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FINAL SAMPLING AND ANALYSIS PLAN FOR PHASE 2 VAPOR INTRUSION INVESTIGATION AT OPERABLE UNIT 1 (OU 1) MCAS CHERRY POINT NC

05/01/2011

CH2M HILL

Final

Sampling and Analysis Plan
Phase II Vapor Intrusion Investigation
Operable Unit 1

Marine Corps Air Station
Cherry Point, North Carolina

Naval Facilities Engineering Command
NAVFAC MID-ATLANTIC

Prepared for

Department of the Navy

Naval Facilities Engineering Command
Mid-Atlantic

Contract No.
N62470-08-D-1000
CTO-097

May 2011

Prepared by

CH2MHILL

SAP Worksheet #1—Title and Approval Page

Final

Sampling and Analysis Plan
Phase II Vapor Intrusion Investigation
Operable Unit 1

Marine Corps Air Station Cherry Point
North Carolina

Contract Task Order 097

May 2011

Prepared for

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Under the

NAVFAC CLEAN 1000 Program
Contract N62470-08-D-1000

Prepared by

CH2MHILL

Charlotte, North Carolina

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Executive Summary

This Sampling and Analysis Plan (SAP) was prepared to support the proposed Phase II vapor intrusion (VI) sampling 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 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 (USEPA, 1994).

This SAP was prepared under the Comprehensive Long-term Environmental Action—Navy (CLEAN) III Contract N62470-08-D-1000 Contract Task Order 097, 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 VI investigation is being conducted by the Navy to assess potential migration of chlorinated volatile organic compounds (cVOCs) 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 and/or significant exposure pathway exists for building occupants.

A VI investigation consists of four primary steps:

- Step 1 – Identification of Buildings of Interest
- Step 2 – Desktop Risk Evaluation
- Step 3 – Sampling and Analysis
- Step 4 – Multiple Lines of Evidence (MLE) Evaluation to Assess Potential Risks

Steps 1 and 2 were completed in preparation of this Phase I SAP. During Phase I, the sampling and analysis (Step 3) and the MLE evaluation (Step 4) were performed at the 21 buildings of interest identified in Steps 1 and 2. The Phase I sampling activities consisted primarily of exterior groundwater and soil vapor sampling. In addition, subslab soil gas sampling was performed at two buildings (Buildings 133 and 137), where the highest cVOC concentrations have historically been detected in shallow groundwater and where potential vadose zone impacts are present.

The Phase I MLE/risk evaluation concluded that the potential for VI impacts above risk-based target levels could not be ruled out at 9 of the 21 Phase I buildings of interest. At these nine buildings, cVOC concentrations in soil vapor, groundwater, and/or subslab soil gas measured during Phase I exceeded groundwater and/or soil vapor screening levels. These

nine buildings are being retained as buildings of interest for Phase II. Three additional buildings were identified as buildings of interest for Phase II during a preferential pathways evaluation; these buildings are connected via underground utilities to areas where cVOC concentrations exceeding the SVSLs were detected in Phase I soil vapor. Additional sampling and analysis (Step 3) and an MLE VI evaluation (Step 4) were recommended for these 12 buildings of interest (CH2M HILL, 2010). These additional VI evaluation activities will be performed during Phase II and are discussed in detail in this SAP. The Phase II Step 3 and Step 4 proposed activities are described below:

- **Step 3 – Sampling and Analysis**
  - Subslab soil gas, indoor air, and outdoor air sampling and building surveys will be performed at the twelve buildings indentified for Phase II sampling. Detailed building surveys will be conducted at Buildings 133, 137, and 3402 because the highest cVOC concentrations were detected at these buildings during Phase I. This SAP documents the number, type, location, and rationale for the proposed Phase II sampling.
- **Step 4 – MLE Evaluation to Assess Potential Risks**
  - The Phase II sampling data and building survey information will be used to update the conceptual site models (CSMs) for each of the 12 Phase II buildings of interest. Data will be evaluated using the MLE approach outlined in the Interstate Technology & Regulatory Council (ITRC) (2007) VI guidance document.
  - Concurrent subslab soil gas and indoor air data collected during Phase II will be used to determine empirically-based attenuation factors.
  - The results and conclusions of this MLE evaluation will be used to make decisions regarding further evaluation or if appropriate, to evaluate mitigation and/or remediation measures.
  - The results and MLE evaluation will be documented in a summary report. The summary report will include analytical results and comparison to screening levels, maps showing sampling and building locations, refined CSMs for each building evaluated, results of the MLE risk evaluation, and conclusions and recommendations.

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 specific to Columbia Analytical Services (CAS) in Simi Valley, California. If additional laboratory services are requested which require modification to the existing SAP, revised SAP worksheets will be submitted to the Navy and regulatory agencies for approval.

SAP Outline

This SAP consists of 37 worksheets specific to the OU1 Phase II VI Investigation SAP. All tables are embedded within the worksheets. All figures are included at the end of the document. The project specific Health and Safety Plan (HSP) is included as **Appendix A**. Field standard operating procedures (SOPs) are included in **Appendix B.** Data management guidelines are included in Data Management Plan presented in **Appendix C** and laboratory SOPs are included in **Appendix D.** The Phase II generic screening levels are presented in **Appendix E.** The United States Department of Defense (DoD) Environmental Laboratory Accreditation Program (ELAP) accreditation letter for CAS is presented in **Appendix F**. Upon approval of this Draft SAP, the sampling activities will be scheduled and executed.

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9 Buildings Retained for Phase II Sampling
10 Field Sampling Strategy Decision Tree
11 Building 143 Proposed Sampling Locations
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15 Building 137 Proposed Sampling Locations
16 Buildings 131 & 3997 Proposed Sampling Locations
17 Buildings 4525/129 & 188 Proposed Sampling Locations
18 Data Evaluation Strategy Decision Tree

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Acronyms and Abbreviations

AF	attenuation factor
AM	Activity Manager
amsl	above mean sea level
AS/SVE	air sparge/soil vapor extraction
bgs	below ground surface
CA	corrective action
CAS	Columbia Analytical Services; Chemical Abstracts Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLEAN	Comprehensive Long-term Environmental Action—Navy
COC	constituent of concern
COPC	constituent of potential concern
CSM	conceptual site model
CTO	Contract Task Order
cVOC	chlorinated volatile organic compound
DCA	dichloroethane
DCE	dichloroethene
DL	Detection Limit
DNAPL	dense non-aqueous phase liquid
DoD	Department of Defense
DQI	data quality indicator
DQO	data quality objective
EAD	Environmental Affairs Department
EDD	electronic data deliverable
EIS	Environmental Information Specialist
ERP	Environmental Restoration Program
FFA	Federal Facilities Agreement
FRCE	Fleet Readiness Center – East
FSP	Field Sampling Plan
ft/day	foot per day
FTL	Field Team Leader
GC	gas chromatograph
HHRA	Human Health Risk Assessment
HQ	hazard quotient
HRC	Hydrogen Release Compound
HSO	Health and Safety Officer
HSP	Health and Safety Plan
HVAC	heating, ventilation, and air conditioning

IASL	indoor air screening level
IDW	investigation-derived waste
IR	Installation Restoration
ITRC	Interstate Technology & Regulatory Council
IWTP	Industrial Wastewater Treatment Plant
J&E	Johnson and Ettinger
LCS	Laboratory Control Sample
LIMS	Laboratory Information Management Systems
µg/L	micrograms per liter
MCAS	Marine Corps Air Station
MDL	method detection limit
MLE	Multiple Lines of Evidence
mL/min	milliliters per minute
MRP	Munitions Response Program
MS	mass spectrometer
MS/MSD	matrix spike/matrix spike duplicate
NA	not applicable
NAVFAC	Naval Facilities Engineering Command
Navy	Department of the Navy
NCDENR	North Carolina Department of Environment and Natural Resources
NC 2L Standard	North Carolina 2L Groundwater Standard
NIRIS	Navy Installation Restoration Information System
OU	operable unit
LCS	Laboratory Control Sample
LOD	Limit of Detection
LOQ	Limit of Quantitation
PAH	polycyclic aromatic hydrocarbon
PAL	Project Action Limit
PC	Project Chemist
PCA	tetrachloroethane
PCE	tetrachloroethene
PID	photoionization detector
PM	Project Manager
PPE	personal protective equipment
PQL	Project Quantitation Limit
PQO	project quality objective
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
QL	quantitation limit
QSM	Quality Systems Manual

RI	Remedial Investigation
RL	reporting limit
RPD	relative percent difference
RPM	Remedial Project Manager
RSD	relative standard deviation
RSL	Regional Screening Level
SAP	Sampling and Analysis Plan
SGSL	soil gas screening level
SNEDD	Supplemental NIRIS Electronic Data Deliverable
SOP	standard operating procedure
STC	Senior Technical Consultant
TBD	to be determined
TCA	trichloroethane
TCE	trichloroethene
TM	Task Manager
TSDF	Treatment, Storage, and Disposal Facility
UFP	Uniform Federal Policy
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VGM	Voluntary Groundwater Monitoring
VI	vapor intrusion
VOC	Volatile Organic Compound
VTSR	validated time of sample receipt

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SAP Worksheet #2—SAP Identifying Information

Site Name/Number: Operable Unit (OU) 1 Central Groundwater Plume

Operable Unit: OU1

Contractor Name: CH2M HILL

Contract Number: N62470-08-D-1000 Contract Task Order (CTO)-97

Contract Title: Comprehensive Long-term Environmental Action—Navy (CLEAN) 1000

1. This Sampling and Analysis Plan (SAP) was prepared in accordance with the requirements of:
   - *Uniform Federal Policy for Quality Assurance Plans (UFP-QAPP)* (USEPA, 2005)
   - *EPA Guidance for Quality Assurance Project Plans, EPA QA/G-5, QAMS* (USEPA, 2002)
2. Identify regulatory program:
   - Comprehensive Environmental Restoration, Compensation, and Liability Act (CERCLA)
3. This SAP is a project-specific SAP.
4. List dates of scoping sessions that were held:

Scoping Session	Date
SAP Chartering	May 7, 2008
Partnering Meeting	May 12, 2010
Partnering Meeting	October 26, 2010

5. List dates and titles of any SAP documents written for previous site work that are relevant to the current investigation.
   - *Operable Unit 1 (OU1) Vapor Intrusion Sampling and Analysis Plan, Marine Corps Air Station Cherry Point, North Carolina* (CH2M HILL, 2009b)
6. List organizational partners (stakeholders) and connection with lead organization:
   - **Lead Organization—**Department of the Navy (Navy) (Naval Facilities Engineering Command [NAVFAC], Mid-Atlantic, and Marine Corps Air Station [MCAS] Cherry Point Environmental Affairs Department [EAD])
   - **Lead Regulatory Agency—**United States Environmental Protection Agency (USEPA) Region 4
   - **State Regulatory Agency—**North Carolina Department of Environment and Natural Resources (NCDENR)

SAP Worksheet #2—SAP Identifying Information (continued)

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.

SAP Worksheet #3—Distribution List

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address
Jason Williams	Remedial Project Manager (RPM)	NAVFAC Mid-Atlantic	(757) 322-4088 (757) 322-8280 (fax)	jason.e.williams2@navy.mil
Will Potter	Installation Restoration (IR) Program Manager	MCAS Cherry Point EAD	(252) 466-5376 (252) 466-2000 (fax) (252) 646–4166 (cell)	william.r.potter@usmc.mil
Gena Townsend	RPM	USEPA Region 4	(404) 562-8538 (404) 562-8518 (fax)	townsend.gena@epa.gov
George Lane	RPM	NCDENR	(919) 508-8462 (919) 733-4811 (fax)	george.lane@ncdenr.gov
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
Keri Hallberg	Project Manager (PM)	CH2M HILL	(704) 543 - 3260	keri,hallberg@ch2m.com
Bill Hannah	Quality Assurance Manager (QAM)	CH2M HILL	(757) 671-6277	Bill.hannah@ch2m.com
Anita Dodson	Navy CLEAN Program Chemist	CH2M HILL	(757) 671-6218	Anita.dodson@ch2m.com
Brett Doerr	Navy CLEAN Program UFP SAP Reviewer	CH2M HILL	(757) 671-6219	Brett.doerr@ch2m.com
Juan Acaron	Project Chemist (PC)	CH2M HILL	(352) 384-7002	juan.acaron@ch2m.com
Loren Lund	Senior Vapor Intrusion (VI) Principal Technologist	CH2M HILL	(208) 357-5351	loren.lund@ch2m.com
Victoria Brynildsen	Project Environmental Information Specialist (EIS)	CH2M HILL	(757)-671-6252	victoria.brynildsen@ch2m.com
Kimberly (Kim) Stokes	Task Manager (TM)	CH2M HILL	(972) 663-2269	kimberly.stokes@ch2m.com
Margaret (Maggie) Radford	Field Team Leader (FTL)	CH2M HILL	(919) 760-1798	Maggie.smith@ch2m.com

SAP Worksheet #3—Distribution List (continued)

Name of SAP Recipients	Title/Role	Organization	Telephone Number	E-mail Address or Mailing Address
To be determined (TBD)	Field Team Members	CH2M HILL	TBD	
Mark Orman	Health and Safety Officer (HSO)	CH2M HILL	(414) 847-0597	mark.orman@ch2m.com
Roni Warren	Human Health Risk Assessor	CH2M HILL	(814) 364-2454	Roni.warren@ch2m.com
Ward Dickens	Data Validator	CH2M HILL	(352) 384-7049	ward.dickens@ch2m.com
Kate Aguilera	Laboratory PM	Columbia Analytical Services (CAS)	(949) 910-0409	kaguilera@caslab.com
TBD - Utility Locating and Heating, Ventilation, and Air Conditioning (HVAC) Subcontractors				

SAP Worksheet #4—Project Personnel Sign-Off Sheet

Name	Organization/Title/Role	Telephone Number	Signature/email Receipt	SAP Section Reviewed	Date SAP Read
Jason Williams	Navy/ RPM	(757) 322-4088			
Doug Bitterman	CH2M HILL/AM	(757) 671-6209 (703) 627-3291 (cell)			
Keri Hallberg	CH2M HILL/ PM	(704) – 543 - 3260			
Juan Acaron	CH2M HILL/PC	(352) 484-7002			
Victoria Brynildsen	CH2M HILL/ Project EIS	(757) 671-6252			
Kim Stokes	CH2M HILL/ TM	(972) 663-2269			
Maggie Radford	CH2M HILL/FTL	(919) 760-1798			
TBD	CH2M HILL / Field Team Members	TBD			
Mark Orman	CH2M HILL/ HSO	(414) 847-0597			
Roni Warren	CH2M HILL/ Human Health Risk Assessor	(814) 364-2454			
Ward Dickens	CH2M HILL/Data Validator	(352) 384-7049			
Kate Aguilera	CAS/PM	(949) 910-0409			
TBD- Utility Locating Subcontractor					
TBD- HVAC Subcontractor					

