06	n/a	74.12	31
108-10-1	4-Methyl-2-Pentanone	0.5	2.05	n/a	100.2	43
591-78-6	2-Hexanone	0.5	2.05	n/a	100.2	58
1634-04-4	Methyl-t-Butyl ether	1.0	3.61	0.050	88.15	73
107-02-8	Acrolein	0.8	1.83	n/a	56.06	56
75-05-8	Acetonitrile	1.0	1.68	n/a	41.05	40
96-18-4	1,2,3-Trichloropropane	0.5	3.01	n/a	147.4	110

i) Normal reporting limits (RLs) based on 200 mL sample volume. The ug/m³ values are example RLs using the value listed in the table.

j) Low level reporting limits based on 500 mL sample volume

Appendix II: Figures

Figure 1: BFB Tuning Criteria

Mass	Abundance Criteria
50	15 to 40% of mass 95
75	30 to 60% of mass 95
95	Base peak, 100% relative abundance
96	5 to 9% of mass 95
173	Less than 2% of mass 174
174	Greater than 50% of mass 95
175	5 to 9% of mass 174
176	95% to 101% of mass 174
177	5 to 9 % of mass 176

Note: All ion abundances must be normalized to m/z 95, the nominal base peak, even though m/z 174 may be over 100 % of m/z 95.

Figure 2: Example Data Review Checklist

STL Knoxville GC/MS Air Initial Calibration Data Review / Narrative Checklist
Method: TO-14 and TO-15 - KNOX-MS-0001, Rev 9

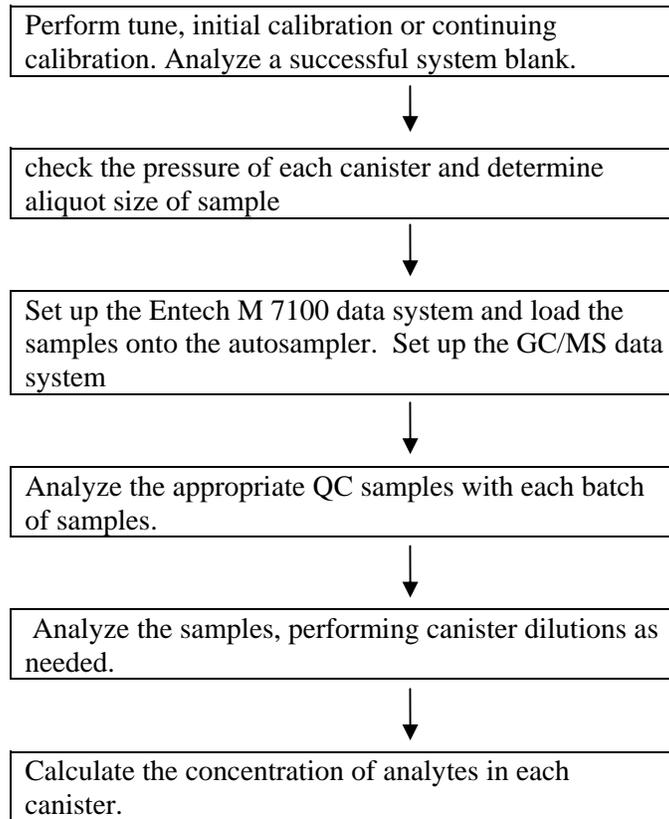
Analysis Date:		Instrument:		ICAL Batch/Scan Name:		Scanned ?	
Review Items		N/A	Yes	No	If No, why is data reportable?	2d	✓
1. Did BFB meet tune criteria?							
2. Were all standards injected within 24 hr of BFB?							
3. Was date/time of analysis verified between analysis header and logbook as correct?							
4. Is low level std at or <RL and are the remaining points consecutive?							
5. Were at least 5 levels of each compound analyzed?							
6. Is %RSD for all target analytes ≤ 30%? (with up to 2 compounds with RSD ≤ 40%)							
7. Have all peaks been auto identified? If not, list:							
8. If curves were used, is correlation coefficient ≥0.990?							
9. At least 6 consecutive points used for quadratic curves, and at least 5 consecutive points for linear curves?							
10. For linear or quadratic: is a tangent's slope to the curve entirely positive or negative and continuous.							
11. For linear or quadratic: origin NOT included or forced?							
12. Is the "Y" intercept less than the RL for each curve?							
13. RT for each IS ±20 sec avg. RT?							
14. Area for each IS + 40% avg. area?							
15. Each analyte ± 0.06 RRT of avg. RRT?							
16. If manual integrations were performed, are they clearly identified, initialed, dated and reason given?					Reasons: 1)Corrected split peak; 2)Unresolved peak; 3)tailing; 4)RT shift; 5)wrong peak selected; 6)other		
17. Have alternate hits/manual integrations been verified as correct and are correct RFs listed in ICAL summary?							
18. Was ICAL summary form processed using correct methods and files?							
19. Are the ICAL start and end dates/times correct on ICAL summary?							
20. Elution order checked on isomeric pairs? <ul style="list-style-type: none"> • dichlorodifluoromethane / 1,2-dichlorotetrafluoroethane • trichlorofluoromethane / 1,1,2-trichlorotrifluoroethane • vinyl acetate / hexane • cis- and trans- isomers • ethyl benzene / m/p -xylene / o-xylene • 4-ethyl toluene/1,3,5-trimethylbenzene/1,2,4-trimethylbenzene • 1,3-, 1,4-, and 1,2-dichlorobenzene 							
21. Is the second source analysis of a reference standard within limits? (65-135% R; 20-180% for benzyl chloride)							
22. If criteria were not met, was a NCM generated, approved by supervisor, and copy included in folder?							
23. Does the ICAL folder contain complete data in the following order: Data review checklist, a complete runlog, Entech report, BFB info, ICAL summary, curves, followed by [Quan reports, chromatograms, manual integrations] in increasing amount order.							
Analyst:		Date:		2nd Level Reviewer :		Date:	
Comments:				Comments:			

Figure 2: Example Data Review Checklist (continued)

STL Knoxville GC/MS Air Data Review / Narrative Checklist				LOT/Project # _____				
Method: TO-14 and TO-15 - KNOX-MS-0001, Rev 9				Page 1 of 1				
Instrument:								
Scanned File:								
Review Items								
A. Tune / Continuing Calibration				N/A	Yes	No	Why is data reportable?	2nd ✓
1. Were all samples injected within 24 hr of BFB?								
2. Has a Continuing Calibration Checklist been completed for each analytical batch?								
3. Was the correct ICAL used for quantitation?								
B. CLIENT SAMPLE AND QC SAMPLE Results				N/A	Yes	No	Why is data reportable?	
1. Were all special project requirements met?								
2. Were dilution factors/can prep information verified?								
3. Have the can number & lab ID been verified between the analysis log & sample prep log?								
4. Were samples received in cans?							/ [Tedlar1] Samples rec'd on (date) in Tedlar bags & ana by TO-14 (TO-15) within 72 hours from sampling. / [Tedlar2] Samples rec'd on (date) in Tedlar bags & transferred into Summa canisters within 72 hours.	
5. Sample analyses done within analytical holding time (HT)? <i>If no, list samples: _____</i>							/ [ht2] Client requested analysis after HT expired. / Other: _____	
6. Are surrogates and internal standards within QC limits? (70-130% R for surr.; 60-140%R from CICAL for IS) <i>If no, list samples/reason (e.g., sur1):</i> Sample Reason Sample Reason _____ _____ _____ _____ _____ _____ _____ _____							/ [sur1] DUP surr. %R demonstrated same effect. / [sur2] Reanalysis demonstrated same effect. / [sur5] At client's request, data was flagged as estimated & released without further investigation.* / [is1] Per client, reanalysis was not performed * / [is2] Reanalysis confirmed a matrix effect. / Obvious matrix effect	
7. Were all positive results and false negatives on quan report verified to be correct in LIMS?								
8. For dilutions, is highest concentration hit \geq 20% cal range and not above calibration range? <i>List samples and reason (e.g., elev1):</i> Sample Reason Sample Reason _____ _____ _____ _____ _____ _____ _____ _____							/ [elev1] Elevated RL for (ANALYTE) due to sample matrix interferences. / [elev3] Elevated RLs for all analytes due to difficult sample matrix. / [elev4] Elevated RLs based on screening / [elev5] Elevated RLs for all analytes due to presence of non-target compounds.	
9. If manual integrations were performed, are they clearly identified, initialed, dated and reason given?							Reasons: 1)Corrected split peak; 2)Unresolved peak; 3)tailing; 4)RT shift; 5)wrong peak selected; 6)other	
10. Have alternate hits/manual integrations been verified as correct?								
C. Preparation QC								
1. System blank run every 24 hours prior to samples?								
2. System blank surrogate recoveries within QC limits (70-130% R)?							/ [mb1] All sample surrogates OK and there is no analyte >RL in samples associated with blank.*	
3. Are all analytes present in the system blank < RL? <i>If no, list blank ID: _____</i>							/ [mb3] No analyte > RL in associated samples.* / [mb4] Sample results > 20x higher than blank.	
4. DUP done per 20 samples and are all RPDs within limits? (for target analytes >5x RL, <25% RPD; no criteria for methanol and n-butanol) <i>If no, list DUP ID: _____</i>								
5. Are all LCS analytes on final report within limits?							/ [LCS6] Flagged out but within SOP limits. LCS ID: _____	
D. Other								
1. Final report acceptable? (Results correct, RLs calculated correctly, units correct, surrogate %R correct, appropriate flags used, dilution factor correct, analysis dates correct.)								
2. Are all nonconformances documented appropriately and copy included with deliverable?								
3. Were the standards scanned properly?								
4. Was a narrative prepared and all deviations noted?								
5. TO14A Autotext included in narrative (for TO14A samples only).							/ [TO14]	
6. All target analytes on o.cal >30%D but <40%D noted in the narrative?							/ [oca1] The ocal exhibited a %D ICAL >30% but \leq 40% for the following analytes: _____	
Analyst:		Date:		2 nd Level Reviewer:		Date:		
Comments:				Comments:				

* Such action must be taken in consultation with client.

Figure 3: Flow Chart



Appendix III: Example Instrument parameters

```
TOPLEVEL PARAMETERS
-----
Method Information For: C:\MSDCHEM\1\METHODS\T014.M
Method Sections To Run:
  ( ) Save Copy of Method With Data
  ( ) Pre-Run Cmd/Macro =
  (X) Data Acquisition
  ( ) Data Analysis
  ( ) Post-Run Cmd/Macro =
Method Comments:
  T014 METHOD USING HP-DB-5 60M X 0.32MM X 1.0 FILM THICKNESS

END OF TOPLEVEL PARAMETERS
-----

INSTRUMENT CONTROL PARAMETERS
-----

Sample Inlet:      GC
Injection Source:  Manual
Injection Location: Front
Mass Spectrometer: Enabled

=====
HP6890 GC METHOD
=====

OVEN
Initial temp: 35 'C (On)           Maximum temp: 230 'C
Initial time: 5.00 min             Equilibration time: 0.00 min
Ramps:
#   Rate   Final temp   Final time
1   6.00    65             0.00
2  12.00   155            0.00
3  25.00   220            7.00
4   0.0    0.0(Off)
Post temp: 35 'C
Post time: 0.00 min
Run time: 27.10 min

FRONT INLET (UNKNOWN)             BACK INLET ( )
Mode: Split
Initial temp: 200 'C (On)
Pressure: 7.89 psi (On)
Split ratio: 2:1
Split flow: 3.0 mL/min
Total flow: 7.3 mL/min
Gas saver: Off
Gas type: Helium

COLUMN 1                          COLUMN 2
Capillary Column                   (not installed)
Model Number: HP 19091J-216
HP-5 5% Phenyl Methyl Siloxane
Max temperature: 325 'C
Nominal length: 59.0 m
Nominal diameter: 320.00 um
Nominal film thickness: 1.00 um
Mode: constant flow
Initial flow: 1.5 mL/min
Nominal init pressure: 7.90 psi
Average velocity: 31 cm/sec

Method: T014.M                      Wed Apr 30 14:03:13 2003          Page: 1
```

```

Inlet: Front Inlet
Outlet: MSD
Outlet pressure: vacuum

FRONT DETECTOR (NO DET)          BACK DETECTOR (NO DET)
SIGNAL 1                          SIGNAL 2
Data rate: 20 Hz                 Data rate: 20 Hz
Type: test plot                  Type: test plot
Save Data: Off                   Save Data: Off
Zero: 0.0 (Off)                  Zero: 0.0 (Off)
Range: 0                          Range: 0
Fast Peaks: Off                  Fast Peaks: Off
Attenuation: 0                    Attenuation: 0

COLUMN COMP 1                     COLUMN COMP 2
(No Detectors Installed)         (No Detectors Installed)

THERMAL AUX 2
Use: MSD Transfer Line Heater
Description:
Initial temp: 150 °C (On)
Initial time: 0.00 min
# Rate Final temp Final time
1 0.0(Off)

POST RUN
Post Time: 0.00 min

TIME TABLE
Time Specifier Parameter & Setpoint

7673 Injector

Front Injector:
Injector not configured, use these parameters if it becomes configured
Sample Washes 2
Sample Pumps 4
Injection Volume 1.0 microliters
Syringe Size 10.0 microliters
PostInj Solvent A Washes 4
PostInj Solvent B Washes 0
Viscosity Delay 0 seconds
Plunger Speed Fast

Back Injector:
No parameters specified

MS ACQUISITION PARAMETERS

General Information
-----
Tune File : bfb.u
Acquisition Mode : Scan

MS Information
--
Solvent Delay : 3.80 min
EM Absolute : False
EM Offset : 0
Resulting EM Voltage : 1858.8

[Scan Parameters]
Low Mass : 28.5
High Mass : 260.5
Threshold : 200
Sample # : 3 A/D Samples 8
Plot 2 low mass : 28.5
Plot 2 high mass : 260.5

[MSZones]
MS Quad : 106 C maximum 200 C
MS Source : 230 C maximum 250 C

END OF MS ACQUISITION PARAMETERS

PostRun InstCntl macro(s) exist: msacq2.mac

END OF INSTRUMENT CONTROL PARAMETERS

```

Appendix IV: Recommended Calibration levels (normal reporting limit based on 200 mL sample analysis)

Compound	Level, ppb v/v*								
	1	2	3	4	4A	5	6	7	8
Bromochloromethane	10	10	10	10	10	10	10	10	10
1,4-Difluorobenzene	10	10	10	10	10	10	10	10	10
Chlorobenzene-d5	10	10	10	10	10	10	10	10	10
1,2-Dichloroethane-d4	10	10	10	10	10	10	10	10	10
Toluene-d8	10	10	10	10	10	10	10	10	10
4-Bromofluorobenzene	10	10	10	10	10	10	10	10	10
Chlorodifluoromethane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Dichlorodifluoromethane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Chloromethane	-	-	0.4	0.8	2.5	5	10	15	30
1,2-Dichlorotetrafluoro-methane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Vinyl Chloride	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Methanol	-	-	-	3.2	10	20	40	60	120
1,3-Butadiene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
n-Butane	-	0.2	0.4	0.8	2.5	5	10	15	30
Bromomethane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Chloroethane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Trichlorofluoromethane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Acrolein	-	0.4	0.8	1.6	5.0	10	20	30	60
Acetonitrile	-	-	0.8	1.6	5.0	10	20	30	60
Acetone	-	-	-	1.6	5.0	10	20	30	60
Pentane	-	-	0.4	0.8	2.5	5	10	15	30
Ethyl Ether	-	0.4	0.8	1.6	5.0	10	20	30	60
1,1-Dichloroethene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Acrylonitrile	-	0.4	0.8	1.6	5.0	10	20	30	60
1,1,2-Trichlorotrifluoroethane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Methylene Chloride	-	-	0.4	0.8	2.5	5	10	15	30
3-chloropropene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Carbon Disulfide	-	0.2	0.4	0.8	2.5	5	10	15	30
Trans-1,2-Dichloroethene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Methyl-t-butyl Ether	0.1	0.4	0.8	1.6	5.0	10	20	30	60
1,1-Dichloroethane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Vinyl Acetate	-	0.4	0.8	1.6	5.0	10	20	30	60
2-Butanone	-	-	0.8	1.6	5.0	10	20	30	60
Hexane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
cis-1,2-Dichloroethene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Chloroform	0.1	0.2	0.4	0.8	2.5	5	10	15	30
1,1,1-Trichloroethane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
1,2-Dichloroethane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Benzene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
1-Butanol	-	0.4	0.8	1.6	5.0	10	20	30	60
Cyclohexane	-	0.2	0.4	0.8	2.5	5	10	15	30
Carbon Tetrachloride	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Heptane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
1,2-Dichloropropane	0.1	0.2	0.4	0.8	2.5	5	10	15	30

Appendix IV: Recommended Calibration levels (normal reporting limit based on 200 mL sample analysis), continued

Compound	Level, ppb v/v*								
	1	2	3	4	4A	5	6	7	8
Trichloroethene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Dibromomethane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Bromodichloromethane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
4-Methyl-2-Pentanone	-	0.4	0.8	1.6	5.0	10	20	30	60
cis-1,3-Dichloropropene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
trans-1,3-Dichloropropene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Toluene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
1,1,2-Trichloroethane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
2-Hexanone	-	0.4	0.8	1.6	5.0	10	20	30	60
Octane	-	0.2	0.4	0.8	2.5	5	10	15	30
Dibromochloromethane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
1,2-Dibromoethane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Tetrachloroethene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Chlorobenzene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Ethylbenzene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
m/p-Xylene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Bromoform	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Nonane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Styrene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
o-Xylene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
1,1,2,2-Tetrachloroethane	0.1	0.2	0.4	0.8	2.5	5	10	15	30
1,2,3-Trichloropropane	-	-	0.4	0.8	2.5	5	10	15	30
Cumene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
n-Propylbenzene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
4-Ethyltoluene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
1,3,5-Trimethylbenzene	0.1	0.2	0.4	0.8	2.5	5	10	15	30
Alpha-Methylstyrene	-	0.2	0.4	0.8	2.5	5	10	15	30
Decane	-	0.2	0.4	0.8	2.5	5	10	15	30
1,2,4-Trimethylbenzene	-	0.2	0.4	0.8	2.5	5	10	15	30
1,3-Dichlorobenzene	-	0.2	0.4	0.8	2.5	5	10	15	30
Benzyl Chloride	-	0.2	0.4	0.8	2.5	5	10	15	30
1,4-Dichlorobenzene	-	0.2	0.4	0.8	2.5	5	10	15	30
1,2-Dichlorobenzene	-	0.2	0.4	0.8	2.5	5	10	15	30
Undecane	-	0.2	0.4	0.8	2.5	5	10	15	30
Dodecane	-	0.2	0.4	0.8	2.5	5	10	15	30
1,2,4-Trichlorobenzene	-	0.2	0.4	0.8	2.5	5	10	15	30
Naphthalene	-	0.2	0.4	0.8	2.5	5	10	15	30
Hexachlorobutadiene	-	0.2	0.4	0.8	2.5	5	10	15	30
Sec-butylbenzene	-	0.2	0.4	0.8	2.5	5	10	15	30
n-Butylbenzene	-	0.2	0.4	0.8	2.5	5	10	15	30
Vinyl Bromide	-	0.2	0.4	0.8	2.5	5	10	15	30
Tert-Butanol	-	0.4	0.8	1.6	5.0	10	20	30	60
2,2,4-Trimethylpentane	-	0.2	0.4	0.8	2.5	5	10	15	30
2-Chlorotoluene	-	0.2	0.4	0.8	2.5	5	10	15	30

* See section 10.3.11.

Appendix V: Recommended Low Level Calibration levels (normal reporting limit based on 500 mL sample analysis)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
For compounds listed in Tables 1, 2, and 3 that are noted for Low Level analysis	0.010	0.020	0.040	0.100	0.200	0.500	1.0

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Implementation Date: _____

SOP No. KNOX-MS-0015
Revision No. 11
Revision Date: 10/09/08
Page: 1 of 55

TESTAMERICA KNOXVILE
STANDARD OPERATING PROCEDURE
TITLE: DETERMINATION OF VOLATILE ORGANICS BY GC/MS
BASED ON METHOD 8260B
(SUPERSEDES: KNOX-MS-0015, Revision 10)

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Environmental, Health and Safety Coordinator
Approved By: J. [Signature] 10-15-08
Laboratory Director

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1. SCOPE AND APPLICATION

- 1.1. This method is applicable to the determination of volatile organic compounds in waters, wastewater, organic waste, soils, sludges, and other solid matrices. Standard analytes are listed in Tables 1 and 2. Table 3 lists TCLP analytes, reporting limits and regulatory levels.
- 1.2. This SOP is based on SW-846 Method 8260B, 5030B and 5035.
- 1.3. This method can be used to quantify most volatile organic compounds that have boiling points below 200°C and are insoluble or slightly soluble in water. Volatile water soluble compounds can be included in this analytical technique; however, for more soluble compounds, quantitation limits are approximately ten times higher because of poor purging efficiency.
- 1.4. The method is based upon a purge and trap, gas chromatograph/mass spectrometric (GC/MS) procedure. The approximate working range is 5 to 200 µg/L for 5 mL waters, 1 to 40 µg/L for 25 mL purge waters, 5 to 200 µg/kg for low-level soils, and 250 to 10,000 µg/kg for high-level soils. Reporting limits are listed in Tables 1, 2 and 3.
- 1.5. Method performance is monitored through the use of surrogate compounds, matrix spike/matrix spike duplicates, and laboratory control spike samples.

2. SUMMARY OF METHOD

- 2.1. Volatile compounds are introduced into the gas chromatograph by the purge and trap method. The components are separated via the chromatograph and detected using a mass spectrometer, which is used to provide both qualitative and quantitative information.
- 2.2. Aqueous samples are purged directly. Generally, soils are preserved by extracting the volatile analytes into methanol. If low detection limits are required, soil samples may be preserved with sodium bisulfate and purged directly.
- 2.3. In the purge and trap process, an inert gas is bubbled through the solution at ambient temperature or at 40°C (40°C required for low level soils) and the volatile components are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbant column where the volatile components are trapped. After purging is completed, the sorbant column (trap) is heated and backflushed with inert gas to desorb the components onto a gas chromatographic column. The gas chromatographic column is then heated to elute the components that are detected with a mass spectrometer.

- 2.4. Qualitative identifications are confirmed by analyzing standards under the same conditions used for samples and comparing the resultant mass spectra and GC retention times. Each identified component is quantified by relating the MS response for an appropriate selected ion produced by that compound to the MS response for another ion produced by an internal standard.

3. DEFINITIONS

- 3.1. Batch: The batch is a set of up to 20 samples of the same matrix processed using the same procedures and reagents within the same 24 hour time period. Using this method, each BFB analysis will normally start a new batch. Batches for high level soils are defined at the sample preparation stage and may be analyzed on multiple instruments over multiple days, although reasonable effort should be made to keep the samples together. See section 11.3.2.
 - 3.1.1. The Quality Control batch must contain a matrix spike/spike duplicate (MS/MSD), a Laboratory Control Sample (LCS), and a method blank. When there is insufficient sample to analyze an MS/MSD, an LCS/LCSD is analyzed. In some cases, at client request, the MS/MSD may be replaced with a matrix spike and sample duplicate. Refer to the QC Program document (QA-003) for further details of the batch definition.
- 3.2. Method Blank: A method blank consisting of all reagents added to the samples must be analyzed with each batch of samples. The method blank is used to identify any background interference or contamination of the analytical system that may lead to the reporting of elevated concentration levels or false positive data.
- 3.3. Laboratory Control Sample (LCS): Laboratory Control Samples are well characterized, laboratory generated samples used to monitor the laboratory's day-to-day performance of routine analytical methods. The LCS, spiked with a group of target compounds representative of the method analytes, is used to monitor the accuracy of the analytical process, independent of matrix effects. Ongoing monitoring of the LCS results provides evidence that the laboratory is performing the method within accepted QC guidelines for accuracy and precision. An LCS from a source other than that of the calibration standards may also be used as the calibration verification (CCV) as long as the acceptance criteria for both the LCS and CCV are met.
- 3.4. Surrogates: Surrogates are organic compounds which are similar to the target analyte(s) in chemical composition and behavior in the analytical process, but which are not normally found in environmental samples. Each sample, blank, LCS, and MS/MSD is spiked with surrogate standards. Surrogate spike recoveries must be evaluated by determining whether the concentration (measured as percent recovery) falls within the required recovery limits.

- 3.5. Matrix Spike/Matrix Spike Duplicate (MS/MSD): A matrix spike is an environmental sample to which known concentrations of target analytes have been added. A matrix spike duplicate is a second aliquot of the same sample that is prepared and analyzed along with the sample and matrix spike. Matrix spikes and duplicates are used to evaluate accuracy and precision in the actual sample matrix.
- 3.6. Calibration Check Compound (CCC): CCCs are a representative group of compounds that are used to evaluate initial calibrations and calibration verifications. Relative percent difference for the initial calibration and % drift (or % difference) for the calibration verification response factors are calculated and compared to the specified method criteria.
- 3.7. System Performance Check Compounds (SPCC): SPCCs are compounds that are sensitive to system performance problems and are used to evaluate system performance and sensitivity. A response factor from the calibration verification is calculated for the SPCC compounds and compared to the specified method criteria.
- 3.8. Internal Standards (IS): Internal Standards are compounds added to every standard, QC sample, client sample or extract at a known concentration prior to analysis for the purpose of quantitation. For example, internal standards are used as the basis for quantitation of target compounds by GC/MS.
- 3.9. Additional definitions can be found in the TestAmerica Knoxville Quality Assurance Manual (QAM), current revision.

4. INTERFERENCES

- 4.1. Method interferences may be caused by contaminants in solvents, reagents, glassware, and other processing apparatus that lead to discrete artifacts. All of these materials must be routinely demonstrated to be free from interferences under conditions of the analysis by running laboratory method blanks as described in the Quality Control section. The use of ultra high purity gases, pre-purged purified reagent water, and approved lots of purge and trap grade methanol will greatly reduce introduction of contaminants. In extreme cases the purging vessels may be pre-purged to isolate the instrument from laboratory air contaminated by solvents used in other parts of the laboratory.
- 4.2. Samples can be contaminated by diffusion of volatile organics (particularly methylene chloride and fluorocarbons) into the sample through the septum seal during shipment and storage. A field blank prepared from reagent water and carried through the sampling and handling protocol can serve as a check on such contamination.

- 4.3. Matrix interferences may be caused by non-target contaminants that are coextracted from the sample. The extent of matrix interferences will vary considerably from source to source depending upon the nature and diversity of the site being sampled.
- 4.4. Cross-contamination can occur whenever high-level and low-level samples are analyzed sequentially or in the same purge position on an autosampler. Whenever an unusually concentrated sample is analyzed, it should be followed by one or more blanks to check for cross-contamination. The purge and trap system may require extensive bake-out and cleaning after a high-level sample.
- 4.5. Some samples may foam when purged due to surfactants present in the sample. The samples may be diluted to preserve instrument integrity.

5. SAFETY

- 5.1. Employees must abide by the policies and procedures in the TestAmerica Environmental Health and Safety Manual, and this document.
- 5.2. Specific Safety Concerns or Requirements
 - 5.2.1. The gas chromatograph and mass spectrometer contain zones that have elevated temperatures. The analyst needs to be aware of the locations of those zones, and must cool them to room temperature prior to working on them.
 - 5.2.2. The mass spectrometer is under deep vacuum. The mass spectrometer must be brought to atmospheric pressure prior to working on the source. Depending on the type of work involved, either turn the power to the instrument off, or disconnect it from its source of power.
- 5.3. Primary Materials Used: The following is a list of the materials used in this method, which have a serious or significant hazard rating. NOTE: This list does not include all materials used in the method. **The table contains a summary of the primary hazards listed in the MSDS for each of the materials listed in the table.** A complete list of materials used in the method can be found in the reagents and materials section. Employees must review the information in the MSDS for each material before using it for the first time or when there are major changes to the MSDS.

Material	Hazards	Exposure Limit (2)	Signs and symptoms of exposure
Methanol	Flammable Poison Irritant	200 ppm-TWA	A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Symptoms of overexposure may include headache, drowsiness and dizziness. Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure. Irritant to the eyes.
1- Exposure limit refers to the OSHA regulatory exposure limit.			

5.3.1. Chemicals that have been classified as carcinogens, or potential carcinogens, under OSHA include acrylonitrile, benzene, carbon tetrachloride, chloroform, 1,2-dibromo-3-chloropropane, 1,4-dichlorobenzene, and vinyl chloride.

5.4. Exposure to chemicals must be maintained **as low as reasonably achievable**, therefore, unless they are known to be non-hazardous, all samples should be opened, transferred, and prepared in a fume hood, or under other means of mechanical ventilation. Solvent and waste containers will be kept closed unless transfers are being made.

5.5. The preparation of standards and reagents will be conducted in a fume hood with the sash closed as far as the operations will permit.

5.6. All work must be stopped in the event of a known or potential compromise to the health and safety of an associate. The situation must be reported **immediately** to a laboratory supervisor.

6. EQUIPMENT AND SUPPLIES

6.1. Microsyringes: 10 μ L and larger, 0.006 inch ID needle.

6.2. Syringe: 5 or 25 mL glass with luerlok tip, if applicable to the purging device.

6.3. Balance: Analytical, capable of accurately weighing 0.0001 g, and a top-loading balance capable of weighing 0.1 g

6.4. Glassware:

6.4.1. Vials, with screw caps and Teflon liners: 5 ml, 20 ml and 40 ml.

6.4.2. Volumetric flasks: 10 mL and 100 mL, class A with ground-glass stoppers.

6.5. Spatula: Stainless steel.

- 6.6. Disposable pipets: Pasteur.
- 6.7. pH paper: Wide range.
- 6.8. Stir bars.
- 6.9. Gases:
 - 6.9.1. Helium: Ultra high purity, gr. 5, 99.999%.
 - 6.9.2. Compressed air: Used for instrument pneumatics.
 - 6.9.3. Liquid nitrogen: Used for cryogenic cooling if necessary.
- 6.10. Purge and Trap Device: The purge and trap device consists of the sample purger, the trap, the desorber and the transfer line to the GC.
 - 6.10.1. Sample Purger: The recommended purging chamber is designed to accept 25 mL samples with a water column at least 3 cm deep. The purge gas must pass through the water column as finely divided bubbles, each with a diameter of less than 3 mm at the origin. The purge gas must be introduced no more than 5 mm from the base of the water column. Alternative sample purge devices may be used provided equivalent performance is demonstrated. Low level soils are purged directly from a VOA vial.
 - 6.10.2. Trap: A variety of traps may be used, depending on the target analytes required. For most purposes the Vocab 3000 trap is suitable. Other traps, such as Vocab 4000, or Tenax/Silica gel/Charcoal may be used if the quality control criteria are met.
 - 6.10.3. Desorber: The desorber should be capable of rapidly heating the trap to 250°C. Many such devices are commercially available.
 - 6.10.4. Sample Heater: A heater capable of maintaining the purge device at 40°C is necessary for low level soil analysis.
- 6.11. Gas Chromatograph/Mass Spectrometer System:
 - 6.11.1. Gas Chromatograph/Mass Spectrometer (GC/MS) System: An HP5973 analytical system complete with a temperature-programmable gas chromatograph. The GC capillary column is directly coupled to the MS source.

- 6.11.2. Column: 20 m x 0.18 mm I.D. 1- μ m film thickness silicon-coated fused-silica capillary column (J&W DB-624 or equivalent).
- 6.11.3. Mass Spectrometer: The mass spectrometer must be capable of scanning 35-300 AMU every two seconds or less, using 70 volts electron energy in the electron impact mode and capable of producing a mass spectrum that meets the required criteria when 50 ng of 4-bromofluorobenzene (BFB) are injected onto the gas chromatograph column inlet.
- 6.11.4. Data System: A computer system must be interfaced to the mass spectrometer. The system must allow the continuous acquisition and storage on machine-readable media of all mass spectra obtained throughout the duration of the chromatographic program. Target™ software is used and can search any GC/MS data file for ions of a specific mass and can plot such ion abundances versus time or scan number. This type of plot is defined as the Extracted Ion Current Profile (EICP). This software allows integrating the abundances in any EICP between specified time or scan-number limits. The most recent version of the EPA/NIH Mass Spectral Library is recommended.
- 6.11.5. Autosampler: Varian Archon Autosampler.

7. REAGENTS AND STANDARDS

7.1. Reagents

- 7.1.1. Methanol: Purge and Trap Grade, High Purity
- 7.1.2. Reagent Water: High purity water that meets the requirements for a method blank when analyzed. (See section 9.4) Reagent water may be purchased as commercial distilled water and prepared by purging with an inert gas overnight. Other methods of preparing reagent water are acceptable.
- 7.1.3. Sodium bisulfate

7.2. Standards

- 7.2.1. Calibration Standards
 - 7.2.1.1. Stock Solutions: Stock solutions may be purchased as certified solutions from commercial sources or prepared from pure standard materials as appropriate. These standards are prepared

in methanol and stored in Teflon-sealed screw-cap bottles with minimal headspace at -10° to -20°C .

NOTE: Unopened stock solutions expire according to the manufacturer's expiration date. Once opened, the stock solution expires on the manufacturer's expiration date or in 6 months, whichever is shorter. Stock standards prepared from pure standard materials expire 6 months from date of preparation. Stock standards for gases expire one week after opening.

- 7.2.1.2. Working standards: A working solution containing the compounds of interest prepared from the stock solution(s) in methanol. These standards are stored in the freezer or as recommended by the manufacturer. Working standards are monitored by comparison to the initial calibration curve. If any of the calibration check compounds drift in response from the initial calibration by more than 20% then corrective action is necessary. This may include steps such as instrument maintenance, preparing a new calibration verification standard or tuning the instrument. If the corrective actions do not correct the problem, then a new initial calibration must be performed.

NOTE: Working standards made from stock solutions shall be replaced after one week. Stock standards for gases shall be replaced after one week. When using premixed certified standards, the unopened standard expiration is according to manufacturer's expiration.

- 7.2.1.3. Aqueous Calibration Standards are prepared in reagent water using the secondary dilution standards. These aqueous standards must be prepared daily.

NOTE: The following expiration criteria apply to the standards described in 7.2.2 – 7.2.6. Working standards made from stock solutions shall be replaced after one week. Stock standards for gases shall be replaced after one week. When using premixed certified standards, the unopened standard expiration is according to manufacturer's expiration.

- 7.2.2. Internal Standards: Internal standards are added to all samples, standards, and blank analyses. Refer to Table 4 for internal standard components.
- 7.2.3. Surrogate Standards: Refer to Table 5 for surrogate standard components and spiking levels.

- 7.2.4. Laboratory Control Sample Spiking Solutions: Refer to Tables 1, 2 and 6 for LCS components and spiking levels. Full analyte spikes are typically used (Tables 1 and 2).
- 7.2.5. Matrix Spiking Solutions: The matrix spike contains the same components as the LCS. Refer to Tables 1,2, and 6.
- 7.2.6. Tuning Standard: A standard is made up that will deliver 50 ng on column upon injection. A recommended concentration of 50 ng/ μ L of 4-Bromo-fluorobenzene in methanol is prepared as described in Sections 7.2.1.1 and 7.2.1.2.

8. SAMPLE COLLECTION, PRESERVATION AND STORAGE

- 8.1. Sampling is not performed for this method by TestAmerica Knoxville. For information regarding sample shipping, refer to SOP KNOX-SC-0003, Receipt and Log In of Commercial Samples, current revision.
- 8.2. Holding times for all volatile analysis are 14 days from sample collection. The holding time for surface or ground water samples that are known to be not preserved prior to receipt is 7 days from collection.
- 8.3. The maximum holding time is 14 days from sampling until the sample is analyzed. Samples must be either preserved in the field or delivered in EnCore™ samplers for laboratory preservation. Lack of preservation must be addressed in the case narrative. Maximum holding time for the EnCore™ sampler (before the sample is added to methanol or sodium bisulfate or water) is 48 hours.
- 8.4. Aqueous samples are stored in 40ml glass vials with Teflon lined septa at 4°C +/- 2°C, with minimum headspace.
- 8.5. Methanol solid extracts are allocated into 2 - 20 mL glass vials with Teflon lined caps and stored at -15°C +/- 5°C.
- 8.6. Water samples are normally preserved at pH \leq 2 with hydrochloric acid. If residual chlorine is present, 2 drops of 10% sodium thiosulfate are added.
- 8.7. Soil samples are typically taken using the EnCore™ sampler and preserved in the lab within 48 hours of sampling. Solid samples may be field preserved with sodium bisulfate solution for low level analysis, or with methanol for high level analysis. For low level soil samples with carbonaceous material present, reagent water may be used.

8.8. There are several methods of sampling soil. The recommended method, which provides the minimum of field difficulties, is to take a 5 g EnCore™ sample. Following shipment back to the lab, the soil is preserved in methanol. This is the high level procedure. If very low detection limits are needed ($< 200 \mu\text{g}/\text{kg}$), then it will be necessary to use two additional 5 g EnCore™ samplers or to use field preservation.

8.9. Sample collection for high level analysis using EnCore™ samplers.

8.9.1. Ship one 5 g EnCore™ sampler per field sample position.

8.9.2. An additional bottle must be shipped for percent moisture determination.

8.9.3. When the samples are returned to the lab, extrude the (nominal) 5g sample into a tared VOA vial containing 5 mL methanol. Obtain the weight of the soil added to the vial and note on the label.

NOTE: The spiking process noted in sections 8.9.4 through 8.9.8 is not performed unless it is determined that analysis of the high level sample is necessary.

8.9.4. Add the correct amount of surrogate spiking mixture. For example, add 5.0 uL of 2500 $\mu\text{g}/\text{mL}$ solution for a nominal 5 g sample.

8.9.5. Add the correct amount of matrix spiking solution to the matrix spike and matrix spike duplicate samples. For example, add 125 uL of 100 $\mu\text{g}/\text{mL}$ solution for a nominal 5 g sample.

8.9.6. Prepare an LCS for each batch by adding the correct amount of matrix spiking solution to clean methanol and reagent sand. For example, 125 uL spike to 5 mL methanol/5 g reagent sand.

8.9.7. Shake the samples for two minutes to distribute the methanol throughout the soil.

8.9.8. Allow to settle, then remove a portion of methanol and store in a clean Teflon capped vial at $4 \pm 2^\circ\text{C}$ until analysis.

8.10. Sample collection for high level analysis using field methanol preservation

8.10.1. Prepare a 20 ml sample container by adding 5.0 mL purge and trap grade methanol.

8.10.2. Seal the bottle and attach a label.

- 8.10.3. Weigh the bottle to the nearest 0.1g and note the weight on the label.
 - 8.10.4. Ship with appropriate sampling instructions.
 - 8.10.5. Each sample will require an additional bottle with no preservative for percent moisture determination.
 - 8.10.6. At client request, the methanol addition and weighing may also be performed in the field.
 - 8.10.7. When the samples are returned to the lab, obtain the weight of the soil added to the vial and note on the label.
 - 8.10.8. Add the correct amount of the 2500 ppm surrogate spiking mixture. For example, 5 μ L for a nominal 5 g sample.
 - 8.10.9. Add the correct amount of the 100 ppm matrix spiking solution to the matrix spike and matrix spike duplicate samples. For example, 125 μ L for a nominal 5 g sample.
 - 8.10.10. Prepare an LCS for each batch by adding the correct amount of the 100 ppm matrix spiking solution to clean methanol and reagent sand. For example, 125 μ L spike to 5 mL methanol/5 g reagent sand.
 - 8.10.11. Shake the samples for two minutes to distribute the methanol throughout the soil.
 - 8.10.12. Allow to settle, then remove a portion of methanol and store in a clean Teflon capped vial at $4^{\circ} \pm 2^{\circ}\text{C}$ until analysis.
- 8.11. Low level procedure
- 8.11.1. If low detection limits are required (typically < 200 $\mu\text{g}/\text{kg}$), sodium bisulfate preservation must be used. However, it is also necessary to take a sample for the high level procedure (field methanol preserved or using the EnCore™ sampler), in case the concentration of analytes in the soil is above the calibration range of the low level procedure.
 - 8.11.2. A purge and trap autosampler capable of sampling from a sealed vial is required for analysis of samples collected using this method (Varian Archon).
 - 8.11.3. The soil sample is taken using a 5g EnCore™ sampling device and returned to the lab. It is recommended that two EnCore™ samplers be used

for each field sample position to allow for any reruns that may be necessary. A separate sample for % moisture determination is also necessary.

- 8.11.4. Prepare VOA vials by adding a magnetic stir bar, approximately 1 g of sodium bisulfate and 5 mL of reagent water.
- 8.11.5. Seal and label the vial. It is strongly recommended that the vial is labeled with an indelible marker rather than a paper label, since paper labels may cause the autosampler to bind and malfunction. The label absolutely must not cover the neck of the vial or the autosampler will malfunction.
- 8.11.6. Weigh the vial to the nearest 0.1g and note the weight in a logbook.
- 8.11.7. Extrude the soil sample from the EnCore™ sampler into the prepared VOA vial. Reweigh the vial to obtain the weight of soil and note in a logbook.

NOTE: Soils containing carbonates may effervesce when added to the sodium bisulfate solution. If this is the case, add 5 mL of water instead, and freeze at <-10°C until analysis. The holding time for the frozen sample is 14 days from sampling. If one sample from a lot (site) effervesces, all soil samples from the site will be preserved in water to protect the integrity of the samples, unless otherwise specified by the client.

- 8.11.8. Alternatively the sodium bisulfate preservation may be performed in the field. This is not recommended because of the many problems that can occur in the field setting. Ship at least two vials per sample. The field samplers must determine the weight of soil sampled. Each sample will require an additional bottle with no preservative for percent moisture determination, and an additional bottle preserved with methanol for the high level procedure. Depending on the type of soil, it may also be necessary to ship vials with no or extra preservative.
- 8.11.9. A preservation blank is prepared using the same reagents (i.e., sodium bisulfate/water solution) as the samples. A stir bar and 5 grams sand is added to the vial. The preservation blank is analyzed and evaluated using the same criteria as the method blank.

8.12. Unpreserved soils

- 8.12.1. At specific client request, unpreserved soils packed into glass jars or brass tubes may be accepted and subsampled in the lab. This is the old procedure based on method 5030A. It is no longer included and is likely

to generate results that are biased low, possibly by more than an order of magnitude.

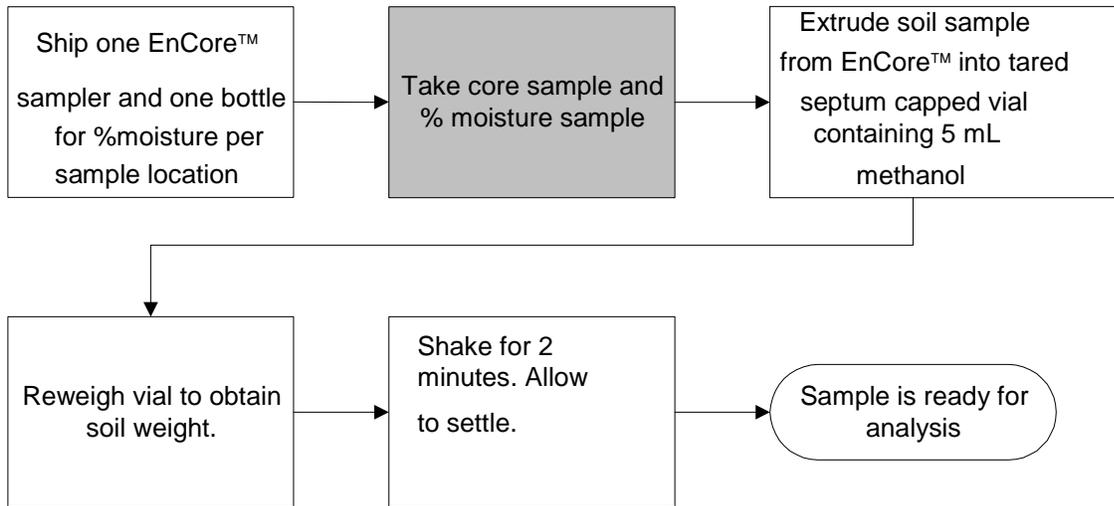
8.13. Holding Blank

8.13.1. Sample receiving prepares holding blanks using reagent water obtained from the GCMS VOA laboratory and places the vials in the refrigerators used to store samples for volatiles analysis. These are logged into QUANTIMS once each week and are removed for analysis after two weeks.