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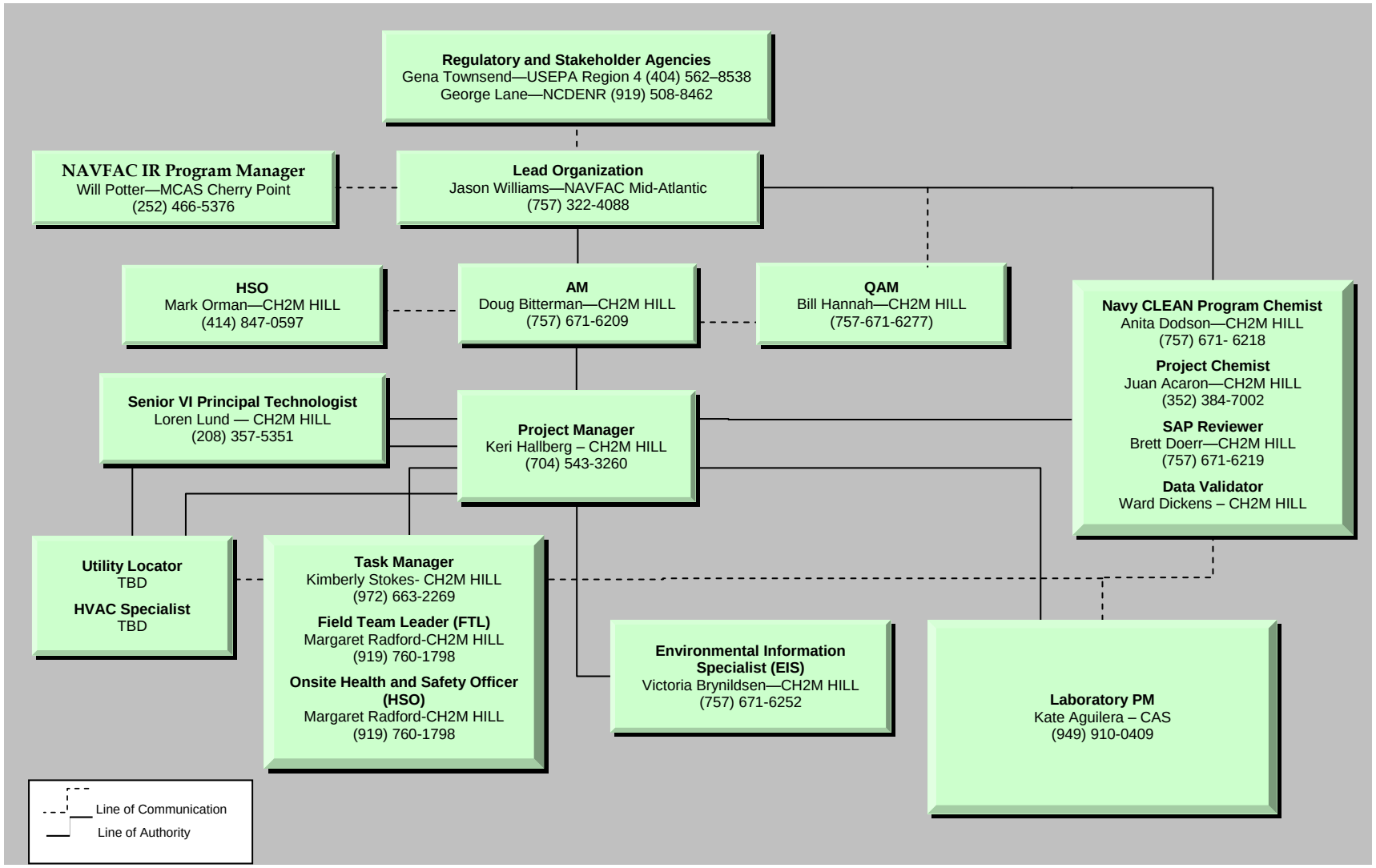
SAP Worksheet #5—Project Organizational Chart



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SAP Worksheet #6—Communication Pathways

Communication Drivers	Responsible Affiliation	Name	Phone Number and/or e-mail	Procedure
Point of Contact (POC) with Partnering Team	Navy RPM for MCAS Cherry Point	Jason Williams	(757) 322-4088	Primary POC for Navy; all materials and information pertaining to the project will be forwarded to the Partnering Team as soon as possible following review. (Duration of Project)
IR Program Manager	MCAS Cherry Point IR Program Manager	Will Potter	(252) 466-5376	Oversees all remedial activities at MCAS Cherry Point. Any issues that may impact the Cherry Point operations are to be reported to him immediately. POC for access to Fleet Readiness Center – East (FRCE) areas. (Immediately)
Primary contact for CH2M HILL activities	CH2M HILL AM for MCAS Cherry Point	Doug Bitterman	(757) 671-6209	Primary POC for Navy and MCAS Cherry Point RPMs; oversees CH2M HILL project delivery for this project. (As Needed)
Manage all Project Phases	CH2M HILL PM	Keri Hallberg	(704) 543 - 3260	Issues reported to the Navy RPM immediately and followed up in writing within 2 business days. Implement modifications to the SAP.
Technical VI Support	CH2M HILL Senior VI Prinicipal Technologist	Loren Lund	(208) 357-5351	Technical oversight of the project. (Duration of Project)
SAP changes in the Field	CH2M HILL FTL			Notify the PM by phone and email of changes to or deviations from the SAP made in the field and the reasons within 24 hours. Changes will be documented. (24 hours)
Daily Field Progress Reports	CH2M HILL FTL			FTL will email or fax daily field progress reports to PM; telephone communication with PM on as-needed basis. (As Needed)
Data tracking from collection through upload to database	CH2M HILL EIS	Victoria Brynildsen	(757)-671-6252	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. (Duration of Project)
Reporting Lab Data Quality Issues	Laboratory PM	Kate Aguilera, CAS	(949) 910-0409	All quality assurance (QA)/quality control (QC) issues with project field samples will be reported by the laboratory to the EIS, PC, and Laboratory Quality Assurance Program Manager within 2 business days. Contact for CAS staff. (2 business days)
Reporting Validated Data	CH2M HILL Data Validator	Ward Dickens	(352) 384-7049	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.(14 calendar days)
Field and Analytical Corrective Actions (CAs)	CH2M HILL Program Chemist	Anita Dodson	(757) 671-6218	The need for CA in response to field and analytical issues will be determined by the FTL and/or CAS's Quality Assurance Program Manager. (As Needed)
Evaluation of Human Health Risks	Human Health Risk Assessor	Roni Warren	(814) 364-2454	Communication with PM. (As Needed)
Field Subcontractor	Utility Clearance, HVAC Specialist	TBD		Communication with FTL and PM. (As Needed)

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SAP Worksheet #7—Personnel Responsibilities and Qualifications Table

Name	Title/Role	Organizational Affiliation	Responsibilities
Jason Williams	RPM	NAVFAC	Coordinates Environmental Restoration (CERCLA/Munitions Response Program [MRP]) activities at MCAS Cherry Point.
Will Potter	IR Program Manager	USMC Cherry Point	Oversight of remedial activities at MCAS Cherry Point.
Doug Bitterman	AM	CH2M HILL	Responsible for Environmental Restoration Program (ERP) at MCAS Cherry Point; Provide senior technical oversight and review.
Bill Hannah	QAM		
Keri Hallberg	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 SAP and provides support during SAP development
Brett Doerr	Navy CLEAN SAP Reviewer	CH2M HILL	Provides program level review of SAP
Loren Lund	Senior VI Principal Technologist	CH2M HILL	Technical oversight of the project.
Juan Acaron	PC	CH2M HILL	Performs oversight of laboratory and data validators, releases analytical data, performs data usability evaluation.
Kimberly Stokes	TM	CH2M HILL	Supports PM and FTL in work planning, field activities, etc.
Maggie Radford	FTL	CH2M HILL	Supervises field sampling and coordinates all field activities
Mark Orman	HSO	CH2M HILL	Oversees health and safety for field activities
Victoria Brynildsen	EIS	CH2M HILL	Manages sample tracking, coordinates with laboratory and data validator, data management
Kate Aguilera	Laboratory PM	CAS	Manages analytical projects from initiation to completion.
Ward Dickens	Data Validation PM	CH2M HILL	Responsible for data validation.
TBD	HVAC Specialist	TBD	Completes HVAC evaluation as part of the detailed building survey.
TBD	Utility Clearance	TBD	Performs clearance of underground utilities.

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SAP Worksheet #8—Special Personnel Training Requirements Table

No specialized training is required for this project.

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

Project Name: Phase II VI Investigation at OU1 **Projected Date(s) of Sampling:** April 2011 **PM: Keri Hallberg**	**Site Name:** OU1 **Site Location:** MCAS Cherry Point, North Carolina
Date of Session: April 12, 2010 **Scoping Session Purpose:** SAP Chartering Meeting	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Keri Hallberg	PM	CH2M HILL	(704) 543-3260	keri.hallberg@ch2m.com	Work Plan Production
Loren Lund	Project STC (Senior VI Principal Technologist)	CH2M HILL	(208) 357-5351	Loren.Lund@ch2m.com	Consultant on Technical Project Planning
Jennifer Simms	VI Subject Matter Expert	CH2M HILL	(215) 640-9071	Jennifer.Simms@ch2m.com	Work Plan Production
Maggie Radford	FTL	CH2M HILL	(919) 760-1798	maggie.radford@ch2m.com	Work Plan Production

Comments/Decisions

Subslab soil gas/indoor air sampling locations were preliminarily identified for nine buildings investigated during Phase I and retained as buildings of interest for the Phase II investigation. Three buildings were added as proposed buildings of interest due to a preferential pathways analysis.

Action Items

None.

Consensus Decisions

Not applicable.

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

Project Name: Phase II VI Investigation at OU1 **Projected Date(s) of Sampling:** April 2011 **PM: Keri Hallberg**	**Site Name:** OU1 **Site Location:** MCAS Cherry Point, North Carolina
Date of Session: May 12, 2010 **Scoping Session Purpose:** Partnering Team Meeting	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Jason Williams	RPM	NAVFAC Mid-Atlantic	(757) 322-4088	jason.e.williams2@navy.mil	Coordinates Navy Environmental Restoration (CERCLA/ MRP) activities; Partnering Team member
Will Potter	IR Program Manager	MCAS EAD	(252) 466-5376	will.potter@usmc.mil	Coordinates MCAS Cherry Point Environmental Restoration Activities; Partnering Team member
Gena Townsend	RPM	USEPA Region 4	(404) 562-8538	townsend.gena@epa.gov	USEPA regulator; Partnering Team member
George Lane	RPM	NCDENR	(919) 508-8462	george.lane@ncdenr.gov	State regulator; Partnering Team member
Doug Bitterman	AM	CH2M HILL	(757)-671-6209	Doug.Bitterman@CH2M.com	Oversees SAP production, Work Plan production, and project support; Partnering Team member
Erica DeLattre	PM	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
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SAP Worksheet #9-2—Project Scoping Session Participants Sheet (continued)

Comments/Decisions

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

The VI evaluation process was summarized as a recap from the January 2010 partnering meeting. The four steps of the Phase I investigation were reviewed and the results of the steps were summarized. The primary purpose of the presentation was to summarize the MLE evaluation (Step 4).

Recommendations for Phase II of the Investigation

Install and sample subslab soil gas probes and collect indoor air and outdoor air samples at nine buildings based on the results of Phase I and three additional buildings based on the preferential pathways analysis.

It was discussed that the proposed sampling locations are estimated based on the Phase I sampling results, but they will likely have to be moved based on the building layout and utilities.

Typically, subslab soil gas sampling would be performed during Phase II of a VI evaluation and indoor air sampling would be performed during Phase III, as necessary. However, both subslab soil gas and indoor air sampling will be performed during Phase II of the OU1 VI evaluation in order to expedite the MLE and risk assessment for the buildings of interest.

Action Items

Not applicable.

Consensus Decisions

Consensus to collect subslab/indoor/outdoor air samples as presented.

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

Project Name: Phase II VI Investigation at OU1 **Projected Date(s) of Sampling:** April 2011 **PM:** Keri Hallberg	**Site Name:** OU1 **Site Location:** MCAS Cherry Point, North Carolina
Date of Session: October 26, 2010 **Scoping Session Purpose:** Partnering Team Meeting	

Name	Title	Affiliation	Phone #	E-mail Address	Project Role
Jason Williams	RPM	NAVFAC Mid-Atlantic	(757) 322-4088	jason.e.williams2@navy.mil	Coordinates Navy Environmental Restoration (CERCLA/MRP) activities; Partnering Team member
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Ben Kowski	Hydrogeologist	USEPA Region 4	NA	NA	Guest

Comments/Decisions

Keri Hallberg/CH2M HILL provided a general update on OU1 VI activities, reviewed the response to comments from the Phase I VI Investigation Report, and reviewed the proposed Phase II sampling locations.

Action Items

Not applicable.

Consensus Decisions

Consensus to collect subslab/indoor air/outdoor air samples as presented.

SAP Worksheet #10—Problem Definition

This worksheet provides a summary of site background and key elements of the conceptual site model (CSM), followed by a narrative description of the problems to be addressed during the Phase II VI investigation.

Background

MCAS Cherry Point

MCAS Cherry Point is a 13,164-acre military reservation adjacent to the city of Havelock in southeastern Craven County, North Carolina (**Figure 1**). MCAS Cherry Point was commissioned in 1942 and provides support facilities and services for the Second Marine Aircraft Wing, FRCE (formerly Naval Aviation Depot), Combat Service Support Detachment 21 of the Second Marine Logistics Group, the Naval Air Maintenance Training Group Detachment, and the Defense Reutilization and Marketing Office. MCAS Cherry Point maintains facilities for training and for supporting the Atlantic Fleet Marine Force aviation units and is designated as a primary aviation supply point.

MCAS Cherry Point is bounded by the Neuse River to the north, Hancock Creek to the east, and North Carolina Highway 101 to the south. The western boundary is an irregular property line located approximately ¾-mile west of Slocum Creek.

In 1943, a massive aircraft assembly and repair facility (FRCE) was added. Hazardous wastes have been generated through historical aircraft assembly and maintenance operations since that time. These wastes have included plating wastes, organic solvents, paint removers and cleaners, oils and lubricants, waste petroleum, and polychlorinated biphenyls (PCBs).

OU1

OU1 is an industrial area of approximately 565 acres in the southwestern portion of MCAS Cherry Point (**Figures 2** and **3**). 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**).

Of the 11 sites identified in the Federal Facilities Agreement (FFA) investigated as part of the OU1 Remedial Investigation (RI), six were identified as contributing to the OU1 Central Groundwater Plume contamination, as described in the OU1 RI Addendum (CH2M HILL, 2009a). The locations of these sites are shown in **Figure 3** and include:

- Site 42—Industrial Wastewater Treatment Plant (IWTP)
- Site 47—Industrial Area Sewer System
- Site 51—Building 137 Former Plating Shop
- Site 52—Building 133 Former Plating Shop and Ditch
- Site 92—Volatile organic compounds (VOCs) in Groundwater near the Stripper Barn
- Site 98—VOCs in Groundwater near Building 4032

A brief description of these sites is included in **Table 10-1**.

SAP Worksheet #10—Problem Definition (continued)

TABLE 10-1
Site Descriptions

Site	Description
Site 42: IWTP	Originally constructed in 1957 to treat wastes from industrial sources such as metal plating, painting, aircraft maintenance, vehicle maintenance, and stormwater. A groundwater extraction and treatment system operated at the site from 1998 to 2005 to remediate the groundwater VOC plume in the vicinity of FRCE.
Site 47: Industrial Area Sewer System	Construction began in 1942 and was expanded over time for a system of underground pipes and aboveground drains to transfer industrial wastewater from various parts of FRCE and OU1 to the IWTP from processes such as metal plating, metal finishing, solvent degreasing, paint stripping, painting, fuel storage, fueling, aircraft washing, and general maintenance. Site 47 includes only the industrial sewers within OU1 that currently discharge to the IWTP. Concentrated wastes are now containerized and transported to the IWTP. Leaks were detected at several locations within the sewer system in the past and have been repaired. Inspections and repairs are conducted as part of the facility's ongoing maintenance process.
Site 51: Building 137 Former Plating Shop	A former Plating Shop that operated from 1942 to 1990 was located within Building 137 and consisted of approximately 4,000 ft^2 that included a 3-foot-deep sump for containment of spillage and tank overflows. The wastes generated in the plating shop consisted of plating solution overflow and rinse water containing zinc and chromium that were discharged to the sump. The sump discharged to the industrial area sewer system (Site 47) until 1987, when the sump was plugged and the plating shop converted to a closed-loop system. From then until the plating shop was moved in 1990, wastes were transported to the IWTP (Site 42) in containers for batch treatment.
Site 52: Building 133 Former Plating Shop and Ditch	A former plating shop that operated from 1942 to 1990 that was located in Building 133, and consisted of approximately 2,000 ft^2 that included a 2.5-foot-deep sump for containment of spillage and tank overflows. Former employees indicated that a ditch was formerly present behind Building 133 that received stormwater and industrial wastewater discharge from the plating shop and other areas within Building 133. This former ditch was covered in the 1970s by an addition to Building 133. The plating shop area was cleaned and renovated in 1996 and is currently used to process and store non-hazardous parts and supplies. The wastes generated in the plating shop consisted of plating solution overflow and rinse water that discharged to the sump. The sump wastes likely discharged to the former ditch behind Building 133 prior to the installation of the industrial sewer system (Site 47). An addition constructed on the southeastern side of the building subsequently covered this ditch. The sump then discharged to the industrial sewer system (Site 47) until 1987, when the sump was plugged and the plating shop converted to a closed-loop system. From then until the plating shop was moved in 1990, wastes were transported to the IWTP (Site 42) in containers for batch treatment.
Site 92: VOCs in Groundwater near the Stripper Barn	Site 92 is a plume of VOC-contaminated groundwater near the Stripper Barn portion of Building 137, where paint is removed from aircraft. The area around the site is covered with buildings and concrete, and portions of the industrial sewer system (Site 47) are located beneath and around the Stripper Barn. In the past, large quantities of solvent were used to remove paint; during the paint removal process, spent solvent flowed into the industrial sewer system. The current paint removal method requires approximately 90 percent less solvent, and spent solvent is captured for proper disposal. Any historical spills that occurred outside the building may have flowed toward storm drains located northeast of the Stripper Barn.
Site 98: VOCs in Groundwater near Building 4032	Site 98 is a plume of VOC-contaminated groundwater near Building 4032, located southeast of the IWTP in the central portion of OU1. Site 98 was discovered by MCAS Cherry Point during an investigation of underground storage tanks (USTs) at Building 4032 in 1994, and was identified as a new site in 1999.