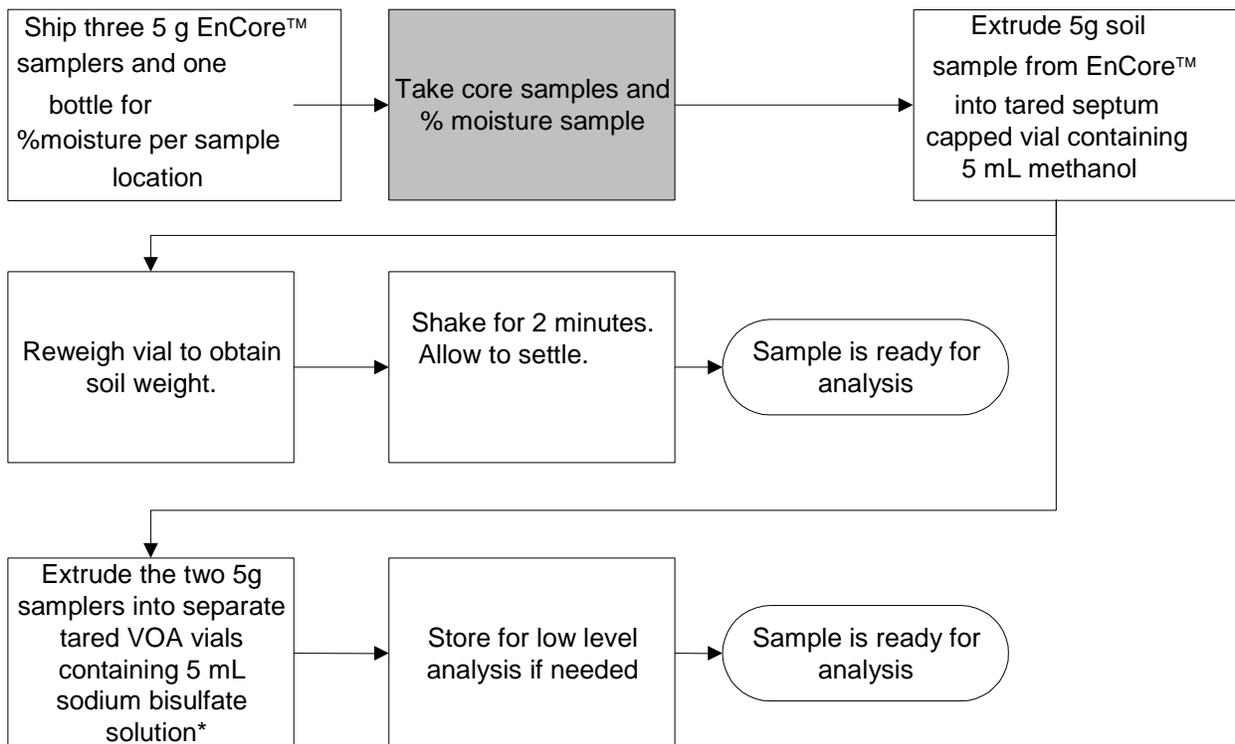
8.13.2. The holding blanks are analyzed according to this SOP. The holding blank must be less than $\frac{1}{2}$ the standard 25ml purge reporting limit (RL) ($<RL$ for common laboratory contaminants). If the holding blank is greater than $\frac{1}{2}RL$ but less than the RL (for analytes that are not common lab contaminants) document this on the quantitation report for the holding blank. If the holding blank is greater than the RL for any analyte, document this on the quantitation report and in a nonconformance memo. As corrective action, review associated method blanks and samples for the presence of any analyte greater than the RL that may be due to laboratory contamination that was observed in the associated holding blank. If laboratory contamination is observed in client samples, ensure that the data is appropriately flagged (B qualifier). Also discuss the nonconformance in the project narrative.

8.14. The methanol extracts are stored prior to analysis at -10 to $-20^{\circ}C$. When long term storage after the analysis is requested by the client, the methanol extracts are also stored at -10 to $-20^{\circ}C$.

EnCore™ procedure when low level is not required (field steps in gray)

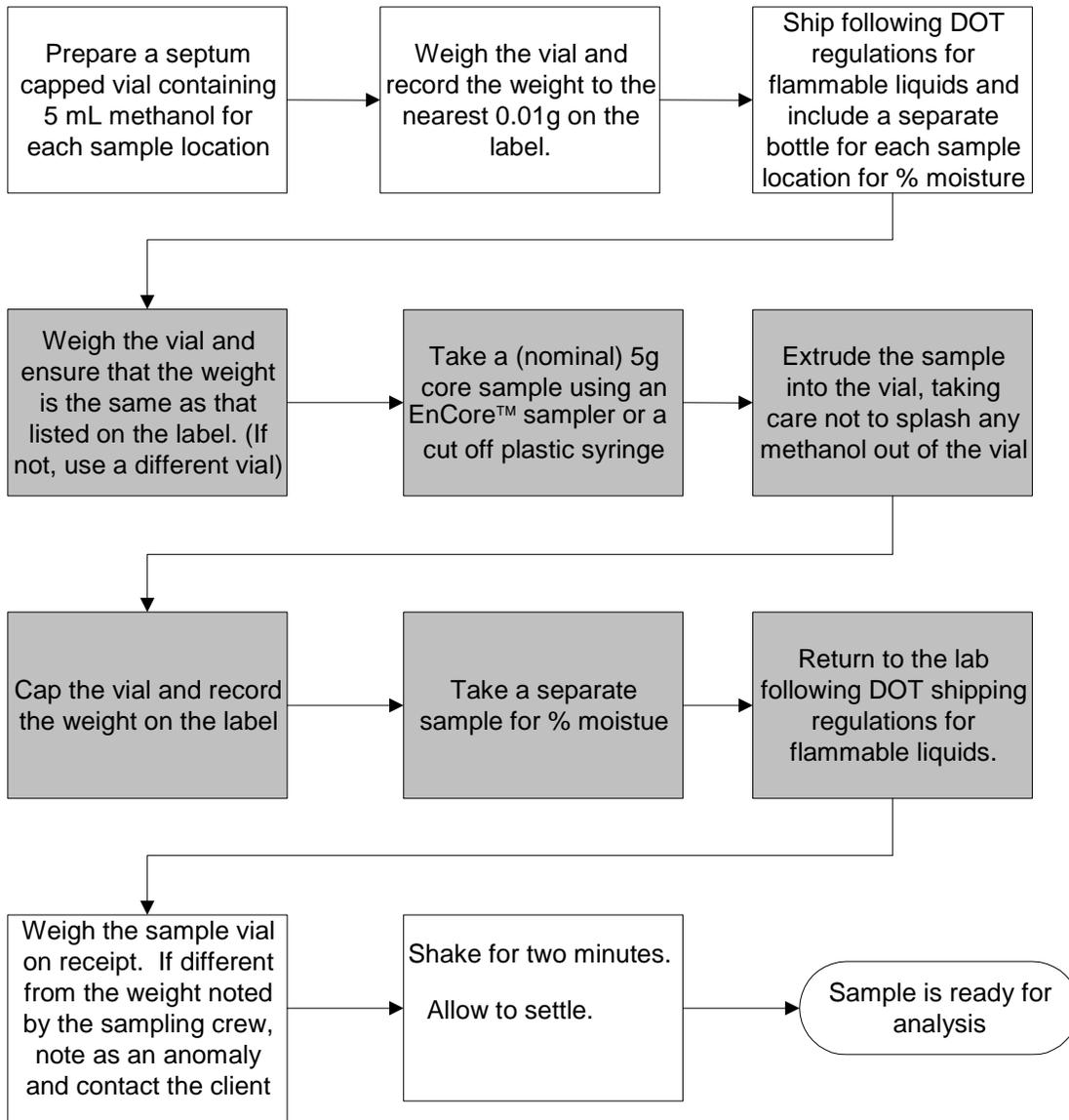


EnCore™ procedure when low level is required

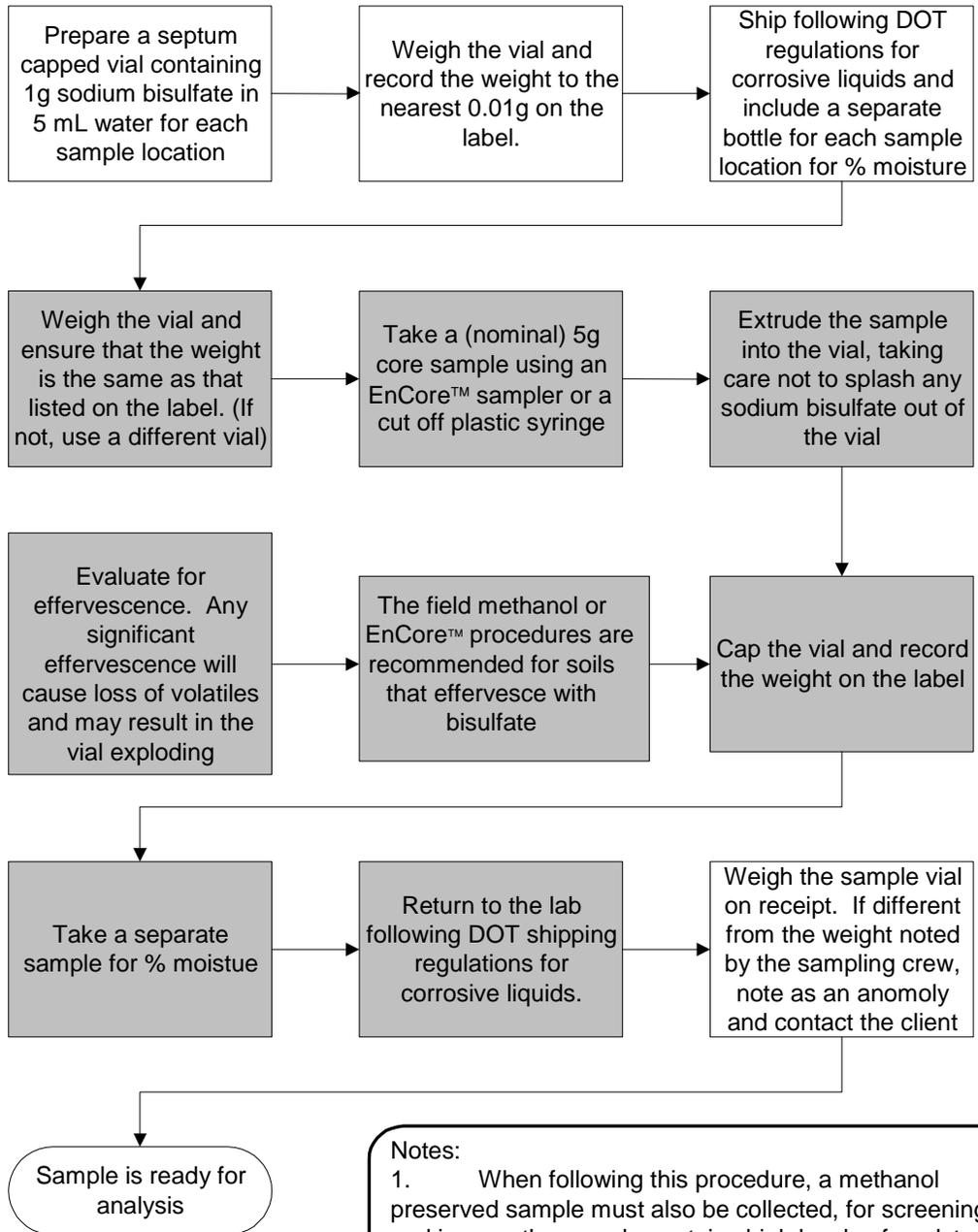


* Or 5 ml reagent water if samples from the lot or site effervesce.

Field methanol extraction procedure (field steps in gray)



Field bisulfate preservation procedure (field steps in gray)



Notes:
1. When following this procedure, a methanol preserved sample must also be collected, for screening and in case the sample contains high levels of analytes.
2. Due to the high probability of sampling problems, this method is not recommended

9. QUALITY CONTROL

9.1. Initial Demonstration of Capability

9.1.1. The initial demonstration described in section 13 and method detection limit (MDL) studies must be acceptable before analysis of samples may begin. MDLs must be analyzed for soils and aqueous samples. See section 13 for acceptance criteria.

9.2. Control Limits: In-house historical control limits must be determined for surrogates, matrix spikes, and laboratory control samples (LCS). These limits must be determined at least annually. The recovery limits are mean recovery +/- 3 standard deviations for surrogates, matrix spikes and LCS.

9.2.1. All surrogate, LCS, and MS recoveries (except when surrogates are diluted greater than 5X) must be entered into QuantIMS (when available) or other database so that accurate historical control limits can be generated. For tests without a separate extraction, surrogates and matrix spikes will be reported for all dilutions.

9.2.2. Refer to the QC Program document (QA-003) for further details of control limits.

9.3. Surrogates: Every sample, blank, and QC sample is spiked with surrogates. Surrogate recoveries in samples, blanks, and QC samples must be assessed to ensure that recoveries are within established limits. The compounds included in the surrogate spiking solutions are listed in Table 5. Reanalyze samples with failing surrogates if sufficient sample material is available and matrix effects have not already been confirmed. The client may be contacted for input if the reanalysis is expected to take place after the sample holding time has been exceeded. If any surrogates are outside limits, the following corrective actions must take place (except when surrogates are diluted greater than 5X):

- Check all calculations for error.
- Ensure that instrument performance is acceptable.
- Recalculate the data and/or reanalyze if either of the above checks reveal a problem.
- Reprepare and reanalyze the sample or flag the data as “Estimated Concentration” if neither of the above resolves the problem.
- The surrogate dibromofluoromethane has been determined to degrade in aqueous samples with $\text{pH} \geq 10$, as well as soils where the preserved sample

solution has a resulting $\text{pH} \geq 10$. In these cases, the samples do not need to be reanalyzed. This should be noted in the narrative.

- 9.3.1. The decision to reanalyze or flag the data should be made in consultation with the client. It is only necessary to reprepare/reanalyze a sample once to demonstrate that poor surrogate recovery is due to matrix effect, unless the analyst believes that the repeated out of control results are not due to matrix effect.
 - 9.3.2. If the surrogates are out of control for the sample, matrix spike and matrix spike duplicate, then matrix effect has been demonstrated for that sample and reparation is not necessary as long as the LCS and method blank are acceptable. If the sample is out of control and the MS and/or MSD is in control, then reanalysis or flagging of the data is required.
 - 9.3.3. Refer to the QC Program document (QA-003) for further details of the corrective actions.
- 9.4. Method Blanks: For each batch of samples, analyze a method blank. The method blank is analyzed after the calibration standards, normally before any samples. The method blank contains the same reagents as the samples (e.g. 1 gram of sodium bisulfate per 5 ml reagent water for low level soils). For low-level waters, the method blank consists of reagent water. For high-level volatiles, the method blank consists of 5.0 mL of methanol and 5 g reagent sand. Surrogates are added and the method blank is carried through the entire analytical procedure. The method blank must not contain any analyte of interest at or above the reporting limit (except common laboratory contaminants, see below) or at or above 5% of the measured concentration of that analyte in the associated samples, whichever is higher.

NOTE: For work done in support of the DOD QSM, the method blank criteria is $\leq \frac{1}{2}$ RL, $<$ RL for common laboratory contaminants.

- If the analyte is a common laboratory contaminant (methylene chloride, acetone, 2-butanone) the data may be reported with qualifiers when the concentration of the analyte is less than five times the reporting limit.
- Reanalysis of samples associated with an unacceptable method blank is required when reportable concentrations are determined in the samples.
- If there is no target analyte greater than the RL in the samples associated with an unacceptable method blank, the data may be reported with qualifiers. Such action should be done in consultation with the client.

- 9.4.1. The method blank must have acceptable surrogate recoveries. If surrogate recoveries are not acceptable, the data must be evaluated to determine if the method blank has served the purpose of demonstrating that the

analysis is free of contamination. If surrogate recoveries are low and there are reportable analytes in the associated samples, re-extraction of the blank and affected samples will normally be required. Consultation with the client should take place.

9.4.2. If reanalysis of the batch is not possible due to limited sample volume or other constraints, the method blank is reported, all associated samples are flagged with a "B", and appropriate comments may be made in a narrative to provide further documentation.

9.4.3. Refer to the QC Program document (QA-003) for further details of the corrective actions.

9.5. Laboratory Control Samples (LCS): For each batch of samples, analyze a LCS. The LCS is analyzed after the calibration standard, and normally before any samples. The LCS contains the standard set of target analytes (see Tables 1, and 2), and contains the same analytes as the matrix spike. For work done in support of the DOD QSM, all target analytes are required to be added in the positive control samples (i.e., LCS, MS, MSD) If any control analyte (Table 6) or surrogate is outside established control limits, the system is out of control and corrective action must occur. Corrective action will normally be re-preparation and reanalysis of the batch. Control limits are based on laboratory historical statistical limits and are maintained in the LIMS.

- If the batch is not re-extracted and reanalyzed, the reasons for accepting the batch must be clearly presented in the project records and the report.
- If re-extraction and reanalysis of the batch is not possible due to limited sample volume or other constraints, the LCS is reported, all associated samples are flagged, and appropriate comments are made in a narrative to provide further documentation.

9.5.1. Refer to the QC Program document (QA-003) for further details of the corrective action.

9.6. Matrix Spikes: For each QC batch, analyze a matrix spike and matrix spike duplicate. Compare the percent recovery and relative percent difference (RPD) to the laboratory specific historically generated limits.

- If any individual recovery or RPD falls outside the acceptable range, corrective action must occur. The initial corrective action will be to check the recovery of that analyte in the LCS. Generally, if the recovery of the analyte in the LCS is within limits, then the laboratory operation is in control and analysis may proceed. The reasons for accepting the batch must be documented.

- If the recovery for any component is outside QC limits for both the matrix spike/ spike duplicate and the LCS, the laboratory is out of control and corrective action must be taken. Corrective action will normally include reanalysis of the batch.
- If a MS/MSD is not possible due to limited sample, then a LCS duplicate should be analyzed. RPD of the LCS and LCSD are compared to the matrix spike limits.
- The matrix spike/duplicate must be analyzed at the same dilution as the unspiked sample, even if the matrix spike compounds will be diluted out.

9.7. For internal standard recovery acceptance criteria, refer to section 11.9.1.

9.8. Nonconformance and Corrective Action: Any deviations from QC procedures must be documented as a nonconformance, with applicable cause and corrective action approved by the facility QA Manager or designee.

9.9. Quality Assurance Summaries: Certain clients may require specific project or program QC that may supersede these method requirements. Quality Assurance Summaries should be developed to address these requirements.

10. CALIBRATION AND STANDARDIZATION

10.1. Refer to S-Q-004, current revision, Acceptable Manual Integration Practices and the TestAmerica Knoxville attachment for information on manual integration practices and documentation requirements.

10.2. Summary

10.2.1. Prior to the analysis of samples and blanks, each GC/MS system must be tuned and calibrated. Hardware tuning is checked through the analysis of the 4-bromofluorobenzene (BFB) to establish that a given GC/MS system meets the standard mass spectral abundance criteria. The GC/MS system must be calibrated initially at a minimum of five concentrations (analyzed under the same BFB electronic settings), to determine the linearity of the response utilizing target calibration standards. Once the system has been calibrated, the calibration must be verified each twelve hour time period for each GC/MS system. The use of separate calibrations is required for water and low soil matrices.

10.3. Recommended Instrument Conditions

10.3.1. General

Electron Energy: 70 volts (nominal)
Mass Range: 35–300 AMU
Scan Time: to give at least 5 scans/peak, but not to exceed 2 second/scan
Injector Temperature: 200–250°C
Source Temperature: According to manufacturer's specifications
Transfer Line Temperature: 250–300°C
Purge Flow: 40 mL/minute
Carrier Gas Flow: 30 mL/minute
Injector Condition: 1/35 split

10.3.2. Gas chromatograph suggested temperature program

10.3.2.1. BFB Analysis: 150°C for 1 minute, then 20°C/minute until 200°C.

10.3.2.2. Sample Analysis

Initial Temperature: 40°C
Initial Hold Time: 3 minutes
Temperature Program: 11°C/minute
Final Temperature: 195°C
Second Temperature Program: 25°C/minute
Final Temperature: 220°C
Final Hold Time: 2.0 minutes

10.4. Instrument Tuning

10.4.1. Each GC/MS system must be hardware-tuned to meet the abundance criteria listed in Table 7 for a maximum of a 50 ng injection or purging of BFB. Analysis must not begin until these criteria are met. These criteria must be met for each twelve-hour time period. The twelve-hour time period begins at the moment of injection of BFB.

10.4.2. Inject 50 ng of the GC/MS tuning standard (1 uL of the 50 ug/ml solution) into the GC/MS system. Obtain a mass spectra of BFB and confirm that all the key m/z criteria in Table 7 are achieved. The typical approach is to use the average of the peak apex, the scan immediately before the apex, and the scan immediately after the apex, with background subtraction of a single scan. This single scan must be prior to and within 20 scans of the start of the BFB elution but must not be part of the BFB peak. Alternatively the peak apex may be used. Background subtraction is required. If all the criteria in Table 7 are not achieved, the analyst must retune the mass spectrometer and repeat the test until all criteria are achieved. The performance criteria must be achieved before any samples, blanks, or standards are analyzed.

10.5. Initial Calibration

- 10.5.1. A series of five or more initial calibration standards is prepared and analyzed for the target compounds and each surrogate compound. Typical calibration levels are given in Tables 11 and 12. Other calibration levels and purge volumes may be used depending on the capabilities of the specific instrument. However, the same purge volume must be used for calibration and sample analysis, and the low level standard must be at or below the reporting limit.
- 10.5.2. It may be necessary to analyze more than one set of calibration standards to encompass all of the analytes required for some tests.
- 10.5.3. Internal standard calibration is used. The internal standards are listed in Table 4. Target compounds should reference the nearest internal standard. Each calibration standard is analyzed and the response factor (RF) for each compound is calculated using the area response of the characteristic ions against the concentration for each compound and internal standard. See equation 1, Section 12, for calculation of response factor.
- 10.5.4. The high point calibration standard is checked for saturation. If a quantitation ion saturates the mass spectrometer, the analyte will be removed from the calibration series, and the next highest concentration is checked for saturation as well. Saturation is present when an ion peak in Target reaches a Y axis maximum of 8.4×10^6 .
- 10.5.5. The % RSD of the calibration check compounds (CCC) must be less than 30%. Refer to Table 9 for the CCCs.
- 10.5.6. The average RF must be calculated for each compound. A system performance check is made prior to using the calibration curve. The five system performance check compounds (SPCC) are checked for a minimum average response factor. Refer to Table 8 for the SPCC compounds and required minimum response factors.
 - 10.5.6.1. If none of the SPCCs are required analytes, project specific calibration specifications must be agreed to with the client.
 - 10.5.6.2. The analyst will evaluate analytes with %RSD > 15% for calibration on a curve.
 - 10.5.6.3. Linear or quadratic curve fits may be used. Use of $1/\text{Concentration}^2$ weighting may be used to improve the accuracy of quantitation at the low end of the curve. The

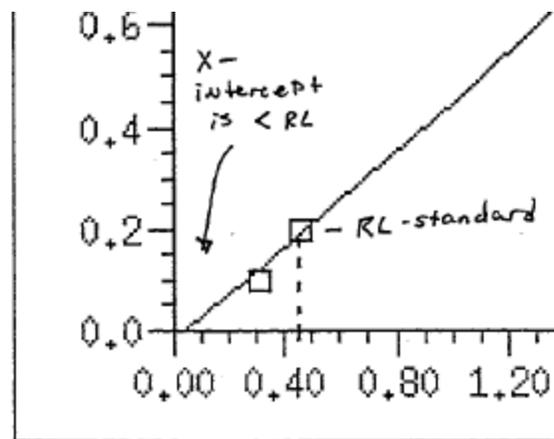
correlation coefficient (coefficient of determination for non-linear curves) must be ≥ 0.990 .

10.5.6.3.1. Analyst may elect to drop points from the calibration to improve subsequent quantitation. The rules for dropping points are:

- May drop points below the RL as long as there is a point remaining at or below the RL.
- May drop high points, decreasing linear range.
- May NOT drop a point between points.

10.5.6.3.2. Rules for curve use:

- The r^2 value obtained from Target must be ≥ 0.990 .
- At least 5 points must be used for average or linear curve.
- At least 6 points must be used for a quadratic curve.
- For quadratic curves, the tangent line to the slope of the curve must be continuous and have either only positive or negative slopes (i.e., no parabolas or breaks in the curve).
- Forcing through zero is allowed. To activate “force through zero” in Target, select “Force” for “curve origin”. “Include” zero for “curve origin” must not be used.
- If “forced through zero” is not used, the X and Y-intercept must be below the RL
- To evaluate the Y-intercept, multiply the *positive* Y-intercept value by the internal standard amount. The resulting value must be less than the RL.
- Negative Y-intercepts indicate an X-intercept. To evaluate the X-intercept, the intercept from the slope must be less than the intercept of a vertical line from the reporting limit standard drawn down to the X-intercept. See example below:



- 10.5.7. If time remains in the 12-hour period initiated by the BFB injection before the initial calibration, samples may be analyzed. Otherwise, proceed to calibration verification.
- 10.5.8. A separate five point calibration must be prepared for analysis of low level soils. Low level soils analysis requires the use of a closed vial autosampler (Varian Archon). Each standard is prepared by spiking the methanolic standard solution through the septum of a VOA vial containing 5 mL of water and 1 g sodium bisulfate. The standards are heated to 40°C for purging. All low-level soil samples, standards, and blanks must also be heated to 40°C for purging. Alternatively, add 5 ml of water to a 40 ml VOA vial for soil samples that effervesce or are received in jars.
- 10.5.9. Initial Calibration Verification Standard (2nd Source Standard): A mid-level standard from a second source is analyzed as an initial calibration verification (ICV). The ICV shall be analyzed with each initial calibration. The ICV must be within +/- 30% of its expected value. Poorer performing analytes may have an alternate acceptance criterion with QA approval (e.g., ketones < 35% and alcohols <40%). If the criteria are not met, the analyst must first verify the concentrations of the primary and secondary source standards and calculations. If no errors are found, repeat the ICV analysis.
- 10.5.10. Note: For work performed under the DOD QSM, the second source calibration verification criteria is $\pm 25\%$ of the expected value for those analytes listed in DOD Appendix DOD-C Table C-2. If a DOD client requests analytes that are not included in this table, TestAmerica Knoxville will review the requested list for any analytes that are poor performers and may not meet the DOD ICV acceptance criterion. The laboratory will notify the client of any analyte (not listed in Table C-1) that are not expected to meet this criterion..

- 10.6. Calibration verification: The initial calibration must be verified every twelve hours.
- 10.6.1. Calibration verification begins with analysis of BFB as described in Section 10.3. If the system tune is acceptable, the calibration verification standard(s) are analyzed. The level 3 calibration standard is suggested as the calibration verification.
 - 10.6.2. The RF data or concentrations from the standards are compared with the average RF or concentrations from the initial five-point calibration to determine the percent difference or drift of the CCC compounds. The calculation is given in equation 4, Section 12.3.4.
 - 10.6.3. The % drift or difference of the CCCs must be $\leq 20\%$ for the calibration verification to be valid. The SPCCs are also monitored. The SPCCs must meet the criteria described in Table 8. In addition, the % drift of all analytes must be $\leq 50\%$ with allowance for up to six target analytes to have % drift $> 50\%$.
 - 10.6.3.1. If none of the CCCs are required analytes, then project specific calibration specifications should be negotiated with the client.
 - 10.6.4. If the CCCs and or the SPCCs do not meet the criteria in Sections 10.5.3, the system must be evaluated and corrective action must be taken. The BFB tune and calibration verification must be acceptable before analysis begins. Extensive corrective action such as the installation of a new column will require a new initial calibration.
 - 10.6.5. Once the above criteria have been met, sample analysis may begin. Initial calibration average RFs (or the calibration curve) will be used for sample quantitation, not the calibration verification RFs. Analysis may proceed until 12 hours from the injection of the BFB have passed. (A sample desorbed less than or equal to 12 hours after the BFB is acceptable.)
 - 10.6.6. If the retention time for any internal standard in the calibration verification changes by more than 0.5 minutes from the mid-level initial calibration standard, the chromatographic system must be inspected for malfunctions and corrected. Reanalysis of samples analyzed while the system was malfunctioning is required.
 - 10.6.7. If the internal standard response in the calibration verification is more than 200% or less than 50% of the response in the mid-level of the initial calibration standard, the chromatographic system must be inspected for malfunctions and corrected. Reanalysis of samples analyzed while the system was malfunctioning is required.

- 10.6.8. If the calibration verification does not meet acceptance criteria, corrective action is required before sample analysis.
- 10.6.9. If routine corrective action procedures fail to produce a second consecutive (immediate) calibration verification within acceptance criteria, then the laboratory has to demonstrate performance after corrective action with two consecutive successful calibration verifications. If the laboratory has not demonstrated acceptable performance, sample analyses must not occur until a new initial calibration curve is established and verified.

11. PROCEDURE

11.1. Procedural Variations

- 11.1.1. One time procedural variations are allowed only if deemed necessary in the professional judgment of supervision to accommodate variation in sample matrix, radioactivity, chemistry, sample size, or other parameters. Any variation in procedure except those specified by project specific instructions shall be completely documented using a Nonconformance Memo and approved by a Supervisor or group leader and QA Manager. If contractually required, the client shall be notified.
- 11.1.2. Any unauthorized deviations from this procedure must also be documented as a nonconformance, with a cause and corrective action described.

11.2. Preliminary Evaluation

- 11.2.1. Where possible, samples are screened by headspace or GC/MS off-tune analysis to determine the correct aliquot for analysis. Alternatively, an appropriate aliquot can be determined from sample histories.
- 11.2.2. Dilutions should be done just prior to the GC/MS analysis of the sample. Dilutions are made in volumetric flasks or in a Luerlok syringe. Calculate the volume of reagent water required for the dilution. Fill the syringe with reagent water, compress the water to vent any residual air and adjust the water volume to the desired amount. Adjust the plunger to the mark and inject the proper aliquot of sample into the syringe. If the dilution required would use less than 1 μL of sample, then serial dilutions must be made in volumetric flasks.
 - 11.2.2.1. The diluted concentration is to be estimated to be in the upper half of the calibration range. See section 11.10 for guidance.

11.3. Sample Analysis Procedure

- 11.3.1. All analysis conditions for samples must be the same as for the calibration verification standards (including purge time and flow, desorb time and temperature, column temperatures, multiplier setting etc.).
- 11.3.2. All samples must be analyzed as part of a batch. The batch is a set of up to 20 samples of the same matrix processed using the same procedures and reagents within the same 24 hour time period. The batch also must contain a MS/MSD, a LCS, and a method blank. If insufficient sample is available to perform an MS/MSD pair, an LCS/LCSD pair will be prepared and analyzed.
 - 11.3.2.1. If there is insufficient time in the 12-hour tune period to analyze 20 samples, the batch may be continued into the next tune period. For high level soils the batch is defined at the sample preparation stage.
 - 11.3.2.2. Laboratory generated QC samples (blank, LCS, MS/MSD) do not count towards the maximum 20 samples in a batch. Field QC samples are included in the batch count.
 - 11.3.2.3. It is not always necessary to reanalyze batch QC with reanalyses of samples. For example, if the samples need to be analyzed at a different dilution, batch QC does not need to be reanalyzed. If samples need to be reanalyzed because the batch QC failed, then batch QC must be reanalyzed. Also, any reruns must be part of a valid batch.

11.4. Water Samples

- 11.4.1. All samples and standard solutions must be at ambient temperature before analysis.
- 11.4.2. Fill a syringe with the sample. If a dilution is necessary it may be made in the syringe if the sample aliquot is $\geq 1 \mu\text{L}$. Check and document the pH of the remaining sample.
- 11.4.3. Add 250 ng of each internal and surrogate standard (see Tables 4 and 5). The internal standards and the surrogate standards may be mixed and added as one spiking solution. Inject the sample into the purging chamber.
- 11.4.4. The sample is purged for eleven minutes (the trap must be at or below 40°C).

- 11.4.5. After purging is complete, desorb the sample, start the GC temperature program, and begin data acquisition. After desorption, bake the trap for 5-10 minutes to condition it for the next analysis. When the trap is cool, it is ready for the next sample.
- 11.4.6. Desorb and bake time and temperature are optimized for the type of trap in use. The same conditions must be used for samples and standards.
- 11.5. Methanol Extract Soils
 - 11.5.1. Add no more than 100 μ L methanolic extract (from Section 8.9) to the 40 ml VOA vial containing 5 ml of organic free water. Add internal standard through the 40 ml vial septum or allow the autosampler to add the appropriate amount. Load the sample onto the autosampler/purge and trap device and analyze as for soil samples. If less than 1 μ L of methanolic extract is to be added to the water, dilute the methanolic extract such that a volume no less than 1 μ L will be added to the water in the 40 ml VOA vial.
- 11.6. Liquid wastes that are soluble in methanol and insoluble in water.
 - 11.6.1. Pipet 2 mL of the sample into a tared vial. Use a top-loading balance. Record the weight to the nearest 0.1 gram.
 - 11.6.2. Quickly add methanol, then add the surrogate spiking solution and bring the final volume to 10 mL. Cap the vial and shake for 2 minutes to mix thoroughly. For a MS/MSD or LCS, add methanol, then add surrogate solution and matrix spike solution and bring the final volume to 10 ml.
 - 11.6.3. NOTE: Organic waste feed samples associated with source test trial burns shall be spiked at an appropriate dilution to obtain reportable surrogate and matrix spike data.
 - 11.6.4. Add no more than 100 μ L methanolic extract to the 40 ml VOA vial containing 5 ml of organic free water. Add internal standard through the 40 ml vial septa or allow the autosampler to add the appropriate amount. Load the sample onto the autosampler/purge and trap device and analyze as for soil samples. If less than 1 μ L of methanolic extract is to be added to the water, dilute the methanolic extract such that a volume no less than 1 μ L will be added to the water in the 40 ml VOA vial.
- 11.7. Aqueous and Low level Soil Sample Analysis (Purge and Trap units that sample directly from the VOA vial)

- 11.7.1. Units that sample from the VOA vial should be equipped with a module that automatically adds surrogate and internal standard solution to the sample prior to purging the sample.
 - 11.7.2. If the autosampler uses automatic IS/SS injection, no further preparation of the VOA vial is needed. Otherwise the internal and surrogate standards must be added to the vial. *Note:* Aqueous samples with high amounts of sediment present in the vial may not be suitable for analysis on this instrumentation, or they may need to be analyzed as soils.
 - 11.7.3. Soil samples must be quantitated against a curve prepared with standards containing about the same amount of sodium bisulfate or water as the samples (1 g in 5 mL).
 - 11.7.4. Soil sample remaining in the vial after sampling with one of these mechanisms is no longer valid for further analysis. A fresh VOA vial must be used for further sample analysis.
 - 11.7.5. For aqueous samples, check the pH of the sample remaining in the VOA vial after analysis is completed.
- 11.8. Low-Level Solids Analysis (from bulk container/jar)
- Note: This technique may seriously underestimate analyte concentration and must not be used except at specific client request for the purpose of comparability with previous data. It is no longer part of SW-846.**
- This method is based on purging a heated sediment/soil sample mixed with reagent water containing the surrogate and, if applicable, internal and matrix spiking standards. Analyze all reagent blanks and standards under the same conditions as the samples (e.g., heated). The calibration curve is also heated during analysis. Purge temperature is 40°C.
- 11.8.1. Do not discard any supernatant liquids. Mix the contents of the container with a narrow metal spatula.
 - 11.8.2. Weigh out 5 g (or other appropriate aliquot) of sample into a 40 ml VOA vial. Record the weight to the nearest 0.1 g. If method sensitivity is demonstrated, a smaller aliquot may be used. Do not use aliquots less than 0.5 g. If the sample is contaminated with analytes such that a purge amount less than 0.5 g is appropriate, use the high level method described in section 11.5.
 - 11.8.3. Add 5 mL of organic free water. Add surrogate/internal standard (and matrix spike solutions if required.). Add directly to the sample from section 11.8.2.

- 11.8.4. The above steps should be performed rapidly and without interruption to avoid loss of volatile organics.
- 11.8.5. Analyze as described in Section 11.7.
- 11.9. Initial review and corrective actions
- 11.9.1. Any samples that do not meet the internal standard criteria for the calibration verification must be evaluated for validity. **Note:** The sample internal standard recovery is referenced against the calibration verification, not the initial calibration; see sections 10.6.6 and 10.6.7. If the change in sensitivity is a matrix effect confined to an individual sample reanalysis is not necessary. The sample in question must be bracketed by acceptable runs. If the change in sensitivity is due to instrument problems, all affected samples must be reanalyzed after the problem is corrected.
- 11.9.2. The surrogate standard recoveries are evaluated to ensure that they are within limits. Corrective action for surrogates out of control will normally be to reanalyze the affected samples. However, if the surrogate standard response is out high and there are no target analytes or tentatively identified compounds, reanalysis is not necessary. Out of control surrogate standard response may be a matrix effect; obvious matrix effects (i.e., high level interfering peaks) that affect the surrogate quantitation do not need to be reanalyzed. It is only necessary to reanalyze a sample once to demonstrate matrix effect, but reanalysis at a dilution should be considered.
- 11.10. Dilutions: If the response for any compound exceeds the working range of the GC/MS system, a dilution of the extract or sample is prepared and analyzed. An appropriate dilution should be in the upper half of the calibration range. Samples may be screened to determine the appropriate dilution for the initial run. If the initial diluted run has no hits or hits below 20% of the calibration range and the matrix allows for analysis at a lesser dilution, then the sample must be reanalyzed at a dilution targeted to bring the largest hit above 50% of the calibration range.
- 11.10.1. Guidance for Dilutions Due to Matrix
- 11.10.1.1. If the sample is initially run at a dilution and the baseline rise is less than half the height of the internal standards, or if individual non target peaks are less than twice the height of the internal standards, then the sample should be reanalyzed at a more concentrated dilution. This requirement is approximate and subject to analyst judgment.

11.10.1.2. If samples have reportable results greater than 2x the reporting limit or ¼ the internal standard height for non-target analytes for a methanol prep, a low level prep is not required, unless otherwise specified by the client.

11.10.2. Reporting Dilutions: The most concentrated dilution with no target compounds above the calibration range will be reported. Other dilutions will only be reported at client request.

11.11. Troubleshooting Guide (Refer to the manufacturer's manual for specific guidance)

11.11.1. Daily Instrument Maintenance: In addition to the checks listed in the instrument maintenance schedule in SOP KNOX-QA-0003, the following daily maintenance should be performed as necessary.

11.11.1.1. Install new or cleaned injection port liner.

11.11.1.2. Install new septum.

11.11.1.3. Install new inlet seal.

11.11.1.4. Perform/adjust mass calibration (autotune/BFB tune).

11.11.1.5. Increase/decrease EM voltage to desired sensitivity based on internal standard response.

11.11.2. Major Maintenance: A new initial calibration is necessary following major maintenance. Major maintenance includes changing the column, cleaning or repairing the source, replacing filaments, changing electronics or replacing the multiplier.

11.11.3. Minor Maintenance

11.11.3.1. Minor maintenance includes daily instrument maintenance described in 11.11.1, cleaning injector port, replacing filters, changing pump oil, autotuning, switching filaments (instrument contains two filaments under vacuum), change/refill IS/surrogate standard vial, changing seals and o-rings, ballasting pump, replacing fuses, or replacing roughing pumps.

11.11.3.2. Replace filters and change pump oil about every 6-12 months.

11.11.3.3. A multiplier gain check is performed if sensitivity is still poor and/or analyst suspects that the multiplier is going bad.

11.11.3.4. Autotuning is performed if the analyst notices mass misassignments or a drift in the response of analytes or internal standards.

11.11.3.5. If minor maintenance does not result in acceptable chromatography, it may be necessary to change the column or clean the source.

12. DATA ANALYSIS AND CALCULATIONS

12.1. Refer to Appendix A for an example data review checklists used to perform and document the review of the data. Using the data review checklist, the analyst also creates a narrative which includes any qualifications of the sample data.

12.2. Qualitative identification: An analyte is identified by retention time and by comparison of the sample mass spectrum with the mass spectrum of a standard of the suspected compound (standard reference spectrum). Mass spectra for standard reference may be obtained on the user's GC/MS by analysis of the calibration standards or from the NIST Library. Two criteria must be satisfied to verify identification: (1) elution of sample component at the same GC retention time as the standard component; and (2) correspondence of the sample component and the standard component characteristic ions. (Note: Care must be taken to ensure that spectral distortion due to co-elution is evaluated.) The characteristic ions from the reference mass spectrum are defined as the three ions with greatest relative intensity, or any ions over 30% relative intensity, if less than three such ions are present in the reference spectrum (i.e. characteristic ions have relative intensity $\geq 30\%$).

- The sample component retention time must compare to within ± 0.2 min. of the retention time of the standard component. For reference, the standard must be run within the same twelve hours as the sample.
- All characteristic ions must maximize in the same scan or within one scan of each other.
- The relative intensities of ions should agree to within $\pm 30\%$ between the standard and sample spectra. (Example: For an ion with an abundance of 50% in the standard spectra, the corresponding sample abundance must be between 20 and 80 percent.)

- 12.2.1. If a compound cannot be verified by all the above criteria, but in the technical judgment of the analyst, the identification is correct, then the analyst shall report that identification and proceed with quantitation.
- 12.3. Tentatively Identified Compounds (TICs): Library searches of peaks present in the chromatogram that are not target compounds (Tentatively Identified Compounds, TIC) may be performed if required by the client. They are evaluated using the TestAmerica Knoxville SOP KNOX-MS-0014, current revision, "Determination of Tentatively Identified Compounds (TICs)".
- 12.4. Calculations.

- 12.4.1. Response factor (RF):

$$RF = \frac{A_x C_{is}}{A_{is} C_x}$$

Where:

A_x = Area of the characteristic ion for the compound to be measured

A_{is} = Area of the characteristic ion for the specific internal standard

C_{is} = Concentration of the specific internal standard, ng

C_x = Concentration of the compound being measured, ng

- 12.4.2. Standard deviation (SD):

$$SD = \sqrt{\sum_{i=1}^N \frac{(X_i - \bar{X})^2}{N - 1}}$$

X_i = Value of X at i through N

N = Number of points

\bar{X} = Average value of X_i

- 12.4.3. Percent relative standard deviation (%RSD):

$$\% RSD = \frac{\text{Standard Deviation}}{RF} \times 100$$

- 12.4.4. Calibration verification percent drift and difference from the initial calibration:

$$\% \text{ Drift} = \frac{C_{\text{expected}} - C_{\text{found}}}{C_{\text{expected}}} \times 100$$

Where

C_{expected} = Known concentration in standard

C_{found} = Measured concentration using selected quantitation method

$$\% \text{ Difference} = \frac{\overline{RF} - RF}{\overline{RF}} \times 100$$

\overline{RF} = Average Analyte Response Factor from Initial Calibration

RF = Measured Analyte Response Factor from Calibration Verification

- 12.4.5. Target compound and surrogate concentrations: Concentrations in the sample may be determined from linear or second order (quadratic) curve fitted to the initial calibration points, or from the average response factor of the initial calibration points. Average response factor may only be used when the RSD criteria listed in section 10.5 are met. Note: For soil analyses, the reporting limit will be different from those listed in Tables 1 and 2 if the amount of sample used is <80% of the nominal amount.

- 12.4.5.1. Calculation of concentration using Average Response Factors

$$C_{pv} = \frac{R_x C_{is}}{R_{is} \overline{RF}}$$

- 12.4.5.2. Calculation of concentration using Linear fit

$$C_{pv} = A + B \frac{(R_x C_{is})}{R_{is}}$$

C_{pv} = Concentration in purge vessel, ug/L (Amt)

R_x = Response for analyte (area of quantitation ion)

R_{is} = Response for internal standard (area of quantitation ion)

C_{is} = Concentration of internal standard

A = Intercept

B = Slope

The corresponding Target software calculation is as follows:

$$C_{pv} = C_{is} \left(b + \frac{1}{m1} \times \frac{R_x}{R_{is}} \right)$$

b = Concentration Ratio Intercept

m1 = Inverse of Slope

12.4.5.3. Calculation of concentration using Quadratic fit

$$C_{pv} = A + B \left(\frac{R_x C_{is}}{R_{is}} \right) + C \left(\frac{R_x C_{is}}{R_{is}} \right)^2$$

C = Curvature

The corresponding Target software calculation is as follows:

$$C_{pv} = C_{is} \left(b + m1 \times \frac{R_x}{R_{is}} + m2 \times \left(\frac{R_x}{R_{is}} \right)^2 \right)$$

m1 = First order coefficient

m2 = Curvature (Second order coefficient)

12.4.5.4. Calculation of Concentration for Water Samples:

$$\text{Concentration, } \mu\text{g/L} = \frac{C_{pv} \cdot DF \cdot Uf \cdot V_t}{V_o \cdot 1000}$$

Where:

V_t = Total Volume Purged (ul)

V_o = Sample Volume used (ml)

DF = Dilution Factor (e.g. for a one to ten dilution D=10)

Uf = Unit correction factor (default =1 [ml/ul]; A value of 0.001 [ml·mg/ul·ug] used for TCLP to convert concentration to mg/L)

12.4.5.5. Calculation of Concentration for Methanol Extracted Soils:

$$\text{Concentration, } \mu\text{g/kg} = \frac{C_{pv} \cdot DF \cdot Wd \cdot V_t}{V_a \cdot Ws \cdot X}$$

Where:

V_t = Final Methanol Extract Volume, uL

V_a = Nominal Volume of extract analyzed, 100 μL

- W_s** = Weight of sample extracted, g
W_d = Default volume of water purged, ml (Default=5ml)
X = (100 - % moisture in sample)/100, for a dry weight basis or 1 for a wet weight basis (moisture factor applied by LIMS)
DF = Dilution Factor (e.g., if 10 uL of methanol extract are analyzed, the dilution factor is 10)

12.4.5.6. Calculation of Concentration for Low Level Soils:

$$\text{Concentration, } \mu\text{g/kg} = \frac{C_{pv} \cdot DF \cdot V_t}{W_s \cdot X \cdot 1000}$$

Where:

- V_t** = Low Soil Sample Purge Volume, uL
W_s = Weight of sample extracted, g
X = (100 - % moisture in sample)/100, for a dry weight basis or 1 for a wet weight basis (moisture factor applied by LIMS)

12.4.5.7. Calculation of TICs: The calculation of TICs (tentatively identified compounds) is identical to the above calculations with the following exceptions:

- A_x** = Area in the total ion chromatogram for the compound being measured
A_{is} = Area of the total ion chromatogram for the nearest internal standard without interference
RF = 1

12.4.6. MS/MSD Recovery

$$\text{Matrix Spike Recovery, \%} = \frac{SSR - SR}{SA} \times 100$$

- SSR** = Spike sample result
SR = Sample result
SA = Spike added

12.4.7. Relative % Difference calculation for the MS/MSD

$$\text{RPD} = \frac{|\text{MSR} - \text{MSDR}|}{\frac{1}{2}(\text{MSR} + \text{MSDR})} \times 100$$

Where:

RPD = Relative percent difference

MSR = Matrix spike result

MSDR = Matrix spike duplicate result

13. METHOD PERFORMANCE

- 13.1. Method Detection Limit: Method Detection Limit (MDL) - An MDL must be determined for each analyte in each routine matrix prior to the analysis of any samples. Method Detection limits are determined and verified as specified in the current revision of SOP CA-Q-S-006 based on 40 CFR Part 136 Appendix B. The result of the MDL determination must support the reporting limit. MDL summaries are stored on the local area network.
- 13.2. Initial Demonstration: Each analyst must perform an initial demonstration of capability (IDOC) for each target analyte prior to performing the analysis independently. The IDOC is determined by analyzing four replicate spikes (e.g., LCSs) as detailed in TestAmerica Knoxville SOP KNOX-QA-0009. This requires analysis of QC check samples containing all of the routine analytes for the method (Table 1 and 2). The QC check sample is made at 10 ug/L or at the current LCS spike level. For some tests it may be necessary to use more than one QC check mix to cover all analytes of interest.
 - 13.2.1. Four aliquots of the QC check sample are analyzed using the same procedures used to analyze samples, including sample preparation.
 - 13.2.2. Calculate the average recovery and standard deviation of the recovery for each analyte of interest. The %RSD should be $\leq 15\%$ for each analyte, and the % recovery should be within 70-130%.
 - 13.2.3. If any analyte does not meet the acceptance criteria, determine if historical data indicates that the analyte purges poorly. In this case, QA approval is required for the IDOC to be acceptable. If the recovery or precision is outside the 70-130% limits and the above criteria is not met, the test must be repeated. Only those analytes that did not meet criteria in the first test need to be evaluated. Repeated failure for any analyte indicates the need for the laboratory to evaluate the analytical procedure and take corrective action.