SAP Worksheet #10—Problem Definition (continued)

Historical Site Investigations, Treatability Studies, and Remedial Actions

A comprehensive summary of historical activities and environmental investigations conducted at OU1 is provided in *Final Remedial Investigation for Operable Unit 1* (TetraTech NUS, 2002) and *OU1 Remedial Investigation Addendum* (CH2M HILL, 2009a).

A summary of historical investigations, treatability studies, and previous remedial actions is provided in **Table 10-2**.

Subsurface Conceptual Site Model

OU1 generally consists of paved or concrete surfaces with buildings throughout the area. The ground surface is relatively flat, ranging in elevation from 18 to 24 feet above mean sea level (amsl), except within the western portion of OU1 adjacent to East Prong Slocum Creek, where the ground surface elevation drops to 2 feet amsl. Surface water bodies present within OU1 include East Prong Slocum Creek and its tributaries, Schoolhouse Branch, and Sandy Branch (**Figure 3**).

The surficial aquifer is the first encountered groundwater beneath OU1 (depth of approximately 4 to 21 feet below ground surface [bgs]) and is unconfined. The saturated thickness ranges from approximately 30 to 45 feet beneath OU1 and is controlled by the fine-grained Yorktown confining unit (generally sandy silt) at the base of the aquifer. The Yorktown aquifer occurs beneath the Yorktown confining unit and is generally a confined to semi-confined aquifer. The saturated thickness is approximately 40 feet and is controlled by the Pungo River confining unit at its base (when present) and the Yorktown confining unit at the top. Groundwater contamination at OU1 has only been identified in the uppermost aquifers (surficial and Yorktown) and not observed in the Pungo River, upper Castle Hayne, or lower Castle Hayne aquifers. Each aquifer is separated by the confining unit except where the units are absent or discontinuous.

A regional, Pleistocene-age paleochannel eroded the Yorktown and Pungo River confining units and deposited younger-aged sediments in the southwestern portion of OU1 (**Figure 4**). As a result, the uppermost aquifers may be in direct hydraulic communication within the paleochannel where the confining units are absent. Groundwater levels northeast of the paleochannel boundary (outside the paleochannel) show a discontinuity across the Yorktown confining unit (which acts as an aquitard) and a downward vertical gradient from the surficial aquifer to the Yorktown aquifer. Groundwater levels southwest of the paleochannel boundary (within the paleochannel) generally show similar groundwater levels between the surficial and Yorktown aquifers and an upward vertical gradient from the Yorktown aquifer to the surficial aquifer.

Groundwater flows generally to the west in the surficial aquifer toward East Prong Slocum Creek and Sandy Branch at an average horizontal hydraulic gradient of approximately 0.003 foot per foot (ft/ft). The average linear horizontal groundwater velocity in the surficial aquifer is estimated at approximately 0.1 to 0.2 foot per day (ft/day).

SAP Worksheet #10—Problem Definition (continued)

TABLE 10-2
OU1 Historical Summary

Investigation Phase	Date	Reference	Summary
Remedial Investigation (RI)	1983–2000	TetraTech NUS (2002)	Collection of soil samples from numerous sites within OU1, groundwater samples from four aquifers beneath OU1 (in descending order: surficial, Yorktown, Pungo River, and Castle Hayne aquifers), and surface water and sediment samples from Sandy Branch, Schoolhouse Branch, East Prong Slocum Creek, and associated tributaries and drainage ditches. Primary contaminants within OU1 were determined to be polycyclic aromatic hydrocarbons (PAHs), pesticides, and PCBs in soil, and VOCs in groundwater. Chlorinated volatile organic compounds (cVOCs) within groundwater were the most widespread primary contaminants at OU1. The target cVOCs within groundwater included 1,1,2,2-tetrachloroethane (1,1,2,2-PCA), tetrachloroethene (PCE), trichloroethene (TCE), 1,1,1-trichloroethane (1,1,1-TCA) and the associated degradation products cis-1,2-dichloroethene (cis-1,2-dichloroethene [DCE]), trans-1,2-DCE, 1,2-dichloroethane (DCA), 1,1-DCA, and vinyl chloride (VC). TCE, total 1,2-DCE, VC, and 1,1-DCA were the most prevalent constituents of potential concern (COPCs) detected. Groundwater contaminated with the target cVOCs generally occurred in two areas within OU1: a small area beneath the northern portion of Building 137 and a larger area extending from Building 133 and the IWTP to the Site 16 landfill. cVOCs were detected in the upper and lower surficial aquifers.
Building 137 Treatability Study	2000–2002	CH2M HILL (2003)	Single-event substrate injection of Hydrogen Release Compound (HRC) into the surficial aquifer at Site 51, beneath Building 137. Groundwater monitoring for VOCs was conducted in a baseline round of sampling prior to the HRC injection in late 2001 and during six post-injection monitoring events conducted over a 1-year period in 2002. Initial reduction of TCE concentrations was observed; however, rebound was observed in later sampling events.
Buildings 133 and 137 Treatability Study	2004–2005	CH2M HILL(2007)	Tracer testing, baseline monitoring, EHC™ injection, and post-injection monitoring. Similar to the 2000-2002 study, concentrations initially decreased, then rebounded. It was concluded that impacts beneath Buildings 133 and 137 were not well understood and additional investigation was required.
Groundwater Extraction System	1998–2005	See CH2M HILL (2009a) for full list of monitoring documents	The system was designed to extract groundwater from the central portion of the plume to an equalization tank containing an air diffusion system followed by treatment at the IWTP. The system was shut down in 2005 due to ineffective system performance and interference with the RI.
Downgradient Air Sparge System	1998–2005	See CH2M HILL (2009a) for full list of monitoring documents	An air sparge/soil vapor extraction (AS/SVE) system was installed and began operation in 1998 at Site 16. The system was installed to treat contaminated shallow groundwater in place prior to its natural discharge to the adjacent surface water bodies. The system was shut down in 2005 due to ineffective system performance and interference with the RI.
OU1 Voluntary Groundwater Monitoring (VGM) Program	2004–2005	Agviq/CH2M HILL JV I (2005, 2006a, 2006b)	The objectives of the VGM program were to track potential plume migration and to maintain awareness of plume configuration. The program included the collection of water-level measurements and groundwater samples from selected monitoring wells located within OU1.

SAP Worksheet #10—Problem Definition (continued)

TABLE 10-2
OU1 Historical Summary

Investigation Phase	Date	Reference	Summary
RI Addendum	2005–2009	CH2M HILL (2009a)	The additional site investigation activities included collection of subsurface soil samples, monitoring well installation, water-level monitoring, collection of groundwater samples, and aquifer hydraulic conductivity ("slug") testing. In addition, some sediment and surface water samples were collected within OU1 as part of ecological risk evaluations conducted following the 2002 RI. Similar to the findings of the 2002 RI, the most prevalent VOCs detected above regulatory standards within groundwater during the additional investigations (in order based on the greatest frequency of exceedances) included TCE, VC, 1,2-DCE, and 1,1-DCE. These chemicals generally exceeded the regulatory standards at a frequency of greater than 10 percent. Other VOCs related to chlorinated solvents detected above regulatory standards included PCE, 1,1,1-TCA, 1,1,2,2-PCA, 1,1-DCA, and 1,2-DCA), but less frequently. Benzene and other petroleum-related hydrocarbons are being investigated under the MCAS Cherry Point UST Program and were not discussed as part of the RI Addendum.
2009 Additional Investigation	2009	CH2M HILL (2010)	Installation and sampling of 4 upper surficial aquifer and 5 lower surficial aquifer monitoring wells to the north, northeast, and downgradient of existing monitoring well 42GW15, to further characterize the cVOC plume along Sandy Branch Tributary #2. Installation and sampling of 1 lower surficial aquifer monitoring well to delineate the southern extent of the cVOC plume. Installation and sampling of 2 lower surficial aquifer monitoring wells to further assess the horizontal extent of elevated cVOC concentrations (i.e. above 10 times the North Carolina 2L Groundwater Standard [NC 2L]) in the downgradient portion of the plume. Installation and sampling of 1 upper surficial aquifer monitoring well at Sites 16, 17, and 83 (total of 3 wells) to serve as part of potential monitoring well network for long-term monitoring. Sampling of 170 existing monitoring wells to establish baseline conditions prior to implementation of a remedial action, to provide another temporal groundwater monitoring event at monitoring wells only sampled once, and to further assess the plume stability and natural attenuation conditions.
Phase I VI Investigation	2009	CH2M HILL (2010)	• **Step 1 – Identification of Buildings of Interest** – *Selection of COPCs*. Groundwater data collected from the upper and lower portions of the surficial aquifer as part of the OU1 RI Addendum activities were screened against generic VI screening levels from the 2002 USEPA Draft VI Guidance target groundwater concentrations based on a 1×10^{-6} cancer risk and a noncancer 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 VI evaluation. – *Building Survey*. A building survey (site reconnaissance) was conducted at each building of interest to describe building type, size, status, occupancy, and construction.

SAP Worksheet #10—Problem Definition (continued)

TABLE 10-2
OU1 Historical Summary

Investigation Phase	Date	Reference	Summary
Phase I VI Investigation (continued)			• **Step 2 – Desktop Risk Evaluation** – *Refinement of Buildings of Interest*. Site-specific modeling was conducted to determine site-specific screening values, focusing sampling activities at buildings with the highest potential for VI 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 above the VOC groundwater plume and/or 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 were collected at buildings identified through Steps 1 and 2 to further characterize the potential VI pathway. During field activities, the presence of potential preferential pathways (e.g., utility corridors) was also identified. • **Step 4 – MLE/Risk Evaluation** – The sampling results were evaluated to develop a CSM for each building identified with a potential VI pathway. Data were evaluated using an MLE approach, as outlined in the VI guidance document (ITRC, 2007). The predictive modeling (using the J&E model) was updated using the analytical results, and the data were re-screened. Upon evaluation of the sampling results, identified preferential pathways were evaluated to determine whether any additional buildings may require further investigation. – The results of the MLE/risk evaluation were used to make decisions regarding further actions. – The sampling results and risk evaluations were documented in a summary report. The summary report included the building inventory, analytical results and comparison to screening levels, and maps showing sampling and building locations. It concluded that 9 of the original 21 buildings of interest were in need of additional VI investigation to determine if the pathway exists.

SAP Worksheet #10—Problem Definition (continued)

Nature and Extent of Contamination

The most prevalent VOCs detected above regulatory standards within the Central Groundwater Plume (in order based on the greatest frequency of exceedance) include TCE, VC, 1,2-DCE, 1,1-DCA, and 1,1-DCE. These chemicals generally exceed the regulatory standards at a frequency of greater than 10 percent in monitoring wells. Other VOCs related to chlorinated solvents detected above regulatory standards, but less frequently, included PCE, 1,1,1-TCA, 1,1,2,2-PCA, and 1,2-DCA. Petroleum hydrocarbons are also present; however, those constituents are being addressed under the UST Program.

Three distinct plumes of TCE and its degradation products occur in the upper surficial aquifer within OU1 (**Figures 5** through **7**). The highest TCE concentrations (**Figure 5**) occur beneath Building 133, at concentrations that may be indicative of the presence of dense non-aqueous phase liquid (DNAPL) (maximum concentration of 17,000 micrograms per liter [µg/L]). Beneath Building 133, TCE generally occurs only within the upper surficial aquifer and was not observed in the lower surficial aquifer. TCE extends from the upper surficial aquifer into the lower surficial aquifer at locations downgradient of Building 133, and the plume extends from the western portion of the building more than 3,000 feet to East Prong Slocum Creek and Sandy Branch. TCE was not observed on the western side of the creeks, as the plume is believed to discharge to the creeks.

Another distinct TCE plume occurs within the upper surficial aquifer beneath Building 137 (**Figure 5**) and extends a few hundred feet to the southwest beneath the building. The plume extends from the upper surficial aquifer to the lower surficial aquifer downgradient of Building 137 and mixes with the plume from beneath the IWTP.

A third TCE groundwater plume within the upper surficial aquifer occurs near the IWTP (**Figure 5**). The TCE plume from this area migrates within the upper and lower surficial aquifers beneath Tributary #2 to Sandy Branch and also joins the larger plume that extends from Building 133.

Detections of 1,2-DCE (**Figure 6**) and VC (**Figure 7**) generally occur at similar monitoring wells with TCE concentrations in exceedance of the NC 2L. The highest concentration of cis-1,2-DCE (maximum concentration of 4,200 µg/L) was detected within the lower surficial aquifer just downgradient of Building 133 (not shown on **Figure 6**). The highest concentration of VC (maximum concentration of 650 µg/L) was also detected in the lower surficial aquifer, downgradient of Building 133 (not shown on **Figure 7**). Similar to TCE, 1,2-DCE and VC contamination extends from the upper surficial aquifer beneath Building 133 to the lower surficial aquifer downgradient of the building, and further to Sandy Branch and East Prong Slocum Creek.

Concentrations of 1,1-DCE generally exceed the NC 2L Standard in a small area within the upper surficial aquifer beneath Building 137, within the lower surficial aquifer downgradient of Building 137 and upgradient of the IWTP, and within the upper surficial aquifer beneath the IWTP. Concentrations of 1,1,1-TCA were detected above the NC 2L Standard at only one monitoring well completed within the upper surficial aquifer, at Building 137.

SAP Worksheet #10—Problem Definition (continued)

Twelve other VOCs and four SVOCs generally exceed their respective NC 2L Standard at a frequency of less than 10 percent. Other cVOCs with concentrations above the NC 2L Standards in descending order of exceedance frequency included PCE, 1,1-DCA, 1,1,2,2-PCA, 1,2-DCA, and bromodichloromethane. PCE generally occurs at locations with elevated concentrations of TCE within the upper surficial aquifer beneath Buildings 133 and 137. Detected concentrations of 1,1-DCA occur primarily beneath Buildings 133 and 137, whereas 1,2-DCA concentrations consist only of localized detections at individual monitoring wells. Concentrations of 1,1,2,2-PCA were detected above the NC 2L Standard only within the upper surficial aquifer at multiple monitoring wells in the downgradient area of the plume. Bromodichloromethane was detected inconsistently and infrequently (CH2M HILL, 2009a).

Receptors

A Human Health Risk Assessment (HHRA) was conducted as part of the OU1 RI Addendum. Potential risks to human health above regulatory target levels were identified for current indoor industrial workers via inhalation of vapors that could migrate from the upper surficial aquifer to indoor air within the overlying buildings (i.e., VI). A simplified CSM produced during the RI Addendum showing potential current and future receptors exposed via the vapor migration pathway, in addition to other exposure pathways that may be present at OU1, is shown on **Figure 8**. Initially, 80 buildings within OU1 were considered for further investigation. After a series of screenings, as summarized in **Table 10-2**, 21 buildings were retained for the Phase I VI investigation **(Figure 9).**

VI exposure at OU1 may occur under current and future land use scenarios. Receptors that may be exposed include current and future industrial workers and future unrestricted use receptors (e.g., residents). However, future risk scenarios will be presented in a HHRA conducted during a subsequent phase of the investigation, as agreed upon during partnering meetings.

Phase I VI Investigation

The Phase I VI investigation was conducted in November 2009 to assess the potential for VI at the 21 identified buildings of interest. Phase I field activities primarily included exterior sampling adjacent to the buildings (i.e., groundwater grab sampling from the top of the water table and co-located exterior soil vapor sampling). In addition, interior sampling (i.e., subslab soil gas sampling) was conducted at Buildings 133 and 137 based on the high source strength, relatively shallow depth to groundwater, and/or the potential presence of DNAPL beneath Building 133. Indoor-to-subslab pressure differential monitoring was also conducted at these two OU1 buildings.

SAP Worksheet #10—Problem Definition (continued)

The results of the Phase I OU1 VI evaluation provided evidence suggesting that the VI pathway is unlikely to result in cVOC concentrations above indoor air risk-based screening levels under current conditions at Buildings 159, 4630, 4032, 4172, 4380, 3987, 1005, 452, and 4808; therefore, Phase II VI investigation activities are not necessary. However, the potential for a complete VI pathway would need to be re-evaluated at Building 159 if cVOCs in groundwater continue to migrate toward the building and higher concentrations are detected in groundwater under the building in the future (CH2M HILL, 2010).