- 13.3. Training Qualification: The group/team leader has the responsibility to ensure that this procedure is performed by an associate who has been properly trained in its use and has the required experience. Refer to SOP KNOX-QA-0009 current revision for further requirements for performing and documenting initial and on-going demonstrations of capability.

14. POLLUTION PREVENTION

- 14.1. This method does not contain any specific modifications that serve to minimize or prevent pollution.

15. WASTE MANAGEMENT

- 15.1. All waste will be disposed of in accordance with Federal, State and Local regulations. Where reasonably feasible, technological changes have been implemented to minimize the potential for pollution of the environment. Employees will abide by this method and the policies in section 13 of the TestAmerica Environmental Health and Safety Manual for “Waste Management and Pollution Prevention.”
- 15.2. The following waste streams are produced when this procedure is carried out.
- Aqueous waste generated from analysis. This material may have a pH of less than 2. This waste will be placed in an acid satellite accumulation container.
 - Solvent waste generated from analysis is placed in the flammable waste stream, contained in a steel satellite accumulation container type or flammable solvent container.
 - VOA vials containing extracted soil samples, which will contain small amounts of methanol will be placed in the vial waste stream 55 gallon open top drum.
 - Expired Standards are stored in metal closed-top containers.

16. REFERENCES

- 16.1. SW846, *Test Methods for Evaluating Solid Waste*, Third Edition, Gas Chromatography/Mass Spectrometry for Volatile Organics, Method 8260B, Update III, December 1996.
- 16.2. SW846, Method 5030B, “Purge and Trap for Aqueous Samples”, Revision 2, December 1996.
- 16.3. SW846, Method 5035, “Closed-System Purge and Trap and Extraction for Volatile Organics in Soil and Waste Samples”, Revision 0, December 1996.
- 16.4. TestAmerica Knoxville Quality Assurance Manual (QAM), current revision.

16.5. S-Q-004, Acceptable Manual Integration Practices and the TestAmerica Knoxville Attachment, current revision.

17. MISCELLANEOUS

17.1. Modifications from the reference method

- 17.1.1. Ion 119 is used as the quantitation ion for chlorobenzene-d5 for 25 mL purge tests.
- 17.1.2. A retention time window of 0.2 minutes is used for all components, since some data systems do not have the capability of using the relative retention time units specified in the reference method.
- 17.1.3. The quantitation and qualifier ions for some compounds have been changed from those recommended in SW-846 in order to improve the reliability of qualitative identification.
- 17.1.4. This SOP allows for the use of the NIST library in the qualitative identification of an analyte. Method 8260B allows for the use of the mass spectra for standard reference from the user's instrument.

Table 1 - Standard Analytes and Reporting Limits

Compound	CAS Number	Water ¹ µg/L	Low soil ² µg/kg	Med. Soil ² µg/kg
Acetone	67-64-1	10	20	1000
Benzene	71-43-2	1	5	250
Bromochloromethane	74-97-5	1	5	250
Bromodichloromethane	75-27-4	1	5	250
Bromoform	75-25-2	1	5	250
Bromomethane	74-83-9	2	10	500
2-Butanone (syn: methyl ethyl ketone, MEK)	78-93-3	5	20	1000
Carbon disulfide	75-15-0	1	5	250
Carbon tetrachloride	56-23-5	1	5	250
Chlorobenzene	108-90-7	1	5	250
Chlorodibromomethane	124-48-1	1	5	250
Chloroethane	75-00-3	2	10	500
Chloroform	67-66-3	1	5	250
Chloromethane	74-87-3	2	10	500
1,2-Dibromoethane (EDB)	106-93-4	1	5	250
Dibromomethane (syn: methylene bromide)	74-95-3	1	5	250
1,1-Dichloroethane	75-34-3	1	5	250
1,2-Dichloroethane	107-06-2	1	5	250
1,1-Dichloroethene	75-35-4	1	5	250
cis-1,2-Dichloroethene	156-59-2	1	5	250
trans-1,2-Dichloroethene	156-60-5	1	5	250
1,2-Dichloroethene (Total)	540-59-0	1	5	250
1,2-Dichloropropane	78-87-5	1	5	250
2,2-Dichloropropane	594-20-7	1	5	250
1,1-Dichloropropene	563-58-6	1	5	250
cis-1,3-Dichloropropene	10061-01-5	1	5	250
trans-1,3-Dichloropropene	10061-02-6	1	5	250
Ethylbenzene	100-41-4	1	5	250
2-Hexanone	591-78-6	5	20	1000
Methylene chloride	75-09-2	2	5	250
4-Methyl-2-pentanone (syn: methyl isobutyl ketone, MIBK)	108-10-1	5	20	1000
Styrene	100-42-5	1	5	250
1,1,1,2-Tetrachloroethane	630-20-6	1	5	250
1,1,2,2-Tetrachloroethane	79-34-5	1	5	250
Tetrachloroethene	127-18-4	1	5	250
Toluene	108-88-3	1	5	250
1,1,1-Trichloroethane	71-55-6	1	5	250
1,1,2-Trichloroethane	79-00-5	1	5	250
Trichloroethene	79-01-6	1	5	250
Vinyl chloride	75-01-4	2	10	500
o-xylene	95-47-6	1	5	250
m-Xylene and p-Xylene	136777-61-2	2	10	500
Xylenes (total)	1330-20-7	3	15	750

¹Levels for 5 mL purge water samples are 5 times higher. This is achieved by analyzing 5 mL sample in a 25 mL final volume.

²Reporting limits listed for soil/sediment are based on wet weight. The reporting limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

Table 2 - Additional Analytes and Reporting Limits

Compound	CAS Number	Water ¹ µg/L	Low soil ² µg/kg	Med. Soil ² µg/kg
Acetonitrile	75-05-8	20	100	5000
Acrylonitrile	107-13-1	20	100	5000
Bromobenzene	108-86-1	1	5	250
1,3-Butadiene	106-99-0	1	5	250
n-Butylbenzene	104-51-8	1	5	250
Sec-Butylbenzene	135-98-8	1	5	250
tert-Butylbenzene	98-06-6	1	5	250
2-Chloroethylvinylether	110-75-8	NA ³	NA ³	1000
2-Chloropropane	75-29-6	1	5	250
2-Chlorotoluene	95-49-8	1	5	250
4-Chlorotoluene	106-43-4	1	5	250
1,2-Dibromo-3-chloropropane	96-12-8	2	10	500
1,2-Dichlorobenzene	95-50-1	1	5	250
1,3-Dichlorobenzene	541-73-1	1	5	250
1,4-Dichlorobenzene	106-46-7	1	5	250
cis-1,4-dichloro-2-butene	1476-11-5	2	10	500
trans-1,4-dichloro-2-butene	110-57-6	2	10	500
1,4-dichloro-2-butene (Total)	164-41-0	4	20	1000
Dichlorodifluoromethane	75-71-8	2	10	500
1,3-Dichloropropane	142-28-9	1	5	250
Hexachlorobutadiene	87-68-3	2	10	500
Hexane	110-54-3	2	10	500
Iodomethane (syn: methyl iodide)	74-88-4	2	10	500
Isopropylbenzene (syn: Cumene)	98-82-8	1	5	250
Isopropyltoluene (syn: p-Cymene)	99-87-6	1	5	250
Methyl tert-butyl ether (MTBE)	1634-04-4	1	5	250
Methyl methacrylate	80-62-6	1	5	250
Napthalene	91-20-3	1	5	250
n-Propylbenzene	103-65-1	1	5	250
Tetrahydrofuran	109-99-9	4	20	1000
1,2,3-Trichlorobenzene	87-61-6	1	5	250
1,2,4-Trichlorobenzene	120-82-1	1	5	250
Trichlorofluoromethane	75-69-4	2	10	500
1,2,3-Trichloropropane	96-18-4	1	5	250
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	76-13-1	2	10	500
1,2,4-Trimethylbenzene	95-63-6	1	5	250
1,3,5-Trimethylbenzene	108-67-8	1	5	250
Vinyl acetate	108-05-4	2	10	500
Vinyl bromide	593-60-2	2	10	500
Methyl Acetate	79-20-9	1	5	250
Cyclohexane	110-82-7	1	5	250
Methyl Cyclohexane	108-87-2	1	5	250
2-Propanol	67-63-0	10	-	-

¹Levels for 5 mL purge water samples are 5 times higher. This is achieved by analyzing 5 mL sample in a 25 mL final volume.

²Reporting limits listed for soil/sediment are based on wet weight. The reporting limits calculated by the laboratory for soil/sediment, calculated on dry weight basis, will be higher.

³2-Chloroethyl vinyl ether cannot be reliably recovered from acid preserved samples or sodium bisulfate preserved soil samples.

Table 3 - TCLP Analytes, Reporting Limits and Regulatory Levels

Compound	CAS Number	Reporting Limit, mg/L	Regulatory Level, mg/L
2-Butanone (syn: methyl ethyl ketone, MEK)	78-93-3	0.20	200
Chloroform	67-66-3	0.05	6.0
Carbon tetrachloride	56-23-5	0.05	0.5
Benzene	71-43-2	0.05	0.5
1,2-Dichloroethane	107-06-2	0.05	0.5
Chlorobenzene	108-90-7	0.05	100
1,1-Dichloroethylene	75-35-4	0.05	0.7
Tetrachloroethylene	127-18-4	0.05	0.7
Trichloroethylene	79-01-6	0.05	0.5
Vinyl Chloride	75-01-4	0.10	0.2

Table 4 - Internal Standards

	Amount added to sample being purged, ng	Quantitation ion
Fluorobenzene	250	96
Chlorobenzene-d5	250	117 (119)
1,4-Dichlorobenzene-d4	250	152

Notes:

- 1) This results in a concentration of each internal in the sample of 50µg/L for a 5 mL purge or 10 µg/L for a 25 mL purge or 50 ug/kg for a 5 gr soil purge.
- 2) This is achieved by spiking 5 uL of a 50 ug/mL standard manually, or if an autosampler loop is used, the concentration of the solution is adjusted to the volume of the spiking loop.
- 3) Mass 119 is used for Chlorobenzene-d5 for 25ml analyses
- 3) Except for high level soils, the surrogate and internal standards may be combined in one solution.

Table 5 - Surrogate Standards

Surrogate Compounds	Amount added to sample being purged, ng
1,2-Dichloroethane-d ₄	250
Dibromofluoromethane	250
Toluene-d ₈	250
4-Bromofluorobenzene	250

Notes:

- 1) This results in a concentration of each surrogate in the sample of 10 µg/L for a 25 mL purge or 50 ug/kg for a 5 gr soil purge.
- 2) This is achieved by spiking 5 uL of a 50 ug/mL standard manually, or if an autosampler loop is used, the concentration of the solution is adjusted to the volume of the spiking loop.
- 3) Except for high level soils, the surrogate and internal standards may be combined in one solution.
- 4) Recovery limits for surrogates are generated from historical data and are maintained by the QA department.

Table 6 - 8260B Matrix Spike / LCS Representative Compounds

Compound	Standard Concentration µg /mL
1,1-Dichloroethene	100
Trichloroethene	100
Toluene	100
Benzene	100
Chlorobenzene	100

Notes:

- 1) 2.5 µL of the 100 ppm standard is added to the LCS or matrix spiked sample. This results in a concentration of each spike analyte in the sample of 10 µg/L for a 25 mL purge or 50 ug/kg for a 5 gr soil purge.
- 2) Recovery and precision limits for LCS and MS/MSD are generated from historical data and are maintained by the QA department. Laboratory control is based on the performance of the method specified representative analytes.
- 3) Full analyte spikes (Table 1 and 2) are typically used in the LCS and MS/MSD.

Table 7 - BFB Key Ion Abundance Criteria

Mass	Ion Abundance Criteria
50	15% to 40% of Mass 95
75	30% to 60% of Mass 95
95	Base Peak, 100% Relative Abundance
96	5% to 9% of Mass 95
173	Less Than 2% of Mass 174
174	Greater Than 50% - 120% of Mass 95
175	5% to 9% of Mass 174
176	Greater Than 95%, But Less Than 101% of Mass 174
177	5% to 9% of Mass 176

Table 8 - SPCC Compounds and Minimum Response Factors

Compound	8260B Min. RF
Chloromethane	0.100
1,1-Dichloroethane	0.100
Bromoform	0.100
1,1,2,2-Tetrachloroethane	0.300
Chlorobenzene	0.300

Table 9 - CCC compounds

Compound	Max. %RSD from Initial Calibration	Max. %D for Calibration Verification
Vinyl Chloride	<30	≤20
1,1-Dichloroethene	<30	≤20
Chloroform	<30	≤20
1,2-Dichloropropane	<30	≤20
Toluene	<30	≤20
Ethylbenzene	<30	≤20

Table 10 - Quantitation Ions***

Compound	IS Group	Primary*	Secondary	Tertiary
Dichlorodifluoromethane	1	85	87	50
Chloromethane	1	50	52	49
Vinyl chloride	1	62	64	61
1,3-Butadiene	1	39		
Bromomethane	1	94	96	
Chloroethane	1	64	66	49
Vinyl bromide	1	106		
Trichlorofluoromethane	1	101	103	66
2-Chloropropane	1	43		
1,1-Dichloroethene	1	96	61	98
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	1	151	101	153
Iodomethane	1	142	127	141
Carbon disulfide	1	76	78	
Acetone	1	43	58	
2-Propanol	1	45		
Acetonitrile	1	40	41	39
Methylene chloride	1	84	49	51
Acrylonitrile	1	53	52	51
trans-1,2-Dichloroethene	1	96	61	98
Methyl tert butyl ether	1	73		
Hexane	1	57	43	
1,1-Dichloroethane	1	63	65	83
Vinyl acetate	1	86	43	
cis-1,2-Dichloroethene	1	96	61	98
2,2-Dichloropropane	1	77	97	
2-Butanone	1	43	72**	
Tetrahydrofuran	1	42		
Bromochloromethane	1	128	130	49
Chloroform	1	83	85	47
1,1,1-Trichloroethane	1	97	99	117
Carbon tetrachloride	1	117	119	121
1,1-Dichloropropene	1	75	77	110
1,2-Dichloroethane	1	62	64	98
Benzene	1	78	52	77
Trichloroethene	1	130	95	97
1,2-Dichloropropane	1	63	65	41
Dibromomethane	1	93	174	95
Methyl methacrylate	1	41	69	100
Bromodichloromethane	1	83	85	129
cis-1,3-Dichloropropene	1	75	77	39
4-Methyl-2-pentanone	2	43	58	57
Toluene	2	91	92	65
trans-1,3-Dichloropropene	2	75	77	39
1,1,2-Trichloroethane	2	97	83	85
Tetrachloroethene	2	164	166	131
1,3-Dichloropropane	2	76	78	
2-Hexanone	2	43	58	57
Chlorodibromomethane	2	129	127	

Table 10 - Quantitation Ions (continued)

Compound	IS Group	Primary*	Secondary	Tertiary
1,2-Dibromoethane	2	107	109	188
Chlorobenzene	2	112	114	77
1,1,1,2-Tetrachloroethane	2	131	133	119
Ethylbenzene	2	106	91	
Xylenes	2	106	91	
Styrene	2	104	103	78
Bromoform	2	173	171	175
Isopropylbenzene	2	105	120	
1,4-Dichloro-2-butene, Cis & Trans	2	53	88/89	
1,1,1,2-Tetrachloroethane	2	83	85	131
Bromobenzene	2	156	158	77
1,2,3-Trichloropropane	3	110	75	
n-Propylbenzene	3	91	120	
2-Chlorotoluene	3	91	126	
1,3,5-Trimethylbenzene	3	105	120	
4-Chlorotoluene	3	91	126	
tert-Butylbenzene	3	119	91	134
1,2,4-Trimethylbenzene	3	105	120	
sec-Butylbenzene	3	105	134	
Dichlorobenzene (all isomers)	3	146	148	111
p-isopropyltoluene	3	119	134	91
n-Butylbenzene	3	91	92	134
1,2-Dibromo-3-chloropropane	3	157	155	75
1,2,4-Trichlorobenzene	3	180	182	145
Hexachlorobutadiene	3	225	223	227
Naphthalene	3	128	129	127
1,2,3-Trichlorobenzene	3	180	182	145
Methyl Acetate	1	43	74	59
Cyclohexane	1	56	84	41
Methyl Cyclohexane	1	83	55	98
1,2-Dichloroethane-d ₄ (Surrogate)	1	65	102	
Dibromofluoromethane (Surrogate)	1	113	111	
Toluene-d ₈ (Surrogate)	2	98	70	100
4-Bromofluorobenzene (Surrogate)	3	95	174	176

* The primary ion should be used for quantitation unless interferences are present, in which case a secondary ion may be used.

** m/z 43 may be used for quantitation of 2-Butanone, but m/z 72 must be present for positive identification.

***The Target software designates the nature of the ions as “Quant”, “Qual” or “Monitor”.

- Quant- i.e., quantitate; designates that ion for quantitation of the target analyte
- Qual – i.e., qualify; designates that ion that must be present in order to identify (or integrate) that analyte.
- Monitor- designates that ion as a monitor for additional qualitative analysis. The Target software does not use this mode to determine if a peak will be integrated.

Primary ions listed in this SOP shall be used in the “Quant” mode unless there are interferences present. In that case, a secondary ion is used. Secondary and tertiary ions can be designated as either “Qual” or “Monitor” mode.

Table 11 - Typical Water Calibration Levels (ug/L) - 25ml Purge

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Dichlorodifluoromethane	1	2	10	20	40	80
Chloromethane	1	2	10	20	40	80
Vinyl chloride	1	2	10	20	40	80
1,3-Butadiene	1	2	10	20	40	80
Bromomethane	1	2	10	20	40	80
Chloroethane	1	2	10	20	40	80
Vinyl bromide	1	2	10	20	40	80
Trichlorofluoromethane	1	2	10	20	40	80
2-Chloropropane	1	2	10	20	40	80
1,1-Dichloroethene	1	2	10	20	40	80
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	1	2	10	20	40	80
Iodomethane	1	2	10	20	40	80
Carbon disulfide	1	2	10	20	40	80
Acetone	4	8	40	80	160	320
2-Propanol	10	20	100	200	400	800
Acetonitrile	20	40	200	400	800	1600
Methylene chloride	1	2	10	20	40	80
Acrylonitrile	20	40	200	400	800	1600
trans-1,2-Dichloroethene	1	2	10	20	40	80
Methyl tert butyl ether	1	2	10	20	40	80
Hexane	1	2	10	20	40	80
1,1-Dichloroethane	1	2	10	20	40	80
Vinyl acetate	-	2	10	20	40	80
cis-1,2-Dichloroethene	1	2	10	20	40	80
2,2-Dichloropropane	1	2	10	20	40	80
2-Butanone	4	8	40	80	160	320
Bromochloromethane	1	2	10	20	40	80
Tetrahydrofuran	4	8	40	80	160	320
Chloroform	1	2	10	20	40	80
1,1,1-Trichloroethane	1	2	10	20	40	80
Carbon tetrachloride	1	2	10	20	40	80
1,1-Dichloropropene	1	2	10	20	40	80
1,2-Dichloroethane	1	2	10	20	40	80
Benzene	1	2	10	20	40	80
Trichloroethene	1	2	10	20	40	80
1,2-Dichloropropane	1	2	10	20	40	80
Dibromomethane	1	2	10	20	40	80
Methyl methacrylate	1	2	10	20	40	80
Bromodichloromethane	1	2	10	20	40	80
2-Chloroethyl vinyl ether	2	4	20	40	80	160
cis-1,3-Dichloropropene	1	2	10	20	40	80
4-Methyl-2-pentanone	4	8	40	80	160	320
Toluene	1	2	10	20	40	80
trans-1,3-Dichloropropene	1	2	10	20	40	80
1,1,2-Trichloroethane	1	2	10	20	40	80
Tetrachloroethene	1	2	10	20	40	80
1,3-Dichloropropane	1	2	10	20	40	80
2-Hexanone	4	8	40	80	160	320
Chlorodibromomethane	1	2	10	20	40	80
1,2-Dibromoethane	1	2	10	20	40	80

Table 11 - Typical Water Calibration Levels (ug/L) - 25ml Purge (continued)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Methyl Acetate	1	2	10	20	40	80
Cyclohexane	1	2	10	20	40	80
Methyl Cyclohexane	1	2	10	20	40	80
Chlorobenzene	1	2	10	20	40	80
1,1,1,2-Tetrachloroethane	1	2	10	20	40	80
Ethylbenzene	1	2	10	20	40	80
m-Xylene and p-Xylene	2	4	20	40	80	160
o-Xylene	1	2	10	20	40	80
Styrene	1	2	10	20	40	80
Bromoform	1	2	10	20	40	80
Isopropylbenzene	1	2	10	20	40	80
cis-1,4-Dichloro-2-butene	1	2	10	20	40	80
1,1,2,2-Tetrachloroethane	1	2	10	20	40	80
Bromobenzene	1	2	10	20	40	80
1,2,3-Trichloropropane	1	2	10	20	40	80
trans-1,4-Dichloro-2-butene	1	2	10	20	40	80
n-Propylbenzene	1	2	10	20	40	80
2-Chlorotoluene	1	2	10	20	40	80
1,3,5-Trimethylbenzene	1	2	10	20	40	80
4-Chlorotoluene	1	2	10	20	40	80
tert-Butylbenzene	1	2	10	20	40	80
1,2,4-Trimethylbenzene	1	2	10	20	40	80
sec-Butylbenzene	1	2	10	20	40	80
1,3-Dichlorobenzene	1	2	10	20	40	80
p-isopropyltoluene	1	2	10	20	40	80
1,4-Dichlorobenzene	1	2	10	20	40	80
n- Butylbenzene	1	2	10	20	40	80
1,2-Dichlorobenzene	1	2	10	20	40	80
1,2-Dibromo-3-chloropropane	1	2	10	20	40	80
1,2,4-Trichlorobenzene	1	2	10	20	40	80
Hexachlorobutadiene	1	2	10	20	40	80
Naphthalene	1	2	10	20	40	80
1,2,3-Trichlorobenzene	1	2	10	20	40	80
1,2-Dichloroethane-d ₄ (Surrogate)	1	2	10	20	40	-
Dibromofluoromethane (Surrogate)	1	2	10	20	40	-
Toluene-d ₈ (Surrogate)	1	2	10	20	40	-
4-Bromofluorobenzene (Surrogate)	1	2	10	20	40	-

Table 12 - Typical Soil Calibration Levels (ug/kg) – Low Level

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Dichlorodifluoromethane	5	10	50	100	250	400
Chloromethane	5	10	50	100	250	400
Vinyl chloride	5	10	50	100	250	400
1,3-Butadiene	5	10	50	100	250	400
Bromomethane	5	10	50	100	250	400
Chloroethane	5	10	50	100	250	400
Vinyl bromide	5	10	50	100	250	400
Trichlorofluoromethane	5	10	50	100	250	400
2-Chloropropane	5	10	50	100	250	400
1,1-Dichloroethene	5	10	50	100	250	400
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	5	10	50	100	250	400
Iodomethane	5	10	50	100	250	400
Carbon disulfide	5	10	50	100	250	400
Acetone	20	40	200	400	1000	1600
2-Propanol	50	100	500	1000	2500	4000
Acetonitrile	100	200	1000	2000	5000	8000
Methylene chloride	5	10	50	100	250	400
Acrylonitrile	100	200	1000	2000	5000	8000
trans-1,2-Dichloroethene	5	10	50	100	250	400
Methyl tert butyl ether	5	10	50	100	250	400
Hexane	5	10	50	100	250	400
1,1-Dichloroethane	5	10	50	100	250	400
Vinyl acetate	-	10	50	100	250	400
cis-1,2-Dichloroethene	5	10	50	100	250	400
2,2-Dichloropropane	5	10	50	100	250	400
2-Butanone	20	40	200	400	1000	1600
Bromochloromethane	5	10	50	100	250	400
Tetrahydrofuran	20	40	200	400	1000	1600
Chloroform	5	10	50	100	250	400
1,1,1-Trichloroethane	5	10	50	100	250	400
Carbon tetrachloride	5	10	50	100	250	400
1,1-Dichloropropene	5	10	50	100	250	400
1,2-Dichloroethane	5	10	50	100	250	400
Benzene	5	10	50	100	250	400
Trichloroethene	5	10	50	100	250	400
1,2-Dichloropropane	5	10	50	100	250	400
Dibromomethane	5	10	50	100	250	400
Methyl methacrylate	5	10	50	100	250	400
Bromodichloromethane	5	10	50	100	250	400
cis-1,3-Dichloropropene	5	10	50	100	250	400
4-Methyl-2-pentanone	20	40	200	400	1000	1600
Toluene	5	10	50	100	250	400
trans-1,3-Dichloropropene	5	10	50	100	250	400
1,1,2-Trichloroethane	5	10	50	100	250	400
Tetrachloroethene	5	10	50	100	250	400
1,3-Dichloropropane	5	10	50	100	250	400
2-Hexanone	20	40	200	400	1000	1600
Chlorodibromomethane	5	10	50	100	250	400
1,2-Dibromoethane	5	10	50	100	250	400
Chlorobenzene	5	10	50	100	250	400

Table 12 - Typical Soil Calibration Levels (ug/kg) – Low Level (continued)

Compound	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
1,1,1,2-Tetrachloroethane	5	10	50	100	250	400
Ethylbenzene	5	10	50	100	250	400
m-Xylene and p-Xylene	10	20	100	200	500	800
o-Xylene	5	10	50	100	250	400
Styrene	5	10	50	100	250	400
Bromoform	5	10	50	100	250	400
Isopropylbenzene	5	10	50	100	250	400
cis-1,4-Dichloro-2-butene	5	10	50	100	250	400
1,1,2,2-Tetrachloroethane	5	10	50	100	250	400
Bromobenzene	5	10	50	100	250	400
1,2,3-Trichloropropane	5	10	50	100	250	400
trans-1,4-Dichloro-2-butene	5	10	50	100	250	400
n-Propylbenzene	5	10	50	100	250	400
2-Chlorotoluene	5	10	50	100	250	400
1,3,5-Trimethylbenzene	5	10	50	100	250	400
4-Chlorotoluene	5	10	50	100	250	400
tert-Butylbenzene	5	10	50	100	250	400
1,2,4-Trimethylbenzene	5	10	50	100	250	400
sec-Butylbenzene	5	10	50	100	250	400
1,3-Dichlorobenzene	5	10	50	100	250	400
p-isopropyltoluene	5	10	50	100	250	400
1,4-Dichlorobenzene	5	10	50	100	250	400
n- Butylbenzene	5	10	50	100	250	400
1,2-Dichlorobenzene	5	10	50	100	250	400
1,2-Dibromo-3-chloropropane	5	10	50	100	250	400
1,2,4-Trichlorobenzene	5	10	50	100	250	400
Hexachlorobutadiene	5	10	50	100	250	400
Naphthalene	5	10	50	100	250	400
1,2,3-Trichlorobenzene	5	10	50	100	250	400
1,2-Dichloroethane-d ₄ (Surrogate)	5	10	50	100	250	-
Dibromofluoromethane (Surrogate)	5	10	50	100	250	-
Toluene-d ₈ (Surrogate)	5	10	50	100	250	-
4-Bromofluorobenzene (Surrogate)	5	10	50	100	250	-

Appendix A: Example Data Review Checklist

TestAmerica Volatile GC/MS Initial Calibration Data Review / Narrative Checklist
Method: 8260B – KNOX-MS-0015, Rev. 11 and Vost Analysis-KNOX-MS-0011, Rev 7

Analysis Date:		Instrument:		ICAL Batch/Scan Name:		Scanned <input type="checkbox"/>
Review Items	N/A	Yes	No	If No, why is data reportable?	2nd	√
1. Did BFB meet tune criteria?						
2. Were all standards injected within 12 hr of BFB?						
3. Was date/time of analysis verified between analysis header and logbook as correct?						
4. Were ≥ 5 levels of each compound/surrogate analyzed?						
5. Was low level standard at or below RL?						
6. Do the average RFs for SPCCs meet minimum RF?						
7. Are %RSD <30% for CCCs?						
8. Was a linear fit or quadratic fit used for analytes >15% RSD?						
9. If curves were used, is correlation coefficient ≥0.990?						
10. At least 6 consecutive points used for quadratic curves?						
11. For quadratic: is a tangent's slope to the curve entirely positive or negative and continuous?						
12. Is the "Y" intercept less than the RL for each curve?						
13. Were all peaks identified automatically?						
<i>If not, list analytes:</i>						
14. If manual integrations were performed, are they clearly identified, initialed, dated and reason given?				Reasons: 1)Corrected split peak; 2)Unresolved peak; 3)tailing; 4)RT shift; 5)wrong peak selected; 6)other		
15. Are the ICAL start and end dates/times correct on ICAL summary?						
16. Was the high point checked for saturation						
17. Elution order checked on isomeric pairs? <ul style="list-style-type: none"> • chlorobenzene-d5 and 1,1,1,2-tetrachloroethane • trichloro fluoromethane and Freon 113 • hexane and vinyl acetate • cis- and trans- isomers • CCL₄ and 1,1,1-TCA • ethyl benzene / m/p-xylene / o-xylene • n-propylbenzene / 2-chlorotoluene / 4-chlorotoluene • 1,3,5-trimethylbenzene / 1,2,4-trimethylbenzene / sec-butylbenzene • 1,3- , 1,4- , and 1,2-dichlorobenzene • 1,2,4 and 1,2,3 -trichlorobenzene 						
18. If criteria were not met, was a NCM generated, approved by supervisor, and copy included in folder?						
19. Does the ICAL folder contain complete data in the following order? Data review checklist, tune pass/fail page, m/z list, tune chromatogram, ICAL summary, & curves, followed by Quan reports, chromatograms & manual integrations, in order from low to high standard.						
20. Was the 2nd source calibration verification standard within 70-130% and are results in ICAL folder? (25% DOD)						
Analyst:	Date:		2nd Level Reviewer :		Date:	
Comments:	Comments:					

Appendix A: Example Data Review Checklist, continued

TestAmerica Volatile GC/MS Continuing Calibration Review / Narrative Checklist
Method: 8260B - KNOX-MS-0015, Rev. 11 and Vost Analysis-KNOX-MS-0011, Rev 7

Analysis Date:	CCAL Batch/ Scan Name:	Instrument:	ICAL Batch/ Scan Name:	Scanned <input type="checkbox"/>
----------------	------------------------	-------------	------------------------	----------------------------------

Review Items	N/A	Yes	No	If No, why is data reportable?	2nd √
1. Did BFB meet tune criteria?					
2. Were all standards injected within 12 hr of BFB?					
3. Was date/time of analysis verified between analysis header and logbook as correct?					
4. Do the RFs for SPCCs meet minimum RF?					
5. Is the %D or drift <20% for all CCCs?					
6. Is the %D or drift ≤ 50% for all other compounds? [Up to 6 TCLs may have %D or drift > 50%; any more and the calibration is INVALID].				<input type="checkbox"/> %D or drift > 50% for the following TCLs: _____ _____	
7. Are the internal standard responses within limits? 8260B: 50-200% of the mid-level ICAL standard					
8. Are the internal standard retention times within limits? 8260B: 30 seconds of the mid-level ICAL standard					
9. If manual integrations were performed, are they clearly identified, initialed, dated and reason given?				Reasons: 1)Corrected split peak; 2)Unresolved peak; 3)tailing; 4)RT shift; 5)wrong peak selected; 6)other	
10. Have alternate hits/manual integrations been verified as correct and are correct RFs listed in CCAL summary?					
11. Was the correct ICAL used for quantitation? (Verify date & time of ICAL is documented correctly on CCAL)					
12. Is the first IS documented correctly on the log?					
13. Elution order checked on isomeric pairs/coeluters? <ul style="list-style-type: none"> • chlorobenzene-d5 and 1,1,1,2-tetrachloroethane • trichloro fluoromethane and Freon 113 • hexane and vinyl acetate • cis- and trans- isomers • CCL₄ and 1,1,1-TCA • ethyl benzene / m/p-xylene / o-xylene • n-propylbenzene / 2-chlorotoluene / 4-chlorotoluene • 1,3,5-trimethylbenzene / 1,2,4-trimethylbenzene / sec-butylbenzene • 1,3-, 1,4-, and 1,2-dichlorobenzene • 1,2,4 and 1,2,3 -trichlorobenzene 					
14. If criteria were not met, was a NCM generated, approved by supervisor, and copy included in folder?					
15. Does the CCAL folder contain complete data in the following order? Data review checklist, tune pass/fail page, m/z list, tune chromatogram, Target CCAL summary, Quan report, chromatogram and manual integrations.					

Analyst:	Date:	2nd Level Reviewer :	Date:
Comments:		Comments:	

Appendix A: Example Data Review Checklist, continued

TestAmerica Volatile GC/MS Data Review / Narrative Checklist
Method: 8260B - KNOX-MS-0015, Rev. 11

LOT/Project # _____
Page 1 of 2

Instrument:						
Scanned File Names:						

Review Items	N/A	Yes	No	Why is data reportable?	2nd ✓
A. Tune / Calibration					
1. Were all samples injected within 12 hr of EFB?					
2. Has a Continuing Calibration Checklist been completed for each analytical batch?					
3. Was the correct ICAL used for quantitation?					
B. Client Sample and QC Sample Results					
1. Were all special project requirements met?					
2. Were prep/dilution factors & header information verified?					
3. Was date/time of analysis verified between analysis header and logbook as correct?					
4. Were the analytes that were not automatically identified in the CCAL searched for manually in the samples?					
5. Sample analyses done within preparation and analytical holding time (HT)? If no, list samples: _____				<input type="checkbox"/> [ht1] HT expired upon receipt. <input type="checkbox"/> [ht2] Client requested analysis after HT expired.* <input type="checkbox"/> Reanalysis done after HT expired. See [sur4].	
6. Was pH ≤2 for all samples? If no, list samples: _____				<input type="checkbox"/> [pH] pH >2. Sample analyzed within 14 days.	
7. Are surrogates and internal standards within QC limits? If no, list samples and reason (e.g., sur1): Sample Reason Sample Reason				<input type="checkbox"/> [sur1] MS/MSD surr.%R demonstrated same effect. <input type="checkbox"/> [sur2] Reanalysis demonstrated same effect. <input type="checkbox"/> [sur3] Not enough sample to reanalyze. <input type="checkbox"/> [sur4] Reanalysis done outside HT. Rerun shows original %R were wrong; both sets data reported. <input type="checkbox"/> [sur5] At client's request, data was flagged as estimated & released without further investigation.* <input type="checkbox"/> [sur6] Dilution showed acceptable %R. <input type="checkbox"/> [sur7] Obvious matrix interference. <input type="checkbox"/> [sur12] Surr.%R high and all targets ND. <input type="checkbox"/> [sur13] Surr.%R low, sample consumed. <input type="checkbox"/> [sur14] Surr.%R high, sample consumed. <input type="checkbox"/> [sur15] abfm out, pH ≥10. <input type="checkbox"/> [is1] Per client, reanalysis was not performed.* <input type="checkbox"/> [is2] Reanalysis confirmed a matrix effect. <input type="checkbox"/> [is3] Reanalysis at dilution was acceptable. <input type="checkbox"/> [is4] MS/MSD IS %R demonstrated same effect. 8260B ONLY ↓ <input type="checkbox"/> [isb1] Sample bracketed by acceptable runs. <input type="checkbox"/> [isb2] IS and associated surr. %R out, but sample bracketed by acceptable runs. <input type="checkbox"/> [isb3] IS and unassociated surr. %R out. Reanalysis confirmed a matrix effect.	
8. Are internal standards <0.5min of last CCAL?					
9. Were positive hits evaluated using qualitative identification criteria and technical judgement?					
10. Are positive results within calibration range? If no, list samples: _____				<input type="checkbox"/> [dil5] At client's request, sample was analyzed with minimum dilution even though some analytes were outside of calibration range.*	
11. For initial analysis that's a dilution, was the largest analyte >20% of calibration range? List diluted samples and reason (e.g., elev1): Sample Reason Sample Reason				<input type="checkbox"/> [elev1] Elevated RL for (ANALYTE) due to sample matrix interferences. <input type="checkbox"/> [elev2] Elevated RL for (ANALYTE) due to interfering analyte. <input type="checkbox"/> [elev3] Elevated RLs for all analytes due to difficult sample matrix. <input type="checkbox"/> [elev4] Diluted based on screening results. <input type="checkbox"/> [elev5] Elevated RLs for all analytes due to presence of non-target compounds. <input type="checkbox"/> [encore1] Elevated RLs due to limited soil volume.	

* Such action must be taken in consultation with client.

Appendix A: Example Data Review Checklist, continued

TestAmerica Volatile GC/MS Data Review / Narrative Checklist
Method: 8260B - KNOX-MS-0015, Rev. 11

LOT/Project # _____

Page 2 of 2

B. Client Sample and QC Sample Results	N/A	Yes	No	Why is data reportable?	2nd √																				
12. For secondary diluted analyses to bring compounds within calibration range, was the largest analyte targeted to be above 50% of calibration range? List diluted samples and reason (e.g., dil1): <table border="1"> <thead> <tr> <th>Sample</th> <th>Reason</th> <th>Sample</th> <th>Reason</th> </tr> </thead> <tbody> <tr><td>_____</td><td>_____</td><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td><td>_____</td><td>_____</td></tr> <tr><td>_____</td><td>_____</td><td>_____</td><td>_____</td></tr> </tbody> </table>	Sample	Reason	Sample	Reason	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____	_____				<input type="checkbox"/> [dil1] Conc. of (ANALYTE) > calibration range. RLs adjusted accordingly. <input type="checkbox"/> [dil2] Conc. of several compounds > calibration range. RLs adjusted accordingly. <input type="checkbox"/> [dil3] Conc. of (ANALYTE) > calibration range. Both analyses reported to provide lowest RLs. <input type="checkbox"/> [dil4] Conc. of several compounds > calibration range. Both analyses reported to provide lowest RLs.	
Sample	Reason	Sample	Reason																						
_____	_____	_____	_____																						
_____	_____	_____	_____																						
_____	_____	_____	_____																						
_____	_____	_____	_____																						
13. If manual integrations were performed, are they clearly identified, initialed, dated and reason given?				Reasons: 1)Corrected split peak; 2)Unresolved peak; 3)tailing; 4)RT shift; 5)wrong peak selected; 6)other																					
14. Have alternate hits and manual integrations been verified as correct?																									
C. Preparation/Matrix QC																									
1. LCS done per prep batch and all analytes within laboratory established QC limits? If no, list LCS ID: _____				<input type="checkbox"/> [lcs2] Insufficient sample for reanalysis.* <input type="checkbox"/> [lcs3] LCS %R high and all analyte(s) were <RL in associated samples. <input type="checkbox"/> [lcs4] LCS % out, samples consumed. <input type="checkbox"/> [lcs RPD] RPD out, BUT % R OK.																					
2. Method blank done per prep batch and method blank or instrument blank analyzed with each sequence?																									
3. Method blank surrogate recoveries within QC limits?				<input type="checkbox"/> [mb1] All sample surrogates OK and there is no analyte >RL in samples associated with blank.* <input type="checkbox"/> [mb7] Surr. %R out, samples consumed.																					
4. Are all analytes present in the method blank < RL? If no, list blank ID: _____				<input type="checkbox"/> [mb2] Common lab contaminant <5x RL.* <input type="checkbox"/> [mb3] No analyte > RL in associated samples.* <input type="checkbox"/> [mb4] Sample results > 20x higher than blank. <input type="checkbox"/> [mb5] Insufficient sample for reanalysis * <input type="checkbox"/> [mb8] Samples consumed.																					
5. MS/MSD done per batch? Batch # _____				<input type="checkbox"/> [lcsd] Insufficient sample. LCS/LCSD analyzed.																					
6. If MS/MSD was done on this client's sample or for reported batch QC, were MS/MSD recoveries & RPDs within laboratory generated QC limits? If no, list MS/MSD ID: _____				<input type="checkbox"/> [ms1] LCS acceptable - sample matrix effects. <input type="checkbox"/> [ms2] LCS acceptable. High native analyte concentration relative to spike level. <input type="checkbox"/> [rpd] LCS acceptable. RPD out due to lack of sample homogeneity.																					
7. Were MS run #'s assigned correctly?																									
D. Other																									
1. Are all nonconformances documented appropriately and copy included with deliverable?																									
2. Are the correct scanned file names listed at the top of the data review checklist?																									
3. Were the standards scanned properly with runlogs?																									
4. Final report acceptable? (Results correct, RLs calculated correctly, units correct, surrogate %R correct, appropriate flags used, dilution factor correct, and extraction/ analysis dates correct.)																									
5. Was a narrative prepared and all deviations noted?																									
Analyst: _____	Date: _____	2nd Level Reviewer: _____		Date: _____																					
Comments:			Comments:																						

* Such action must be taken in consultation with client.

TESTAMERICA KNOXVILLE
STANDARD OPERATING PROCEDURE
TITLE: SAMPLE RECEIPT AND LOG IN
(SUPERSEDES: KNOX-SC-0003, Rev. 12)

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1. Purpose

- 1.1. This standard operating procedure describes the receipt and log in activities that are the responsibility of the TestAmerica Knoxville sample receiving associates.

2. Responsibilities

- 2.1. It is the responsibility of the TestAmerica Knoxville sample receiving associates to perform the tasks as they are documented in this standard operating procedure.
- 2.2. It is the responsibility of the Laboratory Director and Customer Service Manager to supply adequate training, material and equipment to enable the associates to perform these tasks correctly.

3. Safety

- 3.1. Employees must abide by the policies and procedures in the TestAmerica Environmental Health and Safety Manual and this document.
- 3.2. Procedures shall be carried out in a manner that protects the health and safety of all associates. Exposure to chemicals and samples will be maintained as low as reasonably achievable, therefore, unless they are known to be non-hazardous, all samples must be opened, transferred and prepared in a fume hood, or under other means of mechanical ventilation. Solvent and waste containers will be kept closed unless transfers are being made. The preparation of all standards, reagents and glassware cleaning procedures that involve solvents will be conducted in a fume hood with the sash closed as far as the operations will permit.
- 3.3. All work must be stopped in the event of a known or potential compromise to the health and safety of any associate. The situation must be reported **immediately** to a laboratory supervisor.
- 3.4. Sample receiving associates must wear gloves when handling samples and sample containers.

4. Procedure

- 4.1. Before samples arrive at the laboratory, the laboratory must provide to the sample collection personnel the sample acceptance policy. This is normally sent by the Project Manager to the client with the quote. See Appendix I.
- 4.2. **Project Managers should make a reasonable effort to determine if samples to be received are radioactive in nature.**

- 4.3. The shipping container is opened under a vented fume hood. If there are noxious fumes, work is stopped and the Health and Safety Coordinator is notified. If there are broken or leaking samples that are known or suspected to contain radioactive material, the work is stopped and the Radiation Safety Officer, or designee, is notified.
- 4.4. If the samples are known or suspected to contain radioactive material, the shipping containers and samples are surveyed according to the following.