The Phase I risk evaluation for Buildings 4533, 4498, and 4497 was inconclusive due to non-detects at significantly elevated reporting limits (i.e., up to three orders of magnitude above the risk-based screening levels) in the soil vapor samples, which may have been caused by the presence of petroleum hydrocarbons in the subsurface. VI from petroleum impacts at these buildings is being evaluated through the UST Program.

The potential for a completed VI pathway could not be ruled out for Buildings 143, 4225, 4224, 133, 3402, 4026, 137, 3997, and 131 because COPCs were detected in Phase I samples (groundwater, soil vapor, and/or subslab soil gas) at concentrations exceeding the groundwater and/or soil gas screening levels at these buildings. Therefore, additional investigation of the VI pathway was recommended for these buildings.

Buildings 4525, 129, and 188 were identified during the preferential pathways analysis performed during Phase I. These buildings are located along the northeast side of Building 133 and appear to be connected via subsurface utility lines to areas of Building 133 where elevated cVOC soil gas concentrations were detected in Phase I.

Problem Statement

The OU1 RI Addendum identified the potential for the VI pathway to be significant in several buildings overlying contaminated groundwater. The Phase I vapor intrusion investigation was carried out under agreement with the Partnering Team to obtain additional information regarding the VI exposure pathway for current industrial workers at OU1. The draft final Phase I Vapor Intrusion Investigation Report (CH2M HILL, 2010) concluded that the potential for a completed VI pathway could not be ruled out for Buildings 143, 4225, 4224, 133, 3402, 4026, 137, 3997, and 131 and recommended that additional VI investigation be performed at these buildings. Additionally, Buildings 4525, 129, and 188 were identified for Phase II sampling during the preferential pathways analysis.

The objective of the Phase II VI investigation is to determine whether a complete VI exposure pathway exists at the buildings identified in the Phase I report (CH2M HILL, 2010). Twelve buildings were retained as buildings of interest for the Phase II investigation.

The Phase I report (CH2M HILL, 2010) proposed indoor and outdoor air sampling only at Buildings 133 and 137; however, the Partnering Team concurred, after discussion, that indoor and outdoor air sampling would be conducted at all of the Phase II buildings of interest to expedite the VI investigation.

SAP Worksheet #10—Problem Definition (continued)

Environmental Questions to be Answered

The following are the specific environmental questions to be answered by the Phase II VI investigation:

- **Are chemicals of concern (COCs) present in subslab soil gas at concentrations that could result in indoor air concentrations above risk-based target levels?**

  Subslab soil gas samples will be collected from each of the 12 buildings of interest and will be analyzed for select cVOCs by USEPA Method TO-15 based on the COCs identified in the RI Addendum (CH2M HILL, 2009a) and the COCs that exceeded risk-based target levels during Phase I:

  - 1,1,1-TCA
  - 1,1,2,2-PCA
  - 1,1,2-Trichloro-1,2,2-trifluoroethane (Freon-113)
  - 1,1,2-TCA
  - 1,1-DCA
  - 1,1-DCE
  - 1,2-DCA
  - trans-1,2-DCE
  - Bromoform
  - Chloromethane
  - Dichlorodifluoromethane (Freon-12)
  - Methylene Chloride
  - PCE
  - TCE
  - VC

  The subslab soil gas data will assist in evaluating the VI pathway as a supporting line of evidence. If the contaminants in the subsurface (e.g., groundwater and/or soil) are volatilizing and producing concentrations in the subslab soil gas that could migrate into indoor air and produce indoor air concentrations that result in potentially unacceptable risks, subslab soil gas data will be useful in quantifying the significance of the VI pathway.

- **Are COCs present in indoor air at concentrations above risk-based target levels?**

  Indoor air samples will be collected concurrently with the subslab soil gas samples at each of the 12 buildings of interest. The samples will be analyzed by EPA Method TO-15 for the select cVOCs specified for subslab soil gas sampling. Indoor air samples will provide a direct measurement of exposure point concentration for use in the VI evaluation to determine whether concentrations within the building exceed regulatory target levels. Indoor air concentrations that exceed regulatory target levels but are not observed in corresponding subslab soil gas samples are most likely not related to VI but rather may be related to an indoor source. These concentrations will be considered building by building and exceedances will be reported to the Navy for investigation by the Base health department.

SAP Worksheet #10—Problem Definition (continued)

- **Are there items present in the buildings that may be contributing to cVOC concentrations observed in indoor air samples?**

  Building characteristics pertinent to the VI pathway will be documented during the building surveys and include construction, use, typical HVAC operation, potential indoor air sources of cVOCs (e.g. cleaning products, chemicals used in manufacturing), and slab condition. In addition to the standard building surveys, detailed building surveys will be performed at Buildings 133, 137, and 3402 because the highest cVOC concentrations were exhibited within or near these buildings during Phase I. The detailed building surveys will include HVAC system studies, detailed inventories of potential indoor cVOC sources, research of historical building use, and an evaluation of indoor air volumes and connectivity.

- **How will these data collected and used?**

  Installation and sampling of subslab soil gas probes is proposed during Phase II at Buildings 143, 4225, 4224, 3402, 4026, 3997, and 131. Additional subslab soil gas samples will be collected from the existing subslab probes at Buildings 133 and 137, where subslab soil gas sampling was conducted during Phase I. Additional subslab soil gas probes will also be installed and sampled at Buildings 133 and 137. Indoor air sampling will be performed at all 12 buildings concurrently with the subslab soil gas sampling.

  These data will be used to evaluate current indoor air cVOC concentrations and to calculate subslab soil gas to indoor air attenuation factors (if feasible). Concurrent outdoor air samples will be collected in the vicinity of the 12 buildings in order to evaluate background outdoor air cVOC concentrations.

- **Is there a complete and/or significant exposure pathway for contaminants present in groundwater and/or vadose zone soil beneath the buildings to migrate to indoor air?**

  The MLE collected during the Phase II investigation will be used to evaluate the presence of a complete VI exposure pathway. Phase II data will be used in conjunction with Phase I groundwater/soil vapor data to further develop the CSM. The MLE will be incorporated into the building-specific CSMs. The data to be collected for the MLE evaluation include:

  - Building characteristics (construction, slab condition, HVAC system construction and operation, etc.)
  - Potential indoor air sources (cleaning products, chemicals used within the building for manufacturing, etc.)
  - Subslab soil gas concentrations of select cVOCs
  - Indoor air concentrations of select cVOCs
  - Outdoor air concentrations of select cVOCs (to determine ambient conditions)

SAP Worksheet #10—Problem Definition (continued)

- **Is there unacceptable risk to potential future building occupants from inhalation of indoor air from migration of VOC concentrations in subslab vapor?**

  Future risk scenarios will not be evaluated under this SAP. A HHRA will be conducted during a subsequent phase of the investigation once more data have been collected. Subslab soil gas and indoor air data will be used to calculate site-specific attenuation factors (AFs) to assess the future exposure scenarios for existing buildings.

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

Who will use the data?

The data will be used by the Navy, Marine Corps, and stakeholder agencies (i.e. USEPA and NCDENR).

What are the Project Action Limits (PALs)?

The VI evaluation will be consistent with the MLE data evaluation approach outlined by DoD (2009), ITRC (2007), and USEPA (2002). The approach is outlined on **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**.
  - **Indoor Air.** The indoor air screening levels (IASLs) are based on the USEPA (November 2010) Regional Screening Levels (RSLs) for industrial air. The RSLs are derived assuming a 10^{-6} target cancer risk level or a target noncancer HQ of 1. However, a target noncancer HQ of 0.1 was incorporated into the PALs to account for cumulative effects from potential simultaneous exposure to multiple noncancer COPCs.
  - **Soil Vapor.** Generic soil gas screening levels (SGSLs) were calculated using the methodology in Appendix D of the 2002 USEPA Draft VI Guidance for calculating target soil vapor concentrations corresponding to target indoor air concentrations. SGSLs were calculated by dividing the IASLs by the USEPA generic attenuation factor of 0.1 for depths less than 6 feet. The generic SGSLs are based on a 10^{-6} cancer risk and a noncancer HQ of 0.1. The equation is presented below:

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

    Where,

    $C_{soil\text{-}gas}$ = target soil gas concentration (i.e., SGSL),

    $C_{target,ia}$ = target indoor air concentration (i.e., IASL), 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)]

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

How will the data be used?

- Analytical data will also be evaluated using an MLE approach, which includes examination of concentration trends and potential spatial correlations between Phase I groundwater, near-slab soil vapor, and subslab soil gas data and subslab soil gas and indoor air data from Phase II. The ratio of constituents in groundwater, soil vapor, subslab soil gas, and indoor/outdoor air samples will be evaluated to help identify potential VI contributions or to screen out background sources. Empirical AFs will be calculated using the data collected during Phase II. Concurrent indoor air concentrations will be paired with each subslab soil gas sample collected at a given building and the ratios (i.e., AFs) of indoor air concentrations to subslab soil gas concentrations will be calculated for cVOCs with subslab concentrations greater than 100 times the minimum Phase II reporting limits (RLs). USEPA (2008) states that:

  "*When background indoor air concentrations are equivalent to or greater than the concentration contributed by vapor intrusion, the empirical attenuation factor will be biased high relative to the true attenuation factor (i.e., towards higher, more conservative values) by the contribution of background sources to indoor air. The bias varies in proportion to the relative contribution of background sources to the total indoor air concentration. … The empirical attenuation factor is most likely to represent the attenuation due to vapor intrusion when the indoor air concentration from vapor intrusion is substantially greater than the background indoor air concentration, which is most likely to occur when subsurface vapor concentrations are high.*"

  As discussed by USEPA (2008), it is important to consider background indoor and/or outdoor air concentrations when calculating and interpreting empirical AFs. There is no hard-and-fast rule when attempting to determine if the indoor air concentrations are significantly greater than background levels. USEPA has suggested, during other site evaluations for the Navy, that indoor air concentrations may start to approach the point of being significantly different from outdoor air concentrations if they are more than two times the outdoor air concentrations. Therefore, two times the outdoor air concentrations was selected and will be used when highlighting the result**s.**

  The empirical AFs will be plotted against the subslab soil gas concentrations for cVOCs. Additional information (e.g., building number, cVOC, subslab and indoor air concentration, two times the outdoor air concentration) associated with each of the AFs will also be presented. Building survey results and building history information will also be used as lines of evidence in the evaluation.

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

What will the data be used for?

The data will be used to evaluate whether a complete and/or significant VI pathway exists at the 12 buildings of interest. Subslab soil gas data will be compared with SGSLs derived using either default or site-specific AFs to determine if concentrations in subslab soil gas have the potential to result in future indoor air exceedances of target levels. If feasible and based on the magnitude of the subslab soil gas and indoor air results, a site-specific AF for existing buildings will be calculated using the data collected during the investigation and site-specific PALs will be re-calculated. The Navy will identify and evaluate feasible mitigation measures if results from this Phase II investigation indicate that VI is causing indoor air concentrations to exceed target risk levels.

What types of data are needed (matrix, target analytes, analytical groups, field screening, on-site analytical or off-site laboratory techniques, sampling techniques)?

- Standard building surveys will be conducted at Buildings 143, 4225, 4224, 4026, 3997, 131, 4525, 129, and 188. Building characteristics pertinent to the VI pathway (such as construction, use, typical HVAC operation, and slab condition) will be documented during the building surveys. Detailed building surveys will be conducted at Buildings 133, 137, and 3402. The detailed building surveys will include HVAC system studies, detailed inventories of potential indoor cVOC sources, research of historical building use, and an evaluation of indoor air volumes and connectivity.

- Subslab soil gas samples will be collected at Buildings 143, 4225, 4224, 4026, 3997, 131, 4525, 129, 188, 133, 137, and 3402. Subslab soil gas probes will be installed immediately below the buildings' slabs. Subslab soil gas samples will be collected over a 5-minute period in 1-L SUMMA canisters. The samples will be analyzed for select cVOCs by EPA Method TO-15.

- Indoor samples will be collected over a 24-hour period in 6-L SUMMA canisters at Buildings 143, 4225, 4224, 4026, 3997, 131, 4525, 129, 188, 133, 137, and 3402. The samples will be analyzed for select cVOCs by USEPA Method TO-15.

- Outdoor air samples will be collected over a 24-hour period in 6-L SUMMA canisters at Buildings 133, 137, 131, 4225, and 143. The samples will be analyzed for select cVOCs by EPA Method TO-15.

- Subslab soil gas, indoor air, and outdoor air samples will be submitted to an offsite laboratory for analysis (CAS).

- The select cVOCs for Phase II will be the same cVOCs that were identified during the Phase I SAP development by screening shallow groundwater data against the 2002 USEPA Draft VI Guidance target groundwater concentrations. The select cVOCs 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 SAP. However, both cVOCs and petroleum-related compounds will be considered in the cumulative risk evaluation.

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

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 the VI pathway. Laboratory methods will be validated using the procedures outlined in **Worksheet #36.**
- Data shall meet the Measurement Performance Criteria listed in the Department of Defense (DoD) Quality Systems Manual (QSM) Version 4.1.
- cVOC data collected during the final round of sampling will be validated by an internal validation team led by Ward Dickens. All other parameters will be reviewed internally by the Project Chemist (PC). QC samples are detailed in **Worksheet #20**. cVOC data, which will receive third party validation, will require a Level 4 data package and field QC sampling. All other parameters will require a Level 3 data package.

How much data should be collected (number of samples for each analytical group, matrix, and concentration)?

The proposed sample locations are shown in **Figures 11** through **17** and are listed below. The samples will be analyzed for select cVOCs by USEPA method TO-15 (subslab soil gas) and TO-15 (indoor and outdoor air).

- Building143
  - 3 subslab soil gas
  - 2 indoor air
  - 1 outdoor air
- Building 4225
  - 5 subslab soil gas
  - 3 indoor air
  - 1 outdoor air
- Building 4224
  - 4 subslab soil gas
  - 2 indoor air
- Building 133
  - 9 subslab soil gas (5 existing probes, 4 new installs)
  - 5 indoor air
  - 1 outdoor air
- Building 137
  - 9 subslab soil gas (3 existing probes, 6 new installs)
  - 6 indoor air
  - 1 outdoor air
- Building 3402
  - 3 subslab soil gas
  - 2 indoor air
- Building 4026
  - 2 subslab soil gas
  - 2 indoor air
- Building 3997
  - 4 subslab soil gas
  - 3 indoor air
- Building 131
  - 4 subslab soil gas
  - 3 indoor air
  - 1 outdoor air
- Building 4525
  - 3 subslab soil gas
  - 2 indoor air
- Building 129
  - 2 subslab soil gas
  - 1 indoor air
- Building 188
  - 2 subslab soil gas
  - 1 indoor air

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

The data will be collected in accordance with the standard operating procedures (SOPs) presented in **Worksheet #21**. The rationale for the data to be collected is provided in **Worksheet #17**. The field sampling strategy is presented in **Figure 18.**

Where, when, and how should the data be collected/generated?

- Samples will be collected in the 12 buildings of interest within OU1. The data will be collected during one field mobilization event planned to occur in February 2011.
- Data will be collected and generated in accordance with the procedures outlined in this SAP. See the SOPs in **Appendix B** for more details.

Who will collect and generate the data? How will the data be reported?

- CH2M HILL staff will oversee the drilling and installation of the proposed subslab soil gas probes and collect the subslab soil gas, indoor air, and outdoor air samples as outlined in **Worksheet #18**.
- Laboratory analyses will be performed by CAS. Once generated, cVOC analytical data collected will be submitted to the internal validation team led by Ward Dickens of CH2M HILL for validation against analytical methodology requirements and measurement performance criteria presented in this SAP.
- The validated data will be uploaded into a centralized electronic database used for Navy projects (Navy Installation Restoration Information System [NIRIS]) by the project team.
- All data will be reported in a Phase II VI Investigation Report, which will be submitted to the Navy as a draft for review prior to distribution to NCDENR and USEPA for review and approval.

How will the data be archived?

- Data will be archived according to procedures specified in the CLEAN program/ contract. All data will be uploaded into a centralized database developed and maintained by CH2M HILL and used for Navy projects and will also be loaded into NIRIS. At the end of the project, paper copies of archived laboratory data and validation reports will be archived by Iron Mountain.

List the Project Quality Objectives (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 10**.

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

Matrix: Air (Subslab, Indoor, and Outdoor Air)
Analytical Group: cVOCs
Concentration Level: Low

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	cVOCs	One per 10 samples per matrix	Precision	Relative percent difference (RPD) < 25%	S&A

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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 for MCAS Cherry Point, North Carolina* (CH2M HILL, 2004) addresses the protocols and 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) is presented in **Appendix A**.