NOTE: If radioactive samples are to be received, the Project Manager should make a reasonable effort to obtain screening data (either Gross Alpha/Gross Beta data (activity and specific activity), or specific radionuclide data (activity and specific activity)) from the client for each of the samples. The Radiation Safety Officer shall make a reasonable effort to ensure that any screening data received is acceptable.

4.4.1. If the package is labeled as a RADIOACTIVE MATERIAL shipment (as defined by 49 CFR 173.403), the sample control associate shall ensure that the external surfaces of the package are monitored by performing the following within 3 hours of receipt of the package, if received during the hours of 8:00 a.m. to 5:00 p.m. Monday through Friday, excluding holidays. If received at other times, the package shall be monitored within 3 hours after the beginning of the next working day.

4.4.2. Wipe Survey

- 4.4.2.1. Place a filter paper disc on the surface to be sampled.
- 4.4.2.2. Move the disc over an “s”-shaped area using moderate pressure, covering at least approximately 100 cm² (6 in²), or at least approximately 20 inches in length, or the entire surface, if it is less than 100 cm² in area.
- 4.4.2.3. Place the disc smear in a container such that individual smears are separated from each other to prevent cross contamination.
- 4.4.2.4. Count each smear for alpha and beta activity in the Protean IPC9025 for five minutes. A shorter count time may be used if the count is long enough to have a detection limit below the contamination limit.

4.4.3. Exposure Rate

- 4.4.3.1. Measure the contact exposure rate of the package with a Ludlum Model 19 Micro-R Meter according to the TestAmerica Knoxville SOP KNOX-HS-0014, current revision, "Background and Source Check and Use of Portable Radiation Survey Instruments."
 - 4.4.3.2. Measure the exposure rate of the package at 1 meter with a Ludlum Model 19 Micro-R Meter.
 - 4.4.3.3. If the monitoring data of the package exceeds the site license criteria, contact the RSO, or designee.
- 4.5. The sample control associate shall open the package and ensure that the external surfaces of the containers are monitored by performing Section 4.4.2 on each container (or as a composite of any number of the containers), and Section 4.4.3 on each container.
 - 4.6. If the monitoring data of any sample exceeds the site license criteria, contact the RSO, or designee.
 - 4.7. Record all monitoring data, of both packages and containers, on a Radiological Survey form.
 - 4.8. Classification of samples shall be performed according to TestAmerica Knoxville SOP KNOX-HS-0001, current revision, "Radiological Sample Screening and Classification".
 - 4.9. The sample control associate shall ensure that all radiological documents are available for second level review by the RSO, or designee prior to release of the samples to the laboratory.
 - 4.10. The sample control associate shall ensure that each container holding a radioactive sample is labeled/marked as CAT I or CAT II, as appropriate.
 - 4.11. If the package is known to contain samples that are radioactive, but the package is not labeled as RADIOACTIVE MATERIAL, the following procedure is followed:

NOTE: The indication that a package contains radioactive samples may be through verbal or written communication from a client, historical knowledge of a site/project by a sample control associate, or through labeling/marketing of containers within the package with a recognized

radioactive label/markings. If a cooler is discovered to contain radioactive samples it will not be moved until the cooler and sample containers can be surveyed.

4.11.1. The sample control associate shall open the package and ensure that the external surfaces of the containers are monitored by performing the following.

4.11.1.1. Wipe Survey

4.11.1.1.1. Perform the procedure specified in Section 4.4.2 on each container (or as a composite of any number of the containers).

4.11.1.2. Count Rate

4.11.1.2.1. Measure the count rate of the package with a Ludlum Model 3 with Model 44-9 Pancake G-M Detector according to TestAmerica Knoxville SOP, KNOX-HS-0014, current revision, "Background and Source Check and Use of Portable Radiation Survey Instruments".

4.11.2. If the monitoring data of any sample exceeds the site license criteria, contact the RSO, or designee. Additionally, the sample control associate shall proceed back to Section 4.4.2, and perform additional monitoring of packages and containers described in that section.

4.11.3. Record all container monitoring data on a Radiological Survey form.

4.11.4. Classification of samples shall be performed according to the TestAmerica Knoxville SOP KNOX-HS-0001, current revision, "Radiological Sample Screening and Classification".

NOTE: If historical screening information is available for a sample, this data may be used for sample classification.

4.11.5. The sample control associate shall ensure that all radiological documents are available for second level review by the RSO, or designee prior to release of the samples to the laboratory.

4.11.6. The sample control associate shall ensure that each container holding a radioactive sample is labeled/marked as CAT I or CAT II, as appropriate.

4.12. If the package is suspected to contain samples that are radioactive:

NOTE: Suspicion that a package contains samples that are radioactive can be the result of keywords such as, but not limited to: FUSRAP, national laboratory, nuclear, uranium mine, Hanford, Las Vegas, Los Alamos, Mound, Oak Ridge, and Paducah. Additionally, shipping papers should be examined for contamination survey information, or screening data as an indication of the potential radioactive nature of samples.

4.12.1. Contact the RSO, or designee, who shall, working with information supplied by the Project Manager/client, determine whether or not the samples are to be processed as radioactive samples, or non-radioactive samples.

4.12.2. If the samples are determined to be radioactive, the sample control associate will proceed to process the samples as specified in Section 4.11.1

4.13. If the package is known or suspected to contain radioactive materials, and is treated as containing radioactive sample(s) based on the previous assessment(s) and the package or containers are crushed, wet, or damaged, the sample control associate shall proceed to monitor the packages and containers as specified in Section 4.4.2

4.14. The sample control associate will open and examine the shipping container and remove the enclosed sample documents. The following are recorded on the client's chain of custody form:

- Were custody seals present?
- The temperature of the cooler. If a temperature vial is present, it is used to take the temperature. Otherwise, the temperature is taken along the side of the bottle containers. The way the temperature was taken is recorded. The acceptable temperature range for sample coolers is above the freezing temperature of water to 6°C. The exceptions are samples from North Carolina and samples for Methods 1668 or 1613B (0-4 °C), VOST samples (up to 10 °C) and samples from Massachusetts (2-6 °C).
- The shipper's tracking number.
- Signature/initials and date.

4.14.1. If samples are delivered after normal business hours and a sample receiving associate is not present, the lab associate that receives the

shipment will sign and date the chain of custody form to acknowledge receipt of the shipping container and take the temperature of the cooler, if required. The lab associate will then store the shipping container in the proper location. The shipping container will remain there until the next business day; at that time, the sample receipt and login procedures will be completed.

4.15. The following information is then recorded on the Sample Receipt/Condition Upon Receipt Anomaly Checklist (See Appendix III):

- Presence of custody seals on the outside of the cooler or on the sample containers.
- Presence of chain-of-custody forms inside the cooler.
- The chain-of-custody forms were properly filled out in ink.
- The chain-of-custody forms were signed and dated in the appropriate places.
- Presence of the shipper's packing slip and/or request for analysis.
- Conditions of samples at receipt (chilled, etc.). If a temperature vial is present, it is used to take the temperature. Otherwise, the temperature is taken along the side of the bottle containers. The way the temperature was taken is recorded. Summa canisters should be received at ambient temperature.
- Condition of bottles upon receipt (good condition, broken, etc.).
- Complete bottle labels (date, signed, analysis, and preservations).
- Information on bottle labels and tags agree with custody papers.
- Correct bottles used for the tests indicated.
- VOA bottles checked for the presence of air bubbles. If headspace is noted, the sample receiving associate will affix a round label (approximately 3/4") and mark the vial with "HS" with indelible ink.
- Verify sample pH as appropriate (does not include VOAs). For each sample container use a new disposable Pasteur pipette to transfer a drop onto pH paper. Read the pH to the nearest pH unit and record the pH on the client's chain of custody form. If it is necessary for the laboratory to

perform sample preservation, record the preservative used, the lot number of the preservative, analyst initials and the date and time on the COC or CUR. If samples for metals analysis are preserved in the laboratory, the sample bottle is labeled with the date and time digestion may begin (at least 24 hours after preservation).

- Check samples for residual chlorine. For each sample, use a new disposable Pasteur pipette to transfer approximately 5 mL of sample to a residual chlorine strip. Note the reading on the client's chain of custody form. If residual chlorine is detected, the laboratory will add 2 mL of sodium thiosulfate solution to the sample and recheck for the presence of residual chlorine. If sodium thiosulfate is added to the sample, the lot number, analysts initials and date will be noted on the CUR or the chain of custody.
 - Sufficient amount of sample sent for all analyses requested.
 - Samples were verified received within holding time as specified in LQM.
 - Samples were received via overnight courier, client drop off or other means.
- 4.16. The sample control associate then removes all sample containers. Any broken, leaking or dirty sample containers are placed inside the fume hood. Dirty sample containers are cleaned appropriately so as not to contaminate the sample storage area.
- 4.17. The sample control associate examines all documents and compares the information from the sample container labels and chain-of-custody records to ensure that there are no discrepancies between the documents and that all documents are properly completed and signed.
- 4.18. If any problems or discrepancies are noted during the sample receiving process, such as improper paperwork or broken or leaking samples, the sample control associate signs for the shipment and documents the problems on the Sample Receipt/Condition Upon Receipt Anomaly Checklist (CUR, see Appendix III). The sample control associate immediately notifies the project manager. The project manager contacts the client to rectify the situation.
- 4.19. If all samples recorded on the chain-of-custody record were received by the laboratory and there are no problems observed with the sample shipment, the sample control associate signs, dates and times the chain-of-custody record in the "Received for Laboratory by:" box on the document.

- 4.20. After the samples have been removed from shipping containers and organized according to the client's chain-of-custody form and the appropriate sample receipt paperwork (e.g., CUR, Sample Receipt Checklist) has been completed, the sample control associate logs the samples into the LIMS using the quote number provided by the project manager.
- 4.20.1. If the quote number is unknown, the sample receiving associate contacts the project manager to obtain the appropriate quote number for the client samples.
- 4.20.2. If the project is an unusually complex project such as a source air trial burn, the sample receiving associate will typically request assistance from the project manager to ensure the client samples are logged in properly. This may include a physical review of the samples and chain of custody documentation by the project manager prior to sample log-in.
- 4.20.3. If there are questions or issues that prevent the sample receiving associate from logging the samples into the LIMS, and the project manager cannot review the sample receiving documentation immediately, the samples requiring temperature preservation are placed in a sample storage refrigerator (volatiles samples stored separately) until the project manager review is completed.
- 4.21. The project information is taken from the designated quote and the following information is entered into QuantIMS
- Date and time of receipt
 - Client sample IDs
 - Collection dates/times
 - Storage location
 - Test parameters (method codes and target analyte lists as defined by the Project Manager in the quote and requested by the client on the chain of custody)
 - Sample Type (Refer to the QuantIMS checklist as defined by the PM)
 - Refer to the QuantIMS general comments/checklist comments for any other fields that must be populated to meet electronic deliverable (EDD) requirements.

- 4.21.1.1. Some clients request that the samples be reported by Sample Delivery Group (SDG). The SDG is a group of samples received over a client-specified time period (therefore, different lots) that are reported together. The SDGs are tracked by sample receiving and documented in an Excel spreadsheet in Qmidtn01/public/SDG/numerical and/or alphabetic name of SDG.
- 4.21.1.2. All water samples requesting either total or dissolved/filtered metals analyses will be processed as follows:
- The sample receiving associate will assign the work order for total metals analysis SAC, and the work order for dissolved metals SAC from the quote. Note that the last three work order characters will be discreet for both SACs.
 - The sample receiving associate will enter QIMS sample comments as either "field filtered" or "needs to be filtered at the lab".
 - The sample receiving associate will either write on the container or affix a label on the filtered metals container as either "LF" for lab filtered or "FF" for field filtered.
 - The samples needing to be lab filtered will be stored at $4^{\circ} \pm 2^{\circ}\text{C}$ until the metals group filters and preserves the samples; after filtering and preservation, the samples may be stored at room temperature.
 - The sample receiving will verbally notify the metals group when the client requests the lab to filter samples.
- 4.22. QuantIMS assigns unique numbers and/or letter combinations to all projects, lots, samples and tests.
- 4.22.1. The first set of numbers/letters for a group of samples entering the laboratory is called the lot or lab ID number. Samples also receive a work order number that describes the type of test a sample will receive. As an analyst receives notice of the sample for their respective department, they batch groups of similar samples together and the samples are then assigned a batch number.
- 4.22.2. Each group of samples received or shipped from a specific site on the same day is logged in under a unique lot number. Each sample within a given lot receives a laboratory number or ID. Each lab ID is 12 of a possible 13 characters (H3A010121-001).
- 4.22.3. Lot number: The lot number is 9 characters long. Lot number **H1A010121**

is described as follows:

- **H** - the alpha character indicates the TestAmerica location where the samples were received. (H = Knoxville)
- **3** - the numeric character indicates the last digit of the year (i.e., 2003)
- **A** - the alpha character indicates the month (A = January, B = February, etc.)
- the next 2 numeric characters identify the day of the month, in this case the first day of the month.
- **0121**- the last 4 numeric characters are the sequential assignment of numbers specific to each lot received. Each day the first lot logged in receives the number 0001. Batch specific QC samples (method blanks, LCS, LCSD) receive a sequential assignment of 0000.

4.22.4. Sample Numbers: The samples in each lot are assigned a sample number that is attached to the lot number and are reset at each new lot. For example, the first and second samples in the lot above are labeled H3A010121-**001** and H3A010121-**002**.

4.22.5. Suffixes: Each sample also has a 1 character field (which may not be needed for all samples) called the suffix which identifies it as a:

Client sample - no suffix
Method blank - B
Check/Control Sample - C
Check dup/Dup control - L
Matrix spike (MS) - S
Matrix spike dup (MSD) - D
Sample dup/dup analysis - X
Serial dilution - P

4.22.6. 4.10.6 Each test has an 8 digit work order number. Work order number **A1234-2-01** is described as follows:

- **A1234** - The first 5 characters identify each sample.
- **2** - The 'modifier' indicates the type of run. In this case this is the second time the sample had to be run. If it needs reextraction/repreparation and run again the number would indicate a "3".
- **01** - The suffix is the test number of that specific sample. For example the "01" may indicate the 'silver' analysis, "02" may indicate the 'arsenic' analysis, an "03" may indicate a 'BOD', etc.
- The client requested analytical and preparatory methods and analyte lists defined by the project manager in the quote are linked to the work order number.

- 4.23. QuantIMS generates the sample labels based on the information from the quote and the login process. The sample containers are labeled, with the sample receiving associate carefully matching the client ID and analysis on the container with that on the QuantIMS label.
- 4.24. The samples that are to be analyzed at TestAmerica Knoxville are then placed in the sample storage refrigerators. Volatiles are stored separate from other analyses and metals samples are stored on shelves.
- 4.25. Samples that are to be subcontracted to another laboratory for analysis are packaged for shipment to the subcontract laboratory.
 - 4.25.1. The sample control associate examines all documents and compares the information from the sample container labels and chain of custody records to verify that the appropriate samples are being prepared for shipment.
 - 4.25.2. The containers are properly packaged to prevent breakage or leakage during shipment. All TestAmerica, DOT and IATA guidelines must be followed.
 - 4.25.3. The cooler is lined with a plastic liner to prevent leakage from the cooler. If ice is needed, it is packed and sealed in heavy plastic bags.
 - 4.25.4. The containers are wrapped in packing material and/or placed in plastic bags.
 - 4.25.5. Once the cooler is packed and ready for shipment, the sample control associates signs and dates the chain of custody. A copy of the completed chain of custody record is made. The original is placed in a plastic bag in the cooler with the samples. The copy of the chain of custody record, along with the shipper's tracking number, is given to the project manager with the rest of the project documentation.
 - 4.25.6. The cooler is sealed shut. All coolers are shipped with signed custody seals.
- 4.26. All sample receiving documents relevant to the lot are labeled with the lot number. All paperwork received from the client as well as that generated during sample login is filed in the lot project folder. Refer to the TestAmerica Knoxville SOP KNOX-AD-0002, "Project Records", current revision.
- 4.27. Once the sample login process is complete, the project file is ready for the project manager to review and the samples are ready for analysis.

- 4.28. Any deviations from this procedure by TestAmerica associates must be documented as a nonconformance, with a cause and corrective action described.

5. Definitions

- 5.1. Definitions can be found in the TestAmerica Knoxville Quality Assurance Manual (QAM), current revision.

6. Appendices

- 6.1. Appendix I: References
 - 6.1.1. TestAmerica Knoxville Quality Assurance Manual (QAM), current revision.
- 6.2. Appendix II: Example Sample Acceptance Policy
- 6.3. Appendix III: Example Sample Receipt/Condition Upon Receipt Anomaly Checklist

Appendix II: Example Sample Acceptance Policy

TestAmerica Knoxville Sample Acceptance Policy

The information below outlines the circumstances under which sample will be accepted by TestAmerica Knoxville. Failure to meet the following criteria will be noted in the project narrative. Please notify your PM with any questions.

Area of Concern

1. Proper, full and complete documentation, which includes sample identification, the location, data and time of collection, collector's name, preservation type, sample type, test requested and any special remarks concerning the samples shall be provided with the samples.

2. The samples shall be properly labeled to include unique identification. The labels must be durable (water resistant) and indelible ink must be used.

3. The samples shall be collected in the appropriate sample containers.

4. The samples shall arrive at the laboratory within the specified holding time for the analyses requested.

5. Sufficient sample volume must be available to perform the necessary tests.

6. The client will be notified upon sample receipt if the samples exhibit obvious signs of damage, contamination or inadequate preservation.

Appendix III: Example Sample Receipt/Condition Upon Receipt Anomaly Checklist

TESTAMERICA KNOXVILLE SAMPLE RECEIPT/CONDITION UPON RECEIPT ANOMALY CHECKLIST

Client: _____ Project: _____ Lot Number: _____

Review Items	Yes	No	NA	If No, what was the problem?	Comments/Actions Taken
1. Do sample container labels match COC? (IDs, Dates, Times)				<input type="checkbox"/> 1a Do not match COC <input type="checkbox"/> 1b Incomplete information <input type="checkbox"/> 1c Marking smeared <input type="checkbox"/> 1d Label torn <input type="checkbox"/> 1e No label <input type="checkbox"/> 1f COC not received <input type="checkbox"/> 1g Other: _____	
2. Is the cooler temperature within limits? (> freezing temp. of water to 6 °C; NC, 1668, 1613B: 0-4°C; VOST: 10°C; MA: 2-6 °C)				<input type="checkbox"/> 2a Temp Blank = _____ <input type="checkbox"/> 2b Cooler Temp = _____	
3. Were samples received with correct chemical preservative (excluding Encore)?				<input type="checkbox"/> 3a Sample preservative = _____	
4. Were custody seals present/intact on cooler and/or containers?				<input type="checkbox"/> 4a Not present <input type="checkbox"/> 4b Not intact <input type="checkbox"/> 4c Other: _____	
5. Were all of the samples listed on the COC received?				<input type="checkbox"/> 5a Samples received-not on COC <input type="checkbox"/> 5b Samples not received-on COC	
6. Were all of the sample containers received intact?				<input type="checkbox"/> 6a Leaking <input type="checkbox"/> 6b Broken	
7. Were VOA samples received without headspace?				<input type="checkbox"/> 7a Headspace (VOA only)	
8. Were samples received in appropriate containers?				<input type="checkbox"/> 8a Improper container	
9. Did you check for residual chlorine, if necessary?				<input type="checkbox"/> 9a Could not be determined due to matrix interference	
10. Were samples received within holding time?				<input type="checkbox"/> 10a Holding time expired	
11. For rad samples, was sample activity info. provided?				<input type="checkbox"/> Incomplete information	
12. For SOG water samples (1613B, 1668A, 8290, LR PAHs), do samples have visible solids present?				If yes & appears to be ≥1%, was SOG notified? _____	
13. Are the shipping containers intact?				<input type="checkbox"/> 13a Leaking <input type="checkbox"/> 13b Other: _____	
14. Was COC relinquished? (Signed/Dated/Timed)				<input type="checkbox"/> 14a Not relinquished	
15. Are tests/parameters listed for each sample?				<input type="checkbox"/> 15a Incomplete information	
16. Is the matrix of the samples noted?				<input type="checkbox"/> 15a Incomplete information	
17. Is the date/time of sample collection noted?				<input type="checkbox"/> 15a Incomplete information	
18. Is the client and project name/# identified?				<input type="checkbox"/> 15a Incomplete information	
19. Was the sampler identified on the COC?				<input type="checkbox"/> 15a Incomplete information	
Quote #: _____ PM Instructions: _____					

Sample Receiving Associate: _____ Date: _____

Appendix E
Data Management Plan

DRAFT

**DATA MANAGEMENT PROCESS OVERVIEW
FOR THE
NAVY CLEAN PROGRAM**

Prepared 5 May 2006

Prepared by



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1.0 Introduction

This Data Management Process Overview summarizes CH2M HILL's data management protocol in support of the Navy Clean Program.

The Overview is broadly applicable to the management and dissemination of data generated during environmental investigations. It is intended to be a living document and will be amended or revised to accommodate changes in the scope of environmental investigation or data management requirements.

During field investigations for the Navy Clean Program, CH2M HILL will collect a variety of environmental information that will support data analysis, reporting, and presentation. To ensure quality assurance/quality control (QA/QC) and meet current regulatory requirements, a complete audit trail of the information flow must be established. Each step in the data management process (data collection, storage, and analysis) must be adequately planned, executed, and documented. This Overview will describe in detail the specific processes that will be used by the Data Management team to capture, perform QA/QC reviews, manage/track and report the data associated with the Navy Clean Program.

This DMP is composed of 8 sections. Section 1 of this document introduces the Data Management Process. Section 2 discusses the organization of the CH2M HILL EIMS team. Section 3 discusses the data management role in Project Planning and Setup. Section 4 describes the data management role in Sample Collection and Management. Section 5 discusses the data management activities involved in Lab Analysis. Section 6 describes the data management role in Data Validation. Section 7 discusses the activities involved in Data Management. Section 8 describes Data Evaluation and Reporting procedures. Appendix A presents tables summarizing and assessing current data management materials.

2.0 Data Management Team Organization

The CH2M HILL data management team will work together to properly execute the data management process. The team model presented here is based on a Project Manager supported directly by key technology staff. The functional responsibilities of the team are described below. The responsibilities are identified by titles but not necessarily individual staff positions. The workflow among the members of the data management team is shown in Figure 1.

The Activity Manager (AM) and the Project Manager (PM) are responsible for preparing the work plan, schedule, milestones, and coordinating efforts with the client. The AM/PM may or may not have adequate skills to guide the data management driven aspects of their project. While the AM/PM must be willing to accept guidance from the technology leaders, they do not need to possess the technology skills as a background. The PM also responsible for ensuring

data quality and is brought into the team to perform data QA/QC at various times during the data management process.

The Environmental Information Specialist (EIS) assigned to the project team is responsible for the coordination of new or existing data generated by field activities or provided by laboratory analyses. The EIS oversees contracted analytical and data validation services, ensures that analytical data are complete and consistent, enters field data results into the **Field Data Entry Tool(FDETool)**, and assists the Database Specialist in resolving any data ambiguities. The EIS will conduct verification activities following receipt of electronic data and participate in QA/QC activities to resolve inconsistencies as necessary. The EIS acts as a liaison between the Database Specialist, the PM, and the Project Chemist.

Database Specialists load data into the Environmental database. This includes analytical results from laboratory electronic data deliverables and field data results that have been entered by the EIS into the **FDETool**. The Database Specialists work with the EIS, Program Database Coordinator, and Program Data Management Coordinator to ensure that the data are loaded successfully and following established program standards and procedures.

The Field Team Leaders (FTLs) help prepare the work plan and implement the plan in the field. FTLs assign staff members to sampling teams; assign responsibilities to team members; prepare for and coordinate sampling activities; oversee the collection, recording, and documentation of the field data; and ensure that the chain-of-custody form is completed correctly.

The Project Chemist prepares the laboratory and data validation subcontracts, ensures that the electronic data deliverable was provided in accordance with the contract, assists the EIS in communicating with laboratories and data validators as needed, assists the EIS in interpreting analytical results, assists in designating CAS Numbers to new analytes, and maintains the regulatory criteria in the database.

A Program Database Coordinator (DBC) has overall responsibility for the design, operation, and maintenance of the Environmental Database. The DBC is responsible for the implementation, and evaluation of standard operating procedures to ensure integrity of the enterprise-wide database system. The DBC works directly with the Database Specialist to coordinate the different activity data and to enhance the database tools, and structure as required to increase performance and efficiency for the entire program

The Program Data Management Coordinator (DMC) is responsible for the CH2M HILL data management process at all Navy bases. The DMC manages and tracks data management personnel schedules and deliverables for the Navy program; interacts with the EIS on all aspects of data management activities; provides guidance and coordination to the EIS during resolution of data inconsistencies; coordinates completion of data queries for reports; coordinates database modification efforts with the DBC; is responsible for designing, developing, and implementing standard data entry and data retrieval tools; and leads the data management continuous process improvement investigation.

The IS Operations Lead monitors workload across all IS activities (GIS, Web, and Database) for resource and schedule conflicts, and works with IS resources to make recommendations for process change and improvement.

The **IS Program Lead** serves as the primary point of contact for the Navy regarding IS issues, coordinates resource requirements with regional the IS Staffing Lead, and provides direction and management to the DBC, DMC, and IS Operations Lead.

3.0 Project Planning & Setup

3.1 Attend the Kick-Off Meeting

Review the **Project Instructions**, assign sample nomenclature, go over the EIS level of effort needed and budget with the PM. Complete the **EIS Questions to Ask at Start of Project Form** and **EIS DM Budget Tracking Form**. Enter project information into the **Projects Currently in DM Tracking Table** at the link

\\orion\proj\CLEANII\DATAMGMT\EIS\Projects_Currently_in_DM.xls. This tracking table should be updated/verified daily throughout the data management process.

3.2 Aid in Lab and Data Validator Acquisition

As requested, assist with the creation of the Lab Engineers Estimate, Lab Bidsheet, Lab RFP, Lab Statement of Work (SOW), and the Data Validation Engineers Estimate, Data Validation Bidsheet, Data Validation RFP, and Data Validation SOW based on the **BOA Rates Spreadsheet** and **Established Document Templates**. Submit these documents to the site Project Chemist for review and approval before they are submitted to Contracts.

3.3 Aid in Field Preparation

Inform the lab of sampling schedule. Coordinate with the lab how and when samples will be delivered to the lab (pick up, overnight, drop off). Ensure that the lab is aware of the required turn around times. If requested, order bottle ware and create sample labels. If requested, once the bottles have arrived, review the order to ensure the proper amount and type of equipment has arrived.

Tools Involved in Project Planning and Setup
BOA Rates Spreadsheet
EIS Questions to Ask at Start of Project Form
EIS DM Budget Tracking Form
Established Document Templates
Project Instructions
Projects Currently in DM Tracking Table

4.0 Sample Collection & Management

4.1 Communication with Field Staff and Lab

Communicate with field staff daily during the field event. Help resolve issues that arise in the field (bottle ware shortage, equipment failure, etc). Inform the lab of the shipment dates and the number of coolers or samples being sent. Ensure samples were received in good condition (no breakage, within holding time, within designated temperature). Notify field crew and PM if there were problems with shipment.

4.2 Sample and Documentation Tracking

Create a **Sample Tracking Sheet** and update it as samples are collected using Project Instruction Tables, Chains of Custody (COC), and Lab Login Reports. The **Sample Tracking Sheet** should be updated and kept current throughout the data management process. Perform a 100% Quality Check (QC) on COCs received from the field crew. Inform field crew and/or lab if corrections need to be made. Verify that confirmation sheets/login reports from the lab contain correct information. Coordinate efforts with the lab if information needs to be corrected. As needed, create and file a **Corrections-To-File Letter**. Track samples throughout the data management process. Ensure that labs and validators deliver the Sample Delivery Groups (SDG) on time. Inform the PM if SDGs are late, and remind the lab of late penalties (if any are in place).

All documentation acquired during the data management process, including SOWs, Bids, COCs, Field Notes, **Sample Tracking Sheets**, Login Reports, **Corrections-to-File Letters**, FDETool QC tables, **Post Load Reports**, Invoices, and Communication Logs shall be compiled throughout the process and stored in the appropriate Activity's Project Notebook.

4.3 Field Data Entry Tool

The **FDETool** can be completed at any time during the sampling event timeline, and will be turned in with the data load. After the lab has received the samples and submitted login reports, complete the **Data Request/Needs Form** and email it to the Database Specialist and copy the DMC and back-up Database Specialist to request the **FDETool**. Enter data into the **FDETool** using the **Sample Tracking Sheet**, field log books and COCs. Be as specific as possible with the information entered (check with the PM and/or FTLs if information to be entered is unclear). Once all field data has been entered, run the **FDETool** output reports and QC them according to the **FDET Instructions for Data QC Form** (\\orion\proj\CLEANII\DATAMGMT\EIS\EIS_Reference_Documents). Send the reports to another EIS or PM to review for accuracy.

Northing and Easting information should be requested from the PM, if it is missing in the **FDETool**. This data should be entered into the **FDETool**. **However, if the FDETool is not**

being utilized, the Northing and Easting data can be formatted into a spreadsheet format, which can be sent along with the load. All stations that have coordinates must be loaded into EnDat, even if GIS has received the coordinates. See the **Survey Coordinates Flowchart** at \\orion\proj\CLEANII\DATAMGMT\EIS\EIS_Forms.

4.4 Track EIS Budget

Use the **EIS DM Budget Tracking Form** to track the number of hours spent on each task as they are performed. Inform the PM if the budget may be exceeded.

Tools Involved in Sample Collection & Management
Corrections to File Letter
Data Request/Needs Form
EIS DM Budget Tracking Form
FDET Instructions for Data QC Form
Field Data Entry Tool (FDETool)
Sample Tracking Sheet
Survey Coordinates Flowchart

5.0 Lab Analysis

5.1 QC Lab Data

Verify that the hard copy data and **Electronic Data Deliverables (EDDs)** are complete and acceptable as outlined in the **EIS QC Checklist for Unvalidated and Validated EDDs and Hard Copy Data Form**. Run a quality check on the EDD columns to ensure basic quality. Perform a 10% check of the analysis results. Ensure that the hard copy data matches the EDD. If errors are found, inform the PM and request corrected data from the lab.

5.2 Communicate with the Lab

Should the EDD be missing data, contact the PM and coordinate efforts with the lab to receive the missing data.

5.3 Run Tables

Communicate with the PM to determine if preliminary raw and detects tables are needed. Should tables be desired, verify the requirements and formatting (i.e. headers, footers, or other

special needs) to be included on the table. Run the **Raw & Detects Tables from Unvalidated or Validated EDD Macro** on data in the EDD to create tables to assist the PM with a preliminary data analysis. A separate table must be created for EACH matrix (solid/aqueous) and sample purpose (Normal, Blanks). Ask the PM how the tables should be run before beginning.

5.4 Hard Copy Management

If data are to be validated, follow the instructions for Hard Copy Management in the Data Validation section, below. If data are not to be validated, hold on to the hard copies until project closeout/completion. After all corrections identified through the data management process have been completed (if any), the final report written, and the project determined complete, gain approval from the PM to archive the hard copy. Note, skip to section 7.0, Data Management, for EDDs that are not to be validated.

5.5 Hard Copy Archiving

If data will not be validated, fill out the **Data Archiving (List of Contents) Form**, located at the link \\Orion\PROJ\CLEANII\DATAMGMT\EIS\Data_Archiving, for each SDG, and attach it to the data packages. Once the PM has granted approval for hard copy archiving at project completion, give the boxes of data to the Data Archiving Specialist. The data will be prepped for archiving and filed within the building until the Data Archiving Specialist has received authorization to send the data to storage.

Tools Involved in Lab Analysis
Data Archiving (List of Contents) Form EDD EIS QC Checklist for Unvalidated and Validated EDDs and Hard Copy Data Form Raw & Detects Tables from Unvalidated or Validated EDD Macro

6.0 Data Validation

6.1 Hard Copy Management

If data are to be validated, the hard copy data, EDDs, and a **QC Association Table** will need to be mailed or emailed to the data validator. Photo copy the Form I Summary Package (which should be provided by the lab) before mailing the hard copy, to keep on file while the complete packages is with the validator. Fill out the **Data Archiving (List of Contents) Form** for each SDG, and attach it to the data packages. The **QC Association Table** is created using the COCs, field notes, and the field crew to ensure accuracy. Further instructions on the QC table are located in the form “**QC Association Table**”, under

[\\orion\proj\CLEANII\DATAMGMT\EIS\EIS_Forms](#). The **QC Association Table** can be emailed to the data validator along with the EDD. If sending more than one EDD, prepare the EDDs to the validator's preference (i.e. one large file or divided by SDG).

6.2 Communicate with Validator

Let the data validator know ahead of time when to expect data. Inform the validator of any samples or analyses that should not be validated. (i.e. grain size should not be validated). Work with the data validator to coordinate the return of the data package to CH2M HILL for archiving. Once the data package has been returned to CH2M HILL, follow the Hard Copy Archiving procedure above.

6.3 Post-Validation

Review and QC the validated data according to the **EIS QC Checklist for Unvalidated and Validated EDDs and Hard Copy Data Form**. Verify that the validated hard copy data and EDDs are complete and acceptable. Data validators should have added qualifiers to the DV_QUAL and DV_QUAL_CODE fields only. Check the values in the DV_QUAL field against the valid value choices. Perform a 100% check of the DV_QUAL and DV_QUAL_CODE fields. Ensure that the hard copy values match the EDD. Ensure that every record requiring a data validation qualifier has one (i.e. if the Lab_Qual field has a U qualifier then there MUST be a qualifier in the DV_QUAL field).

Run raw and detects tables of the combined EDD using the **Raw & Detects Tables from Unvalidated or Validated EDD Macro**. Check to make sure there are no duplicate results for any of the samples. Send the raw and detects tables, validation report, and validated EDD to the Project Chemist for a "Pre-Load Check."

Tools Involved in Data Validation
Data Archiving (List of Contents) Form EDD EIS QC Checklist for Unvalidated and Validated EDDs and Hard Copy Data Form QC Association Table

7.0 Data Management

7.1 Load Preparation

Compile the validated SDG EDDs into one Excel file, if they are not formatted as such already. Add in and populate the additional columns CTO, Lab, and Validated at the end of the EDD. Add in a column before Prep_Method called Preparation. Copy and paste the data from Analysis_Method into the Preparation column. Rename the Prep_Method to CH2M_Code, and populate with appropriate valid values. Save the Excel file as an 'Archive EDD' under a new name with the project or event and the date sampling (i.e. "3_CP_CTO-244_GW&SO_103103_ARCHIVE.xls"). Be as specific as possible when saving the file, as it will become the Archive EDD file.

Create a duplicate copy of the Archive EDD file and save it as the Load EDD (i.e. "3_CP_CTO-244_GW&SO_103103_LOAD.xls"). In the Load EDD, delete out the surrogate records by deleting ALL records that have a value in the "Result_Type" column. Delete Lab QC Records by deleting ALL records that have a value in the "Lab_QC_Type" column. Remember to save the Load EDD once the modifications are complete.

After the data has been loaded, incorporate any corrections made to the Load EDD by the Database Specialist into the Archive EDD. Mail a copy of the Archive EDD to the DMC to be stored in the archive file ([\\orion\proj\CLEANII\DATAMGMT\EDD_Archive](#)).

7.2 Run a Pivot Table

As needed, follow the **Analyte Pivot Table Instructions** file to determine if any analytes are classified under more than one analysis group in the Load EDD. (This step is considered a backup check, as a 'Preferred Analysis Group Check' was performed on the unvalidated EDD, as specified on the **EIS QC Checklist for Unvalidated and Validated EDD and Hard Copy Data Form**.) Use the **Preferred Analysis Group Form** as a reference to assign UNREJECTED results to the correct analysis group for these analytes. If an analyte is not on this list then ask a chemist for assistance and update the **Preferred Analysis Group Form** accordingly.

7.3 PM Review of Data Load

Provide the PM with the cross-tabulated raw and detects tables created from the validated data above, and the Load EDD file. Also ask the PM if they would like a copy of the **Sample Tracking Sheet** or **Project Instructions** to assist with the review.

7.4 Email Data Load

Send the QC'd Load EDD file (the version WITHOUT the surrogate and QC data) and **FDETool** in an email to the Database Specialist for loading into EnDat, and copy the DMC and back-up Database Specialist. In the email, attach an electronic copy of the completed **Data Request/Needs Form** with the following information completed:

- Program Name (ex: Clean II)
- Activity (ex: Little Creek)
- Contract Task Order (CTO)
- Prime Contractor (company responsible for providing a product to the Navy)

- Field Contractor (company who performed the field work)
- Was the data upload scheduled with the DB staff?
- Is the data validated?
- Data Validator Name (If no DV then who within CH2M HILL evaluated the data?)
- Number of samples
- Dates of the sampling event
- Number of records in EDD
- Requested Due Date
- Any Reports Requested?

The Database specialist will then conduct any additional formatting modifications to the EDD as needed to load the data into EnDat.

7.5 Post Load

The Database Specialist shall generate **Post Load Reports** and provide them to the EIS for review and QC. Once the **Post Load Reports** have been QC'd by the EIS, the EIS will then send the reports to the PM for review. Inform the PM of any corrections that need to be made, and coordinate these changes with the Database Specialist. Any changes made to the data by the Database Specialist prior to load, or that will be completed after the load should be tracked, and incorporated into the hard copy and EDD files that are to be archived after project completion.

Tools Involved in Data Management
Data Request/Needs Form EDD
Field Data Entry Tool (FDETool)
Pivot Table Instructions
Preferred Analysis Group Form
Project Instructions
Raw & Detects Tables from Unvalidated or Validated EDD Macro
Sample Tracking Sheet
Post Load Reports

8.0 Data Evaluation & Reporting

8.1 Run Tables

Meet with the PM to verify table requirements and formatting (i.e. headers, footers, or other special needs). Raw and detects tables must be created for EACH matrix (solid/aqueous). Pull the data from **EnStat**. There are three macro templates that can be utilized to assist with the

formatting of EnStat output files. These include the **Raw, Detects, & Exceedance Tables from EnStat Output Macro**, **HHRA Tables from EnStat Output Macro**, and **EcoRisk Tables from EnStat Output Macro**.

Run the **Raw, Detects & Exceedance Tables from EnStat Macro**, and send the completed tables to the Project Chemist for a final quality check. Provide the completed, QC'd tables to the PM. Other tables can be generated from the remaining macros as requested.

8.2 Review Laboratory and Validator Invoices

Laboratory invoices should be submitted once the laboratory has completed requested analyses, and submitted all results and requested corrections. Data validation invoices should be submitted shortly after the validation has been completed, and the report submitted to CH2M HILL. Invoices will be submitted to the PM through AP Workflow for approval. The PM should then consult the EIS for invoice review before submitting approval. The EIS should review the invoices, and noting any late charges, etc, and update the **Sample Tracking Sheet** accordingly.

8.3 Complete EIS DM Budget Tracking Form

Meet with the PM and the DMC to review the **EIS DM Budget Tracking Form** and discuss lessons learned.

Tools Involved in Data Evaluation & Reporting
EcoRisk Tables from EnStat Output Macro
EIS DM Budget Tracking Form
EnStat
HHRA Tables from EnStat Output Macro
Raw, Detects, & Exceedance Tables from EnStat Output Macro
Sample Tracking Sheet

Appendix A

Summary & Assessment of Data Management Materials

Summary Of Tools Involved In The Data Management Process

Tools	Assessment
BOA Rates Spreadsheet	This is only updated every 5 years. We need an SOP to remind EISs to add a 10% increase for each year after the update year until it is updated again.
Corrections to File Letter	
Data Archiving (List of Contents) Form	Kevin McGarvey, the Archiving Expert will be working in the WDC office through June, and will be stopping by here. He could be tasked to write up an SOP. We might have some mini-SOPs to work from too.
Data Request/Needs Form	Good
EcoRisk Tables from EnStat Output Macro	Good
EDD	Good, though primary keys need revision.
EIS QC Checklist for Unvalidated and Validated EDDs and Hard Copy Data Form	This is a good procedure checklist, and could easily be made into a formal SOP.
EIS Questions to Ask at Start of Project Form	This could use a few formatting tweaks, but is generally good as is.
EIS DM Budget Tracking Form	This should be updated to incorporate all the aspects of the data management process for more accurate tracking
EnDat Post Load Reports	Good. Used to assess and QC data loaded into EnDat to ensure data load accuracy and completeness
EnStat	This needs work to get it running better/correctly. There is a ppt presentation on using this that could serve as a SOP.
Established Document Templates	Currently we work off of pre-existing docs, which vary. Templates must be established.
FDET Instructions for Data QC Form	Needs evaluation
Field Data Entry Tool (FDETool)	Could use a bulk upload function, and built in QC checks

Tools	Assessment
HHRA Tables from EnStat Output Macro	Needs evaluation
Pivot Table Instructions	Could easily be made into a good SOP
Preferred Analysis Group Form	Good
Project Instructions	From PM
Projects Currently in DM Tracking Table	Good
QC Association Table	The example on the server is intended to use as a template, and could use a little tweaking
Raw & Detects Tables from Unvalidated or Validated EDD Macro	This macro could use formatting updates. There is no SOP for this, but I do have a rough mini-SOP that Felicia wrote up.
Raw, Detects, & Exceedance Tables from EnStat Output Macro	Needs evaluation
Sample Tracking Sheet	Need to develop template
Survey Coordinates Flowchart	Good

Summary of Documentation in the Reference Manuals

Document	Assessment for Current DMP	Assessment for NIRIS
IS Personnel 11-2006	Current	Good
Load Process Step by Step	Generic overview, not SOP. Need Bhavana to write a formal SOP if desired	Need New Document
Navy Clean IS Organization	Out of Date	Need New Document
Reference Manual Binder Covers	Current	Good
Ref Manual Page Dividers	Current	Good
Project Manager Role in IS-DM Process	Current	Good
Environmental Information Specialist Role 1	Current	Good
Data Management Coordinator Role	Current	Good
Navy Clean Data Management Process Flowchart	Current	Good
Survey Coordinates Flowchart	Good	Needs Revision
Life of a Sample Flowchart	Needs Revision	Needs Revision
Chemicals in EnDat 010306	Needs periodic updates	Need New Document
Chemical Synonyms in EnDat	Needs periodic evaluation	Need New Document
Common Chemical Synonyms & Abbreviations	Good	Good
Analyses and Methods Commonly Used	Needs periodic updates	Needs periodic updates
FDET Valid Values	Good	Need New Document
Lab Valid Values	Good	Need New Document
DV Valid Values	Good	Need New Document
Field Sample Naming Scheme	Needs Revision (to Sample Nomenclature Protocol for all Bases)	Uncertain
Field Station Naming Scheme	Needs Revision (to Station Nomenclature Protocol for all Bases)	Uncertain
EDD Format CH2M Navy 120605	Needs Updates	Need New Document

Document	Assessment for Current DMP	Assessment for NIRIS
DCLT Manual	None - This is no longer used, as the Tool is broken	Delete
STS Example	Need to develop template	Need to develop template
Corrections To File	Good	Uncertain
Corrections to File Example	Good	Uncertain
FDET Instructions	Good	Delete
FDET Screen Shot	Good	Delete
FDET Stations Report Example	File does not exist	Delete
FDET Sample Report Example	File does not exist	Delete
FDET Field Results Report Example	File does not exist	Delete
FDET Full Detail Report Example	File does not exist	Delete
FDET Result Report in XL Example	Good	Delete
FDET Instructions for Data QC	Needs Evaluation	Delete
Data Management Checklist _rev0306	Needs Revision	Needs Total Revision/Rewrite
Analyte Pivot Table Instructions	Good	Uncertain
Analyte Pivot Table Example	Can not locate file	Uncertain
Preferred Analysis Group	Needs evaluation - have older version (ABL) too	Uncertain
Ex of Pre-Load QC Raw & Detects Tables	Good	Need new document
Ex of Post-Load Station Check Confirmation Rpt from DB Specialist	Cannot locate file	Uncertain
Ex of Post-Load Sample Check Confirmation Rpt from DB Specialist	Cannot locate file	Uncertain
Ex of Post-Load Field Result Check Confirmation Rpt from DB Specialist	Cannot locate file	Uncertain
Ex of Post-Load Analysis Check Confirmation Rpt from DB Specialist	Cannot locate file	Uncertain
EnStat Tool Instructions	PPT, not SOP. Could easily be made into SOP	Need New Tool
EnDat Threshold Criteria	Needs Evaluation	Need New Document
Definitions of RBC & MCL Threshold Variations	Unable to locate Email Doc	Uncertain

Document	Assessment for Current DMP	Assessment for NIRIS
Ex of Unformatted EnStat Post-Load Tables	Good	Need New Document
Ex of Formatted EnStat Post-Load Tables	Good	Need New Document
IS Costing Template 2006Rates 042506	Needs to be Updates	Needs Updating
IS Data Request-Needs Form	Good	Needs Update/New Document
Quarterly Sampling Projection Forms Example	Good	Good
EIS Project Startup Questions_rev0905	Good	Needs Revision
EIS DM Budget Tracking Form	This should be updated to incorporate all the aspects of the data management process for more accurate tracking	Needs Revision
EIS QC Checklist for Unval & Val EDD & Hard Copy Data	Unable to locate document	Needs Revision
EIS Training Checklist	Good	Needs Revision