Mobilization Activities

Prior to mobilization, NAVFAC Mid-Atlantic, MCAS Cherry Point, NCDENR, and USEPA 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
- HVAC Specialist
- Backup Analytical laboratory

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 and entrance to any building, the PM and the FTL will coordinate with Will Potter, IR Program Manager. The utilities in the area will be marked out prior to installation of subslab soil gas probes. No intrusive activities will be initiated until the utility clearance has been completed.

Subslab Soil Gas

Subslab soil gas probe installation and sampling will be performed in accordance with the CH2M HILL field SOP, *Standard Operating Procedure for Installing Subslab Probes and Collecting Subslab Soil Gas Samples Using SUMMA Canisters* (**Appendix B**).

Permanent subslab soil gas probes will be installed by drilling through the building foundation with a rotary hammer drill with a ½-inch diameter drill bit. The subslab soil gas probes will consist of stainless steel Swagelok® gas-tight fittings (a length of ¼-inch stainless steel tubing not to extend below the slab, a probe union, a sampling union, and a probe cap). The probe will be secured in place with Portland cement so that it is flush with the foundation and the cement will be allowed to dry for 24 hours. The probes will be plugged with a flush mount hex socket plug to allow for a complete seal between the subsurface and indoor environment.

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

A helium leak check will be performed on each newly installed and existing subslab probe prior to sampling to ensure that its seal is intact. The probe will be purged using a sampling manifold (consisting of stainless steel Swagelok® gas-tight valves and fittings and Teflon tubing) and a vacuum pump. Two liters of subslab soil gas will be purged at 200 milliliters per minute (mL/min) into a Tedlar bag and screened with a helium detector.

Subslab soil gas samples will be collected in 1-L SUMMA canisters equipped with critical orifices. The critical orifice will regulate the sample collection rate at 180 mL/min, which will result in a sample collection period of 5 minutes. The subslab soil gas samples will be submitted to the laboratory for analysis of the COPCs identified in **Worksheet #10** by USEPA Method TO-15.

Air quality will be monitored during subslab soil gas probe installation and sampling with a photoionization detector (PID) (MiniRAE 2000 or equivalent). The field team will follow the guidelines for air monitoring outlined in the HSP.

Indoor and Outdoor Air

Indoor and outdoor air samples will be collected in accordance with the CH2M HILL field SOP, *Standard Operating Procedure for Integrated Ambient Indoor, Outdoor, and Crawl Space Air Sampling Method for Trace VOCs Using SUMMA Canisters.*

Indoor and outdoor air samples will be collected over a 24-hour period in 6-L SUMMA canisters equipped with flow controllers (approximate sampling flow rate of 4.16 mL/min). Each SUMMA canister will be placed at the sampling location, turned on, and left undisturbed for 24 hours. The SUMMA canisters will be placed at a height of approximately 3 to 5 feet above the ground (roughly breathing zone height). The SUMMA canisters will be checked after 20 hours to ensure that canister pressure does not reach zero.

The indoor and outdoor air samples will be submitted to the laboratory for analysis of the COPCs identified in **Worksheet #10** by USEPA Method TO-15.

Standard Building Surveys

A standard building survey will be performed at each of the 12 Phase II buildings of interest prior to sampling activities in accordance with the CH2M HILL field SOP, *Conducting Building Surveys for Vapor Intrusion Evaluation.* Chemical products stored and activities performed within the building that may be sources of cVOCs in indoor air (dry-cleaned clothing, solvents, cleaning products, etc.) will be documented. This information will be obtained by visual inspection and by holding discussions with the building occupants. Other building conditions pertinent to VI that were not captured during the previous building survey will also be documented. Such items include the type and typical operation of the HVAC system, potential preferential pathways (piping and other conduits, etc.), and the condition of the slab. An example industrial building survey is presented in **Appendix B**.

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

Detailed Building Survey

Detailed building surveys will be conducted at Buildings 133, 137, and 3402. This survey will include an HVAC system study, creation of a detailed inventory of potentially interfering products used within the buildings, an investigation of historical building use and processes within the building, a review of construction details available from the records review and the MCAS Cherry Point Public Works Department or Facilities Engineering representative, an evaluation of indoor air volumes, and an evaluation of the connectivity between indoor air spaces. An HVAC specialist will be used as a subcontractor for this task.

Quality Assurance/Quality Control

The QA/QC sample collection frequency is as follows (also shown in **Worksheet #20**):

Subslab Soil Gas Samples:

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

Indoor and Outdoor Air Samples:

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

Sampling Equipment Decontamination

All non-disposable sampling equipment will be decontaminated immediately after each use.

Investigation-derived Waste

Investigation-derived waste (IDW) is expected to consist primarily of methanol from decontamination of subslab soil gas probe stainless steel sampling unions. The IDW will be stored in a 50-gallon bucket with a lid and transported to the IWTP for disposal on a daily basis. Disposable equipment, including personal protective equipment (PPE), paper towels, and sample tubing will be disposed of as solid waste.

Quality Control Tasks

SOPs will be implemented for field and laboratory activities.

- QC samples are described on **Worksheet #20**.

Secondary Data

No secondary data were used in the development of this SAP.

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

Data Validation, Review, and Management Tasks

Procedures for recording data, including guidelines for recording and correcting data:

- See the EIS Checklist for Validated and Unvalidated electronic data deliverables (EDDs)/ Supplemental NIRIS Electronic Data Deliverable (SNEDDs) and Hard Copy Data Checklist in **Appendix C** of this SAP for examples of CH2M HILL's hard copy data reporting forms and verification checklists.
- Computerized and manual procedures for data management range from data generation to final use and storage and QC checks for error detection to ensure data integrity.
- The following documents (found in **Appendix D**) provide guidance on these procedures:
  - EIS QC Checklist for Unvalidated and Validated EDDs/ SNEDDs and Hard Copy Data Checklist
  - EDD Prep for Raw and Detects Tables for Unvalidated or Validated Data
  - EDD Prep for Load and Archive Files
- Guidance on data management steps such as data recording, data transformation, data reduction, data transfer and transmittal, data analysis, and data review.
- Found in the Data Management Checklist and Navy CLEAN Data Management Plan (found in **Appendix C**).
- Procedures for data tracking, storage, archiving, retrieval, and security for both electronic and hardcopy data.
- See the Data Management Checklist, NIRIS Instructions, and Navy CLEAN Data Management Plan for more information (**Appendix C**).
- The Project EIS, Victoria Brynildsen, is responsible for data tracking and storage.
- CH2M HILL will coordinate archiving and retrieval of data.
- Perform data validation via an internal validator for cVOCs as per **Worksheets #35 and #36**.

Documentation and Reporting

Work and data will be documented in the Phase II VI Investigation Report.

Assessment/Audit Tasks

See **Worksheets #31 and #32**.

SAP Worksheet #15—Reference Limits and Evaluation Table

The following applies to all of Worksheet #15:

There are those instances where a laboratory's quantitation limit (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 method detection limit (MDL) as estimated. A J qualifier will be applied to these results.

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

Matrix: Indoor Air, Outdoor Air under Phase II
Analytical Group: cVOCs

Analyte	CAS Number	PAL[1]: Adjusted Industrial Air RSLs (µg/m^3)	Project Quantitation Limit (PQL) Goal[2] (µg/m^3)	Laboratory-specific			MS/MSD and Laboratory Control Sample (LCS) Recovery Limits		
				LOQ (µg/m^3)	LOD (µg/m^3)	DL (µg/m^3)	Lower Limit (%)	Upper Limit (%)	RPD (%)
1,1,1-TCA	71-55-6	2200	1100	0.5	0.42	0.19	71	123	25
1,1,2,2-PCA	79-34-5	0.21	0.105	0.5	0.4	0.2	80	126	25
1,1,2-TCA	79-00-5	0.77	0.385	0.5	0.42	0.24	76	122	25
1,1-DCA	75-34-3	7.7	3.85	0.5	0.43	0.2	67	124	25
1,1-DCE	75-35-4	88	44	0.5	0.44	0.3	71	121	25
1,2-DCA	107-06-2	0.47	0.235	0.5	0.43	0.21	64	125	25
Bromoform	75-25-2	11	5.5	0.5	0.43	0.21	73	150	25
Chloromethane	74-87-3	39	19.5	0.5	0.41	0.19	60	130	25
Dichlorodifluoromethane (CFC 12)	75-71-8	88	44	0.5	0.42	0.22	63	114	25
Methylene Chloride	75-09-2	26	13	0.5	0.43	0.2	67	109	25
PCE	127-18-4	2.1	1.05	0.5	0.41	0.19	65	132	25
trans-1,2-DCE	156-60-5	26	13	0.5	0.42	0.24	68	126	25
TCE	79-01-6	6.1	3.05	0.5	0.41	0.21	66	120	25
Trichlorotrifluoroethane (CFC 113)	76-13-1	13000	6500	0.5	0.44	0.23	71	124	25
Vinyl Chloride	75-01-4	2.8	1.4	0.5	0.41	0.21	63	123	25

[1] PALs were developed to be protective of human health and the environment. Refer to **Worksheet #11** for a discussion on PAL development.
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
Adjusted RSLs are from the USEPA RSLs for Industrial Air, November 2010, adjusted for noncancerous effects by dividing RSLs based on noncancer by 10 to account for exposure to multiple constituents. Analytical data will be compared to the most recent version of the RSLs at the time that analytical data are available for use.
Per North Carolina regulations (15A NCAC 02L.0202 (b)(1)), when the regulatory standard for a particular constituent is less than the laboratory's practical quantitation limit (PQL), a concentration at or above the PQL constitutes a violation of the standard. The laboratory for this project is operating under DoD QSMV4.1 criteria and as such any detect at or above the LOQ constitutes a violation of the standard. Shading represents cases where the PAL is lower than the laboratory LOD.
CAS – Chemical Abstracts Service; PAL – Project Action Level; RSL – Regional Screening Level; PQL – Project Quantitation Limit; LOQ- Limit of Quantitation; LOD- Limit of Detection; DL – Detection Limit; LCS – Laboratory Control Sample ; RPD – Relative Percent Difference

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

Matrix: Subslab Vapor under Phase II
Analytical Group: cVOCs

Analyte	CAS Number	PAL[1]: Adjusted Industrial Air RSLs (µg/m^3)	PQL Goal[2] (µg/m^3)	Laboratory-specific			MS/MSD and LCS Recovery Limits		
				LOQ (µg/m^3)	LOD (µg/m^3)	DL (µg/m^3)	Lower Limit (%)	Upper Limit (%)	RPD (%)
1,1,1-TCA	71-55-6	22000	11000	0.5	0.42	0.19	71	123	25
1,1,2,2-PCA	79-34-5	2.1	1.05	0.5	0.4	0.2	80	126	25
1,1,2-TCA	79-00-5	7.7	3.85	0.5	0.42	0.24	76	122	25
1,1-DCA	75-34-3	77	38.5	0.5	0.43	0.2	67	124	25
1,1-DCE	75-35-4	880	440	0.5	0.44	0.3	71	121	25
1,2-DCA	107-06-2	4.7	2.35	0.5	0.43	0.21	64	125	25
Bromoform	75-25-2	110	55	0.5	0.43	0.21	73	150	25
Chloromethane	74-87-3	390	195	0.5	0.41	0.19	60	130	25
Dichlorodifluoromethane (CFC 12)	75-71-8	880	440	0.5	0.42	0.22	63	114	25
Methylene Chloride	75-09-2	260	130	0.5	0.43	0.2	67	109	25
PCE	127-18-4	21	10.5	0.5	0.41	0.19	65	132	25
trans-1,2-DCE	156-60-5	260	130	0.5	0.42	0.24	68	126	25
TCE	79-01-6	61	30.5	0.5	0.41	0.21	66	120	25
Trichlorotrifluoroethane (CFC 113)	76-13-1	130000	65000	0.5	0.44	0.23	71	124	25
Vinyl Chloride	75-01-4	28	14	0.5	0.41	0.21	63	123	25

[1] Refer to **Worksheet #11** for a discussion on PAL development
[2] PQL Goals were determined on a case by case basis and in most cases are at least two times less than the PAL.
Adjusted RSLs are from the USEPA RSLs for Industrial Air, November 2010, adjusted for noncancerous effects by dividing RSLs based on noncancer by 10 to account for exposure to multiple constituents. For subslab vapor samples, the RSLs were also adjusted using an attenuation factor of 0.1. Analytical data will be compared to the most recent version of the RSLs at the time that analytical data are available for use.
Per North Carolina regulations (15A NCAC 02L.0202 (b)(1)), when the regulatory standard for a particular constituent is less than the laboratory's practical quantitation limit (PQL), a concentration at or above the PQL constitutes a violation of the standard. The laboratory for this project is operating under DoD QSMV4.1 criteria and as such any detect at or above the LOQ constitutes a violation of the standard.
CAS – Chemical Abstracts Service; PAL – Project Action Level; RSL – Regional Screening Level; PQL – Project Quantitation Limit; LOQ- Limit of Quantitation; LOD- Limit of Detection; DL – Detection Limit; LCS – Laboratory Control Sample ; RPD – Relative Percent Difference

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SAP Worksheet #16—Project Schedule / Timeline Table

The field investigation activities are currently anticipated to occur in April 2011. A draft study report will be submitted to the Partnering Team for review 60 days after receipt of the validated analytical data. The following table presents a project schedule.

Activities	Dates (MM/DD/YY)		Deliverable
	Anticipated Date(s) of Initiation	Anticipated Date of Completion	
Utility Clearance	05/16/2011	05/20/11	Utility Clearance
Detailed Building Surveys	05/23/2011	05/25/2011	Building Survey
Vapor Sampling	05/26/2011	06/03/2011	Subslab soil gas, indoor air, and outdoor air samples
Laboratory analyses	06/03/2011	07/01/2011	Analytical Reports
Data Validation	07/05/2011	07/15/2011	Validated Data
Draft Phase II VI Report preparation	07/15/11	08/19/2011	Draft Phase II VI Report

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SAP Worksheet #17—Sampling Design and Rationale

The sampling design and rationale were developed using the ITRC and DoD VI guidance documents, and also from the Guidance for Performing Site Inspections Under CERCLA (Interim Final, USEPA, EPA/540-R-92-021, PB92-963375, September 1992). The following table presents a summary of the sampling design and rationale.

Buildings	Subslab Soil Gas Sample Quantity	Indoor Air Gas Sample Quantity	Reasoning
143	3	2	Elevated cVOC concentrations in Phase I exterior soil vapor on west side of building
4225	5	3	Elevated cVOC concentrations in Phase I exterior soil vapor on NE side of building
4224	4	2	Elevated cVOC concentrations in Phase I exterior soil vapor hydraulically upgradient of building
133	5 (existing); 4 (new)	5	Elevated cVOC concentrations in Phase I subslab soil gas; Address temporal variability at existing locations and spatial variability throughout building by addition of new locations
3402	3	2	Elevated cVOC concentrations in Phase I exterior soil vapor on north side of building
4026	2	2	Elevated cVOC concentrations in Phase I exterior soil vapor on north and south sides of building
4525	3	2	Elevated cVOC concentrations in Phase I subslab soil gas in NE section of Building 133; Building 4525 is connected to Building 133 via underground utilities that may act as preferential pathways for vapor migration
129	2	1	Elevated cVOC concentrations in Phase I subslab soil gas in NE section of Building 133; Building 4525 is connected to Building 133 via underground utilities that may act as preferential pathways for vapor migration
188	2	1	Elevated cVOC concentrations in Phase I subslab soil gas in NE section of Building 133; Building 4525 is connected to Building 133 via underground utilities that may act as preferential pathways for vapor migration
137	3 (existing); 6 (new)	6	Elevated cVOC concentrations in Phase I subslab soil gas; Address temporal variability at existing locations and spatial variability throughout building by addition of new locations
131	4	3	Elevated cVOC concentrations in Phase I exterior soil vapor on northwest side of Building 3997 that may indicate impacts beneath Building 131
3997	4	3	Elevated cVOC concentrations in Phase I exterior soil vapor on northwest side of building

SAP Worksheet #17—Sampling Design and Rationale (continued)

Each sampling point was located to evaluate the potential for soil vapor migration into overlying buildings. During field work, sampling locations will be modified as needed to limit the possibility of interferences from other sources (e.g., chemical use within buildings). The number and locations of sampling points were discussed and the Partnering Team and consensus was obtained. The proposed sampling locations are shown in **Figures 11** through **17**.

Subslab soil gas and indoor samples will be collected concurrently at Buildings 133, 137, 143, 4225, 4224, 3402, 4026, 3997, 4525, 129, 188, and 131to further evaluate the potential for vapor migration from cVOCs in the subsurface into the building, and to determine if indoor air concentrations are above target levels. Each sampling location is dependent on the size of the building and proximity to Phase I sampling locations with COPC exceedances. Five outdoor air samples will be collected at OU1 to assess the extent to which the measured indoor air concentrations are the result of outdoor sources.

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]
OU1-14SG01-MMYY OU1-14SG02-MMYY OU1-14SG03-MMYY	Subslab Gas	Immediately under slab	cVOCs	50 (plus 5 field duplicate)	*Standard Operating Procedure for Installing Subslab Probes and Collecting Subslab Soil Gas Samples Using SUMMA Canisters (2/09)*
OU1-16SG01-MMYY OU1-16SG02-MMYY OU1-16SG03-MMYY OU1-16SG04-MMYY OU1-16SG05-MMYY					
OU1-51SG01-MMYY OU1-51SG02-MMYY OU1-51SG02P-MMYY (duplicate) OU1-51SG03-MMYY OU1-51SG04-MMYY OU1-51SG05-MMYY OU1-51SG06-MMYY OU1-51SG07-MMYY OU1-51SG08-MMYY OU1-51SG09-MMYY					

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]
OU1-52SG01-MMYY OU1-52SG02-MMYY OU1-52SG02-MMYY OU1-52SG03-MMYY OU1-52SG03P-MMYY (duplicate) OU1-52SG04-MMYY OU1-52SG05-MMYY OU1-52SG06-MMYY OU1-52SG07-MMYY OU1-52SG08-MMYY OU1-52SG09-MMYY OU1-52SG10-MMYY OU1-52SG11-MMYY OU1-52SG12-MMYY OU1-52SG13-MMYY OU1-52SG13P-MMYY (duplicate) OU1-52SG14-MMYY OU1-52SG15-MMYY OU1-52SG16-MMYY OU1-52SG17-MMYY OU1-52SG18-MMYY OU1-52SG19-MMYY OU1-52SG20-MMYY OU1-52SG21-MMYY OU1-52SG22-MMYY OU1-52SG23-MMYY OU1-52SG23P-MMYY (duplicate) OU1-52SG24-MMYY OU1-52SG25-MMYY	Subslab Gas	Immediately under slab	cVOCs	50 (plus 5 field duplicate)	*Standard Operating Procedure for Installing Subslab Probes and Collecting Subslab Soil Gas Samples Using SUMMA Canisters (2/09)*

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]
OU1-74SG01-MMYY OU1-74SG02-MMYY OU1-74SG03-MMYY OU1-74SG04-MMYY OU1-74SG05-MMYY OU1-74SG06-MMYY OU1-74SG07-MMYY OU1-74SG08-MMYY OU1-74SG08P-MMYY (duplicate)	Subslab Gas	Immediately under slab	cVOCs	50 (plus 5 field duplicate)	*Standard Operating Procedure for Installing Subslab Probes and Collecting Subslab Soil Gas Samples Using SUMMA Canisters (2/09)*
OU1-14IA01-MMYY OU1-14IA02-MMYY	Indoor Air	3 – 5 ft above ground surface	cVOCs	32 (plus 4 field duplicate)	*Integrated Ambient Indoor, Outdoor, and Crawl Space Air Sampling Method for Trace VOCs Using SUMMA Canisters (6/08)*
OU1-16IA01-MMYY OU1-16IA02-MMYY OU1-16IA03-MMYY					
OU1-51IA01-MMYY OU1-51IA02-MMYY OU1-51IA03-MMYY OU1-51IA04-MMYY OU1-51IA05-MMYY OU1-51IA05P-MMYY (duplicate) OU1-51IA06-MMYY					

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]
OU1-52IA01-MMYY OU1-52IA02-MMYY OU1-52IA03-MMYY OU1-52IA04-MMYY OU1-52IA05-MMYY OU1-52IA06-MMYY OU1-52IA07-MMYY OU1-52IA08-MMYY OU1-52IA09-MMYY OU1-52IA09P-MMYY (duplicate) OU1-52IA10-MMYY OU1-52IA11-MMYY OU1-52IA12-MMYY OU1-52IA13-MMYY OU1-52IA14-MMYY OU1-52IA15-MMYY OU1-52IA15P-MMYY(duplicate)	Indoor Air	3 – 5 ft above ground surface	cVOCs	32 (plus 4 field duplicate)	*Integrated Ambient Indoor, Outdoor, and Crawl Space Air Sampling Method for Trace VOCs Using SUMMA Canisters (6/08)*
OU1-74IA01-MMYY OU1-74IA02-MMYY OU1-74IA03-MMYY OU1-74IA04-MMYY OU1-74IA05-MMYY OU1-74IA06-MMYY OU1-74IA06P-MMYY (duplicate)					

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]
OU1-14OA01-MMYY OU1-16OA01-MMYY OU1-51OA01-MMYY OU1-52OA01-MMYY OU1-74OA01-MMYY OU1-74OA01P-MMYY (duplicate)	Outdoor Air	3 – 5 ft above ground surface	cVOCs	5 (plus 1 field duplicate)	*Integrated Ambient Indoor, Outdoor, and Crawl Space Air Sampling Method for Trace VOCs Using SUMMA Canisters (6/08)*

[1]SOPSOP or worksheet listed in **Worksheet #21** that describes the sample collection procedures.
All samples will be named in accordance with sample nomenclature scheme included in **Appendix C**.
MMYY – 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 (Number, Size, and Type)	Sample Volume	Preservation Requirements (Chemical, Temperature, Light Protected)	Maximum Holding Time (Preparation/Analysis)[2]
Subslab Soil Gas	VOCs	TO-15	1-1 Liter SUMMA Can	Not applicable (NA)	NA	30 Days
Indoor/Outdoor Air		TO-15	1 – 6 Liter SUMMA Can	Not applicable (NA)	NA	30 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 validated time of sample receipt [VTSR])

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SAP Worksheet #20—Field Quality Control Sample Summary Table

Site	Matrix	Analytical Group	No. of Sampling Locations	No. of Field Duplicates	Total No. of Samples to Lab
Phase II	Outdoor Air	Select cVOCs	5	1	6
Phase II	Subslab Soil Gas	Select cVOCs	50	5	55
Phase II	Indoor Air	Select cVOCs	32	4	36

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

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

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SAP Worksheet #21—Project Sampling SOP References Table

Reference Number	Title, Revision Date and / or Number	Review Date If No Revision Necessary	Originating Organization of Sampling SOP	Equipment Type	Modified for Project Work? (Y/N)	Comments
Utility Clearance	*Locating and Clearing Underground Utilities (1/08)*	1/17/2011	CH2M HILL	NA	N	
Building Surveys	*Conducting Building Surveys for Vapor Intrusion Evaluation (11/09)*	1/17/2011	CH2M HILL	NA	N	
Ambient Air Sampling	*Integrated Ambient Indoor, Outdoor, and Crawl Space Air Sampling Method for Trace VOCs Using SUMMA Canisters (6/08)*	1/17/2011	CH2M HILL	SUMMA canisters	N	
Subslab Soil Gas Sampling	*Standard Operating Procedure for Installing Subslab Probes and Collecting Subslab Soil Gas Samples Using SUMMA Canisters (2/09)*	1/17/2011	CH2M HILL	SUMMA canisters	N	
Decontamination	*Decontamination of Personnel and Equipment (1/1999)*	3/2010	CH2M HILL	NA	Y	Using Methanol to decontaminate stainless steel sample probe unions
HSE-411	*Waste Management: Non-Hazardous Waste, 10/12/07*	1/17/2011	CH2M HILL	Container labels, waste containers,	N	

Field SOPs are included in **Appendix B.**

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

Field Equipment	Activity	Frequency	Acceptance Criteria	CA	Resp. Person	SOP Reference[1]	Comments
Dielectric MGD2000 Helium Detector	Inspection	Daily before use and when unstable readings occur	Helium reads 100%	Change out humidity filter	FTL	NA	
Vacuum Pump	Inspection	Daily before use	Pressure gauge on manifold reads 0 “Hg when pumping	Verify pump is set at accurate flow; wiring is not frayed; pumping and exhausting in correct flow direction	FTL	NA	
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.	FTL	MiniRAE 2000 Manufacturer’s Instructions	Activities are described in the MiniRAE 2000 Manufacturer’s Instructions, provided in **Appendix C**

[1]Standard 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)
VOA-TO15 _Rev.18	*Determination of Volatile Organic Compounds in Air Samples Collected in Specially Prepared Canisters and Gas Collection Bags and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS); Revision 18, 12/22/10*	Definitive	Air	GC / MS	CAS	N
SMO-SMPL_REC Rev 10	*Sample Receiving, Acceptance, and Log-in; Revision 10; 6/25/10*	NA	NA	NA		

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SAP Worksheet #24—Analytical Instrument Calibration Table

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	CA	Person Responsible for CA	SOP Reference
Gas Chromatograph (GC)/Mass Spectrometer (MS)	BFB Tuning Verification	Once every 24hours or analytical batch	Ion abundance criteria as described in Table 3 of Method TO-15	1) Repeat BFB analysis 2) Retune instrument	Analyst, Dept. Supervisor	VOA-TO15 _Rev.18
GC/MS	Initial Calibration (ICAL) – minimum of five levels	Initially or if continuing calibration no longer meets criteria	1) <30% Relative standard deviation (RSD) with two exceptions up to 40%	1) May repeat 1 point (if 5 levels) or 2 points (if 6 levels)	Analyst, Dept. Supervisor	VOA-TO15 _Rev.18
			2) Area response at each calibration level within 40% of IS mean area response over the ICAL range.	2) Inspect the system for problems and perform required maintenance		
			3) Retention time for each IS within 20s of the mean retention time over the ICAL range.	3) Repeat initial calibration. Problem must be corrected. Samples may not be analyzed until there is a valid ICAL.		
GC/MS	Initial Calibration Verification (ICV)	Following every ICAL	Percent difference of +/-30%	Correct problem and verify second source standard. Rerun second source verification. If that fails, correct problem and repeat initial calibration. Problem must be corrected. Samples may not be analyzed until there is a valid ICV.	Analyst, Dept. Supervisor	VOA-TO15 _Rev.18
GC/MS	Continuing Calibration Verification (CCV)	Once every 24 hours, if an ICAL has not been performed (within the last 24 hours).	Percent difference of +/-30% Note: If CCV is biased high and analyte is ND (not detected) results are acceptable. It will be noted in case narrative.	1) Reanalyze CCV 2) Identify and correct problem; re-analyze or if necessary qualify the data. 3) Repeat initial calibration if CCV CA is unsuccessful.	Analyst, Dept. Supervisor	VOA-TO15 _Rev.18
GC/MS	Internal Standards (IS)	All samples, duplicates, blanks and standards	1) RT must be <20 sec from most recent valid calibration (ICAL midpoint or CCV)	1) Identify and correct the problem	Analyst, Dept. Supervisor	VOA-TO15 _Rev.18
			2) Area response +/-40% of IS area response of most recent valid calibration (ICAL midpoint or CCV)	2) Reanalyze the sample unless obvious matrix interference exists.		
				3) Problem persists, qualify data.		

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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	CA	Responsible Person	SOP Reference
GC/MS	Concentrating Trap	NA	NA	Routine maintenance includes periodic solvent cleaning	Worksheet #24	Worksheet #24	Analyst	VOA-TO15 _Rev.18
GC/MS	Column Performance	NA	NA	Monitored by observing both peak shapes and column bleed.	Worksheet #24	Worksheet #24	Analyst	VOA-TO15 _Rev.18
GC/MS	Vacuum System	NA	NA	Every 6 months, including changing the pump oil and checking the molecular sieve in the backstreaming trap.	Worksheet #24	Worksheet #24	Analyst	VOA-TO15 _Rev.18

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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 B of this SAP.
Sample Packaging (Personnel/Organization): Project Field Team, FTL/CH2M HILL. Field SOPs are in Appendix B of this SAP.
Coordination of Shipment (Personnel/Organization): FTL/CH2M HILL
Type of Shipment/Carrier: FedEx Express Saver
SAMPLE RECEIPT AND ANALYSIS
Sample Receipt (Personnel/Organization): CAS
Sample Custody and Storage (Personnel/Organization): CAS
Sample Preparation (Personnel/Organization): CAS (TO 15 VOCs)
Sample Determinative Analysis (Personnel/Organization): TO 15 VOCs Analyst/CAS, VOCs Department Manager/ CAS
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): NA
SAMPLE DISPOSAL
Personnel/Organization: CAS
Number of Days from Analysis: After submission, the laboratory will keep samples 90 days and the sample extracts for a minimum of 60 days.

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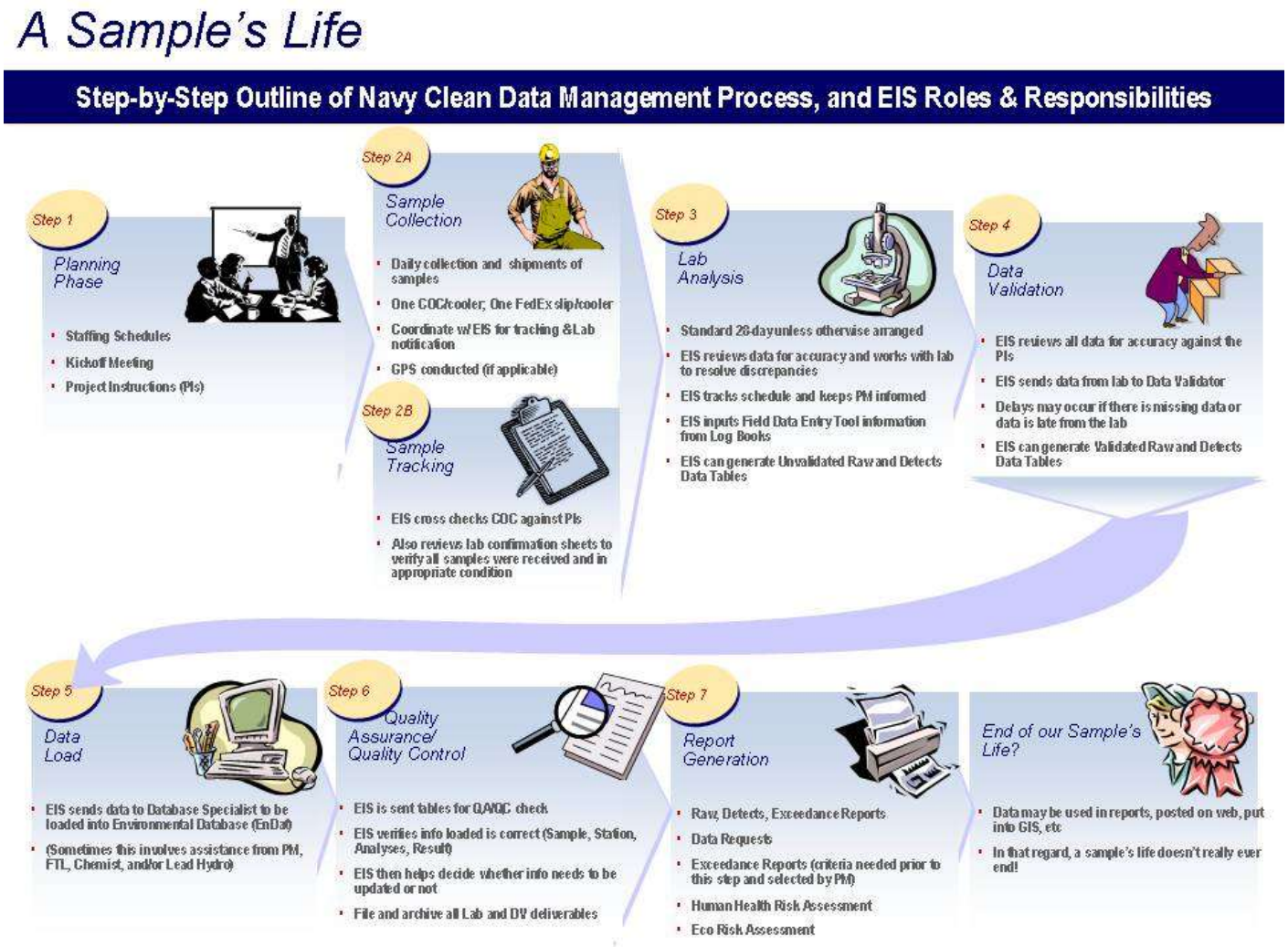
SAP Worksheet #26-2—Sample Handling Flow Diagram, Navy CLEAN Data Management Process



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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. SUMMA canister tags will be updated with initial and final pressure, final data collected, start and end times, and sampler initials. SUMMA canisters will be placed back in the boxes they were shipped to the site in and cushioned with packing material originally included in boxes provided. A chain-of-custody record unique to each sample shipment box will be placed inside the shipment box. Boxes will be taped up and shipped to the laboratories via Fed Ex Express Saver (3 day), with the air bill number indicated on the chain-of-custody record (to relinquish custody). Upon delivery, the laboratory will log in each SUMMA canister 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 CAS.
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 C of this SAP: SMO-SMPL_REC Rev 10
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 on the chain of custody record. 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 records 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 record will document the 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—Laboratory QC Samples Table

Method Performance Criteria are in compliance with DoD QSM version 4.1

Matrix	Air
Analytical Group	Volatile Organics
Analytical Method/SOP Reference	TO-15 / VOA-TO15 _Rev.18

QC Sample:	Frequency/Number	Method/SOP QC Acceptance Limits	CA	Person(s) Responsible for CA	DQI	Measurement Performance Criteria
Method blank	Once every analytical batch of 20 or fewer samples	No analytes > ½ LOQ and >1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater); common lab contaminants none detected > LOQ and >1/10 the amount measured in any sample. Blank results must not otherwise affect sample results.	1) Reanalyze blank 2) Identify and correct problem. Refer to criteria in Box D-1 of DoD QSM v. 4.1 3) Reanalyze blank and affected samples 4) Qualify data. Apply B flag to all results for the specific analytes in all samples in the associated batch.	Analyst	Contamination / Bias	No analytes > ½ LOQ and >1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater); common lab contaminants none detected > LOQ and >1/10 the amount measured in any sample. Blank results must not otherwise affect sample results.
Laboratory control sample	Once every analytical batch of 20 or fewer samples	See **Worksheets #15-1 to #15-2**	1) Reanalyze the LCS and all samples in the associated batch for failed analytes, if sufficient sample is available. 2) Identify and correct the problem. Refer to Appendix G of DoD QSM v.4.1 3) Qualify data and explain in case narrative. Apply flag to specific analytes in all samples in the batch	Analyst	Accuracy / Bias	**Worksheets #15-1 to #15-2**
Internal Standards (IS)	All samples, duplicates, blanks and standards	1) RT must be <20 sec from most recent valid calibration (ICAL midpoint or CCV) 2) Area response +/-40% of IS area response of most recent valid calibration (ICAL midpoint or CCV)	1) Identify and correct the problem. Inspect instrumentation for malfunctions. 2) Reanalyze the sample unless obvious matrix interference exists. 3) If corrective action fails, qualify data and narrate.	Analyst, Dept. Supervisor	Accuracy	1) RT must be <20 sec from most recent valid calibration (ICAL midpoint or CCV) 2) Area response +/-40% of IS area response of most recent valid calibration (ICAL midpoint or CCV)
Surrogate Standards	All samples, duplicates, blanks and standards	70-130% recovery	1) Identify and correct the problem. Inspect instrumentation for malfunctions. 2) Reanalyze the sample unless obvious matrix interference exists 3) If corrective action fails, qualify data and narrate	Analyst, Dept. Supervisor	Accuracy/Bias	70-130% recovery
Laboratory Duplicate (LD)	Once every analytical batch of 20 or fewer samples	RPD within +/-25% for positive hits	1) Analyze third aliquot 2) Flag data if third aliquot unacceptable	Analyst, Dept. Supervisor	Precision	RPD within +/-25% for positive hits

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SAP Worksheet #29—Project Documents and Records Table

Document	Where Maintained
• Field Notebooks • Air Bills • Custody Seals • CA 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 Records, and Tracking Records • Standard Traceability Logs • Equipment Calibration Logs • Sample Prep Logs • Run Logs • Equipment Maintenance, Testing, and Inspection Logs • 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 • CA Forms • Laboratory QA Plan • MDL Study Information • Waste disposal records such as IWTP disposal chit, waste manifests, waste profiles, weigh tickets, certificate of disposal, Treatment, Storage, and Disposal Facility (TSDF) permit, landfill permit, and CERCLA disposal letter	• Field data deliverables such as logbook entries, chain–of-custody records, air bills, EDDs, etc. will be kept on CH2M HILL's local network internet server. • Field parameter data will be loaded with the analytical data intoCH2M HILL Data Warehouse. • 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 CH2M HILL Data Warehouse. • Following project completion, hardcopy deliverables such as logbooks, chain-of-custody records, raw data, data validation reports, etc. will be archived indefinitely at Iron Mountain (see address below).

In general, hardcopy documents are stored at a CH2M HILL project office until they are archived.

CH2M HILL Project Office:
Keri Hallberg/CH2M HILL
11301 Carmel Commons Blvd. Suite 304
Charlotte, NC 28226
(704) 543-3260

Archival Location:
Iron Mountain Records Management
4555 Progress Road
Norfolk, VA 23502

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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
Subslab soil gas	cVOCs	Worksheet #18	TO-15	28 calendar days	CAS Valley Kate Aguilera 2655 Park Center Drive, Ste. A Simi Valley, California 93065 805.526.7161	TBD [1]
Indoor Air/ Outdoor Air			TO-15			

[1] A backup laboratory has not been identified. If circumstances render the subcontracted laboratory unable to perform analytical services, another laboratory will be identified 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
Third Party Laboratory Technical Systems Audit	Laboratories must have current DoD ELAP accreditation which will identify the period of performance.	External	Third party accrediting body	TBD, Third party accrediting body	CAS's Quality Assurance Program Manager, Chaney Humphrey	Chaney Humphrey	Program Chemist-Anita Dodson-CH2M HILL

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SAP Worksheet #32-1—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 from third party accrediting body	CAS Quality Assurance Program Manager, Chaney Humphrey	Within 2 months of audit	Memorandum	Third Party Auditor, TBD	Within 2 months of receipt of initial notification.

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SAP Worksheet #32-2—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

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SAP Worksheet #33—Quality Assurance Management Reports Table

Type of Report	Frequency	Projected Delivery Date	Person Responsible for Report Preparation	Report Recipient(s)
Site Investigation Report	Post-Field Event	Spring 2011	Keri Hallberg/CH2M HILL	Stakeholders (**Worksheet #4**)

The Site Investigation Report will address the following:

- Summary of project QA/QC requirements/procedures
- Conformance of project to SAP requirements/procedures
- Status of project schedule
- Deviations from the SAP and amendments that were approved
- Results of data review activities (how much usable data was generated)
- CAs if needed and their effectiveness
- Data usability with regard 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
Chain-of-custody and Shipping Forms	Chain-of-custody and shipping forms will be reviewed internally upon their completion and verified against the packed sample coolers they represent. The shipper's signature on the chain-of-custody record be initialed by the reviewer, a copy of the chain-of-custody record retained in the site file, and the original and remaining copies taped inside the cooler for shipment. See Chain-of-Custody SOP (**Appendix D**) for further details.	Internal	FTL CH2M HILL
Planning Documents	Evidence of approval and completeness of SAP.	Internal	Keri Hallberg CH2M HILL
Field Logbooks	Field notes will be reviewed to ensure completeness of field data parameters, shipping information, sample collection times, etc. The logbooks will also be used to document, explain, and justify all deviations from the approved SAP.	Internal	Keri Hallberg CH2M HILL
QC Summary Report	A summary of all QC sample results will be verified for completeness once the data are received from the laboratory.	External	Victoria Brynildsen CH2M HILL
Laboratory Data	All laboratory data packages will be verified internally by the laboratory performing the work for completeness and technical accuracy prior to submittal. All received data packages will be examined by an EIS and a Chemist according to the procedures specified in the Navy CLEAN Data Management Plan in **Appendix C**.	Internal/ External	CAS employees Keri Hallberg(CH2M HILL) Vickie Brynildsen (CH2M HILL) Juan Acaron (CH2M HILL)
Chain–of-Custody Documentation	Upon their arrival at the laboratory, the samples will be cross-referenced against the chain-of-custody records. All sample labels will be checked against the chain-of-custody record, 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	CAS employees

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

Step IIa/IIb*	Validation Input	Description	Responsible for Validation (name, organization)
IIa	SOPs	Review field logbooks, laboratory case narratives, data deliverables for compliance to methods and signatures.	FTL, Keri Hallberg CH2M HILL CAS employees
IIa	Method QC Results	Verify that all QC samples were run and compliant with method-required limits as specified in **Worksheet #12**.	Ward Dickens CH2M HILL
IIb	SAP QC Results	Verify that QC samples were run and compliant with limits established in the SAP.	Juan Acaron CH2M HILL Ward Dickens CH2M HILL
IIb	PQLs	Verify that all sample results met the project quantification and action limits specified in **Worksheet #15.**	Keri Hallberg, Juan Acaron CH2M HILL
IIb	Raw data	10% review of raw data to confirm laboratory calculations.	Ward Dickens CH2M HILL

[1]IIa= 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	Subslab Soil Gas,Indoor/Outdoor Air	cVOCs	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 *National Functional Guidelines for Organic Data Review, (October 1999).* 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.	Ward Dickens, CH2M HILL
IIb			See PALs in **Worksheet #15.** See Method calibration and QC criteria in **Worksheets #24** and **#28**.	Juan Acaron and Keri Hallberg 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 are considered usable.
- During verification and validation steps, data may be qualified as estimated with the following qualifiers: J or UJ. 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 are 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
  - R- Rejected result. Result not reliable.
- Additional qualifiers that may be given by the validator are:
  - E- 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. Presumed to be 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 have been uploaded into the electronic database, another check will be performed to ensure that 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 CA 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 DQI.
- If significant biases are detected with laboratory QA/QC samples they will be evaluated to assess the 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 the 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 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 COCs. Data qualifiers will be reflected in the tables and discussed in the data quality evaluation.
- A data quality evaluation considering all of the above will be provided as part of presentations to the Tier I Partnering Team, followed by a technical memorandum prepared to assess remedy effectiveness. The technical memorandum will identify any data usability limitations and make recommendations for CA if necessary.

Identify the personnel responsible for performing the usability assessment.

The CH2M HILL Team, including the PM and PC, 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

CH2M HILL. 2004. *Final Master Field Sampling Plan for Marine Corps Air Station Cherry Point, North Carolina*. November.

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CH2M HILL. 2009b. *Final OU1 VI Sampling and Analysis Plan for Marine Corps Air Station Cherry Point*. North Carolina. August

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Fitzpatrick, N. and J. Fitzgerald. 2002. *An Evaluation of Vapor Intrusion into Buildings through a Study of Field Data*. Soil and Sediment Contamination, 11(4):603-623.

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TetraTech NUS, Inc. 2002a. *Final Remedial Investigation Report for Operable Unit 1 (OU 1)*. Marine Corps Air Station, Cherry Point, North Carolina. November.

USEPA. 1994. *Guidance for the Data Quality Objectives Process.* (QA/G4). EPA/600/R-96/055. Office of Research and Development.

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

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

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Figures

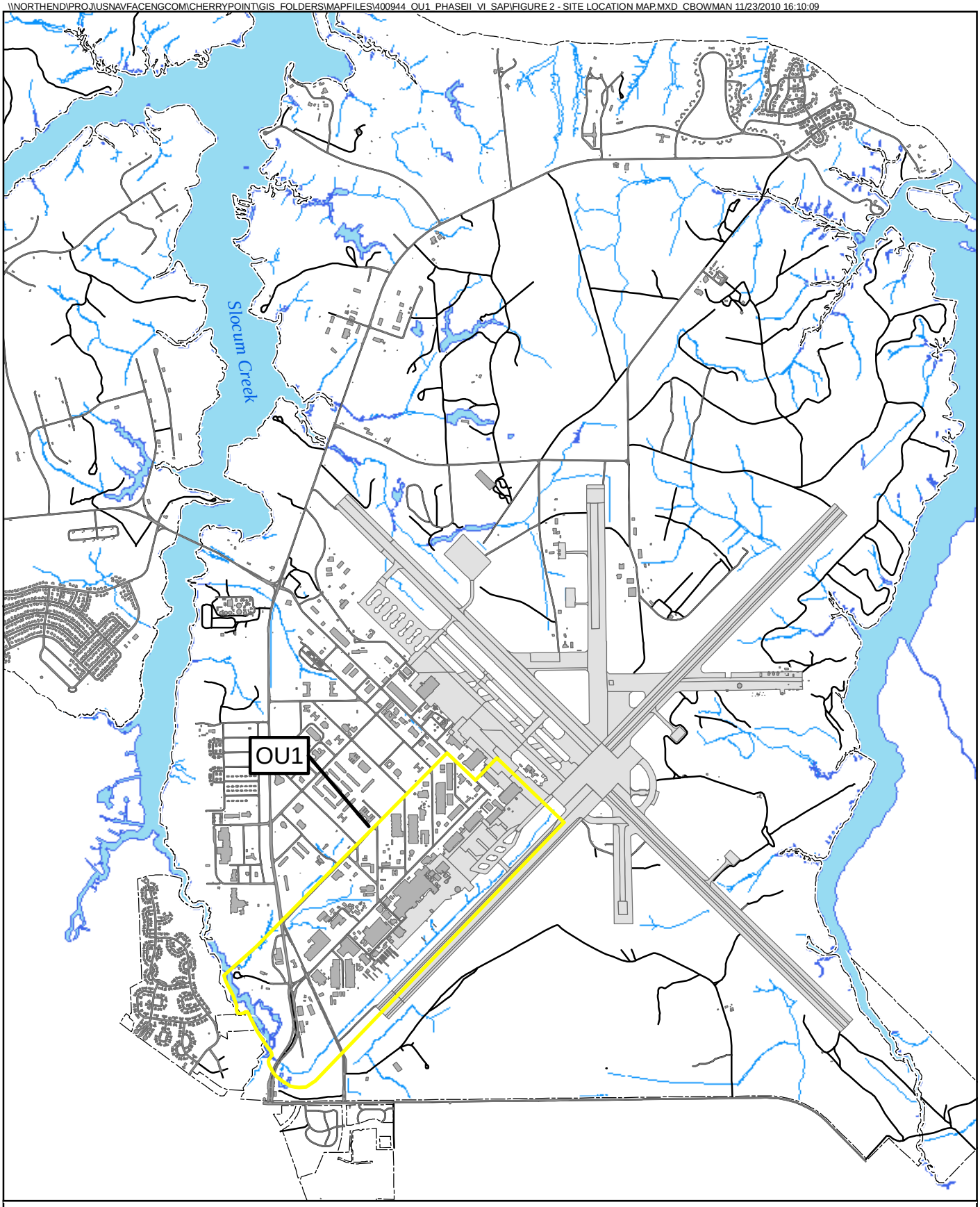
Legend
- Cities
- Rivers and Streams
- Military Installation
- County Boundary

N
W E
S

0 20,000 40,000
Feet

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

CH2MHILL



Legend

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

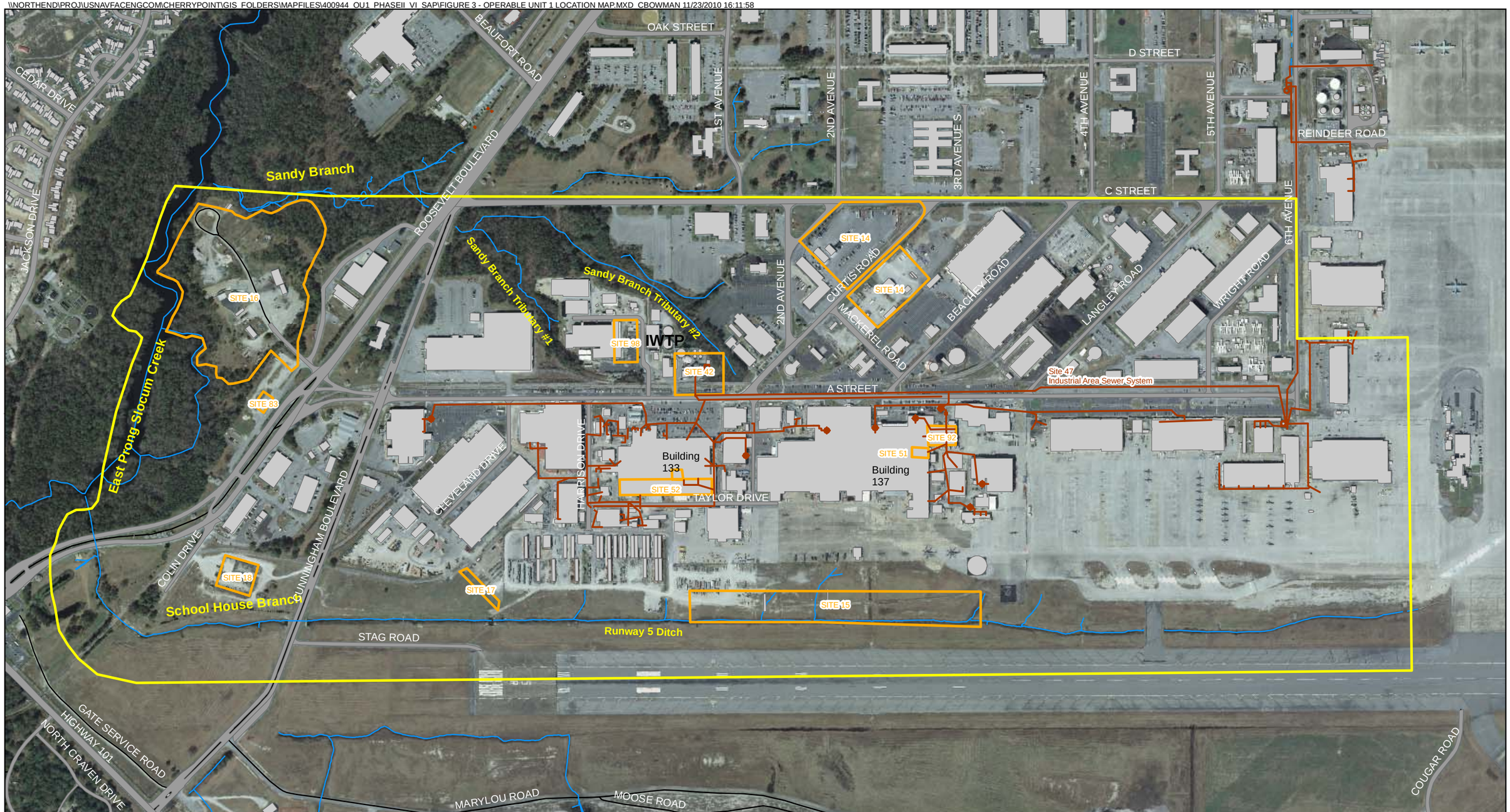
N
W E
S

0 1,500 3,000
Feet

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

CH2MHILL.

\\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_OU1_PHASEII_VI_SAP\FIGURE 3 - OPERABLE UNIT 1 LOCATION MAP.MXD CBOWMAN 11/23/2010 16:11:58



Legend

- Surface Water
- Industrial Area Sewer System
- Site Boundary
- OU1 Boundary
- Existing Buildings

IWTP - Industrial Wastewater Treatment Plant

N W E S

0 600 1,200 Feet

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

CH2MHILL.

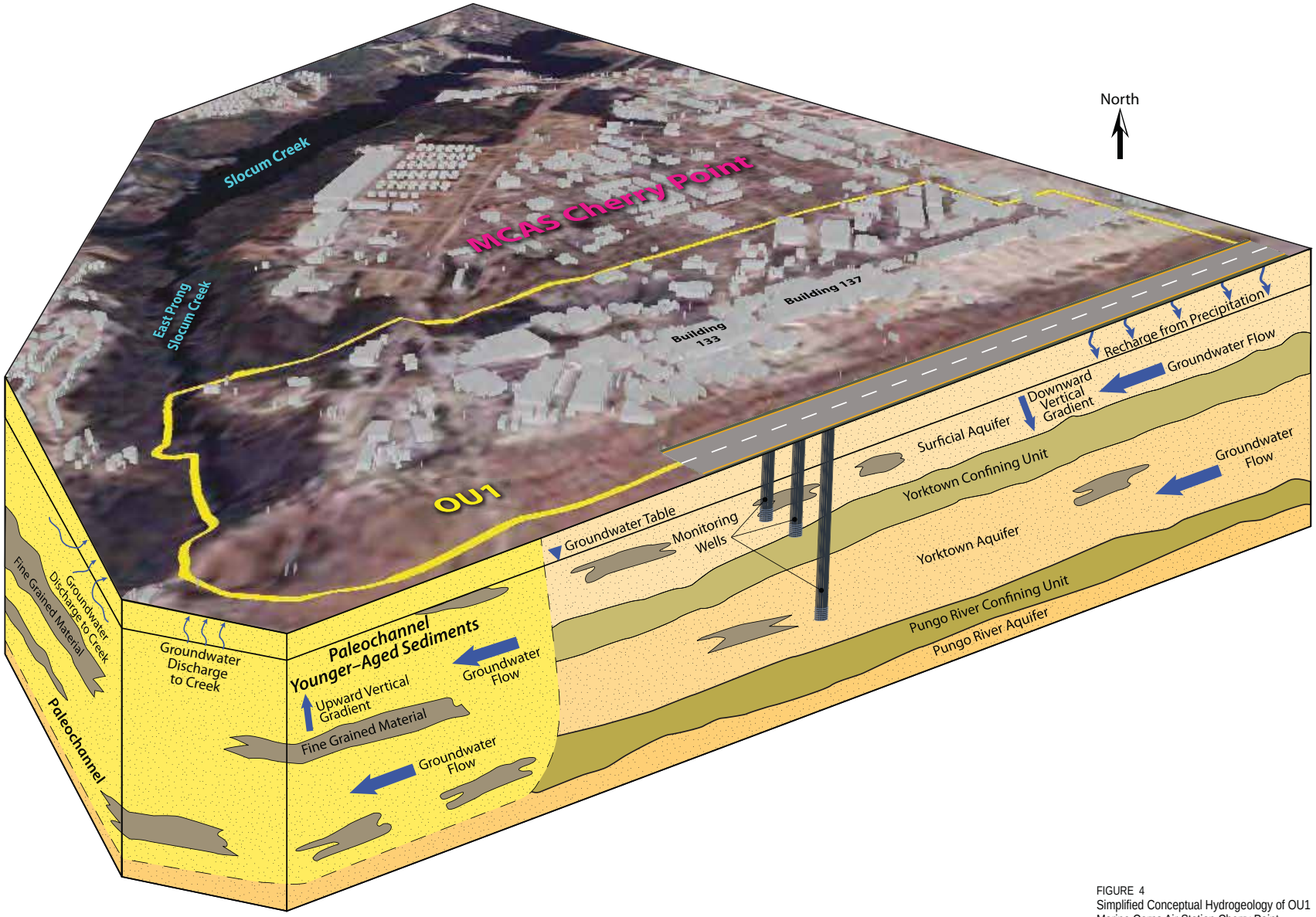


FIGURE 4
Simplified Conceptual Hydrogeology of OU1
Marine Corps Air Station Cherry Point
Cherry Point, NC

CH2MHILL

ES012008006MKE Cherry_Point_3D_Hydrogeology_OU1_v11 03.10.08 cae

\\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_OU1_PHASEII_VI_SAP\FIGURE 5 - TCE - UPPER AQUIFER.MXD CBOWMAN 11/23/2010 17:05:53

Legend

- Extraction Well
- Monitoring Well - Upper Aquifer
- Surface Water
- OU1 Boundary
- Existing Buildings
- 3 - 30 µg/L
- 30 - 300 µg/L
- 300 - 3,000 µg/L
- 3,000 - 11,000 µg/L
- > 11,000 µg/L

IWTP - Industrial Wastewater Treatment Plant

Notes:
NC2L - North Carolina Groundwater Standard
NC2L = 3 µg/L (Jan 2010)
NU = Not Used
Concentrations are from the Spring 2009 sampling event
µg/L = micrograms per liter
U - analyte not detected above detection limit
J - concentration is estimated

N W E S

0 600 1,200 Feet

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

CH2MHILL.

\\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_OU1_PHASEII_VI_SAP\FIGURE 6 - 1_2_DCE - UPPER AQUIFER.MXD CBOWMAN 11/23/2010 17:06:25

Legend

- Extraction Well
- Monitoring Well
- Surface Water
- OU1 Boundary
- Existing Buildings
- 70 - 700 µg/L
- 700 - 7,000 µg/L

Notes:
NC2L - North Carolina Groundwater Standard
NC2L = 70 µg/L (Jan 2010)
NU = Not Used
Concentrations are from the Spring 2009 sampling event
µg/L = micrograms per liter
U - analyte not detected above detection limit
J - concentration is estimated

N W E S

0 600 1,200 Feet

Figure 6
1,2-Dichloroethene (1,2-DCE) Isoconcentration Map
Upper Surficial Aquifer
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL.

IWTP - Industrial Wastewater Treatment Plant

\\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_OU1_PHASEII_VI_SAP\FIGURE 7 - VC - UPPER AQUIFER.MXD CBOWMAN 11/23/2010 17:07:03

Legend

- Extraction Well
- Monitoring Well - Upper Aquifer
- Surface Water
- OU1 Boundary
- Existing Buildings
- 0.03 - 30 µg/L
- 30 - 300 µg/L
- 300 - 3,000 µg/L

Notes:
NC2L - North Carolina Groundwater Standard
NC2L = 0.03 µg/L (Jan 2010)
NU = Not Used
Concentrations are from the Spring 2009 sampling event
µg/L = micrograms per liter
U - analyte not detected above detection limit
J - concentration is estimated

N W E S

0 600 1,200 Feet

Figure 7
Vinyl Chloride Isoconcentration Map
Upper Surficial Aquifer
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL.

IWTP - Industrial Wastewater Treatment Plant

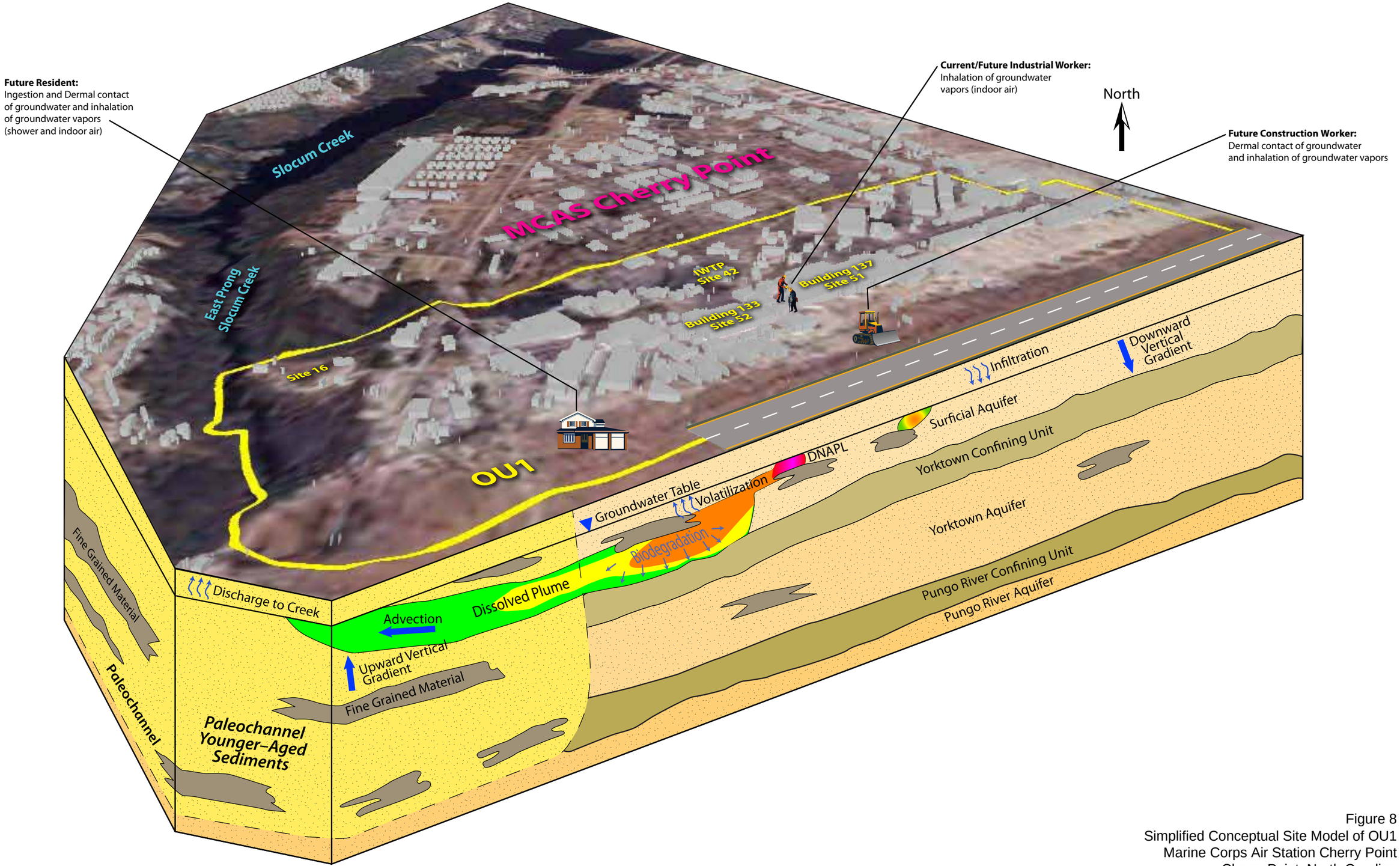
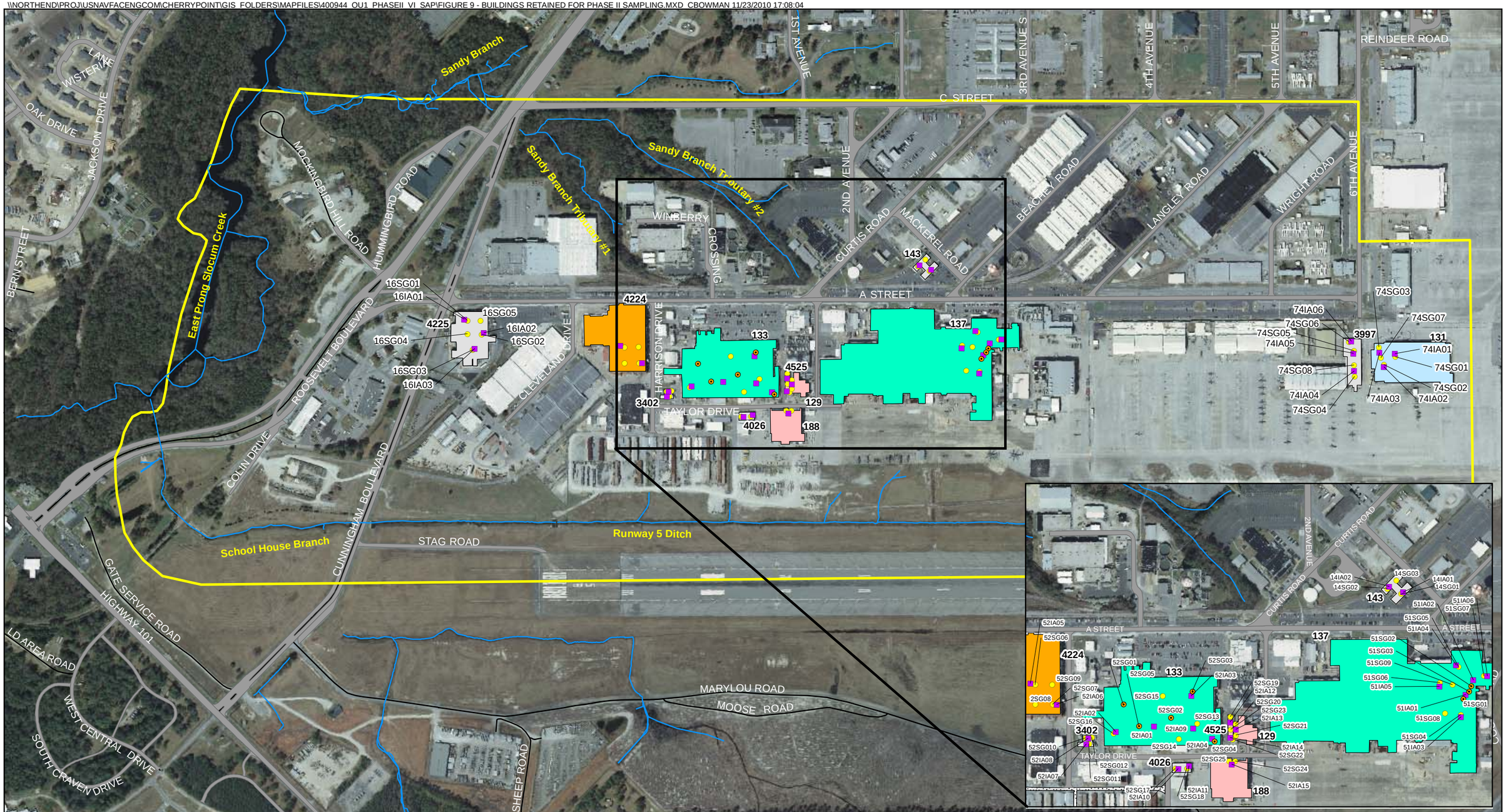


Figure 8
Simplified Conceptual Site Model of OU1
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_OU1_PHASEII_VI_SAP\FIGURE 9 - BUILDINGS RETAINED FOR PHASE II SAMPLING.MXD CBOWMAN 11/23/2010 17:08:04



Legend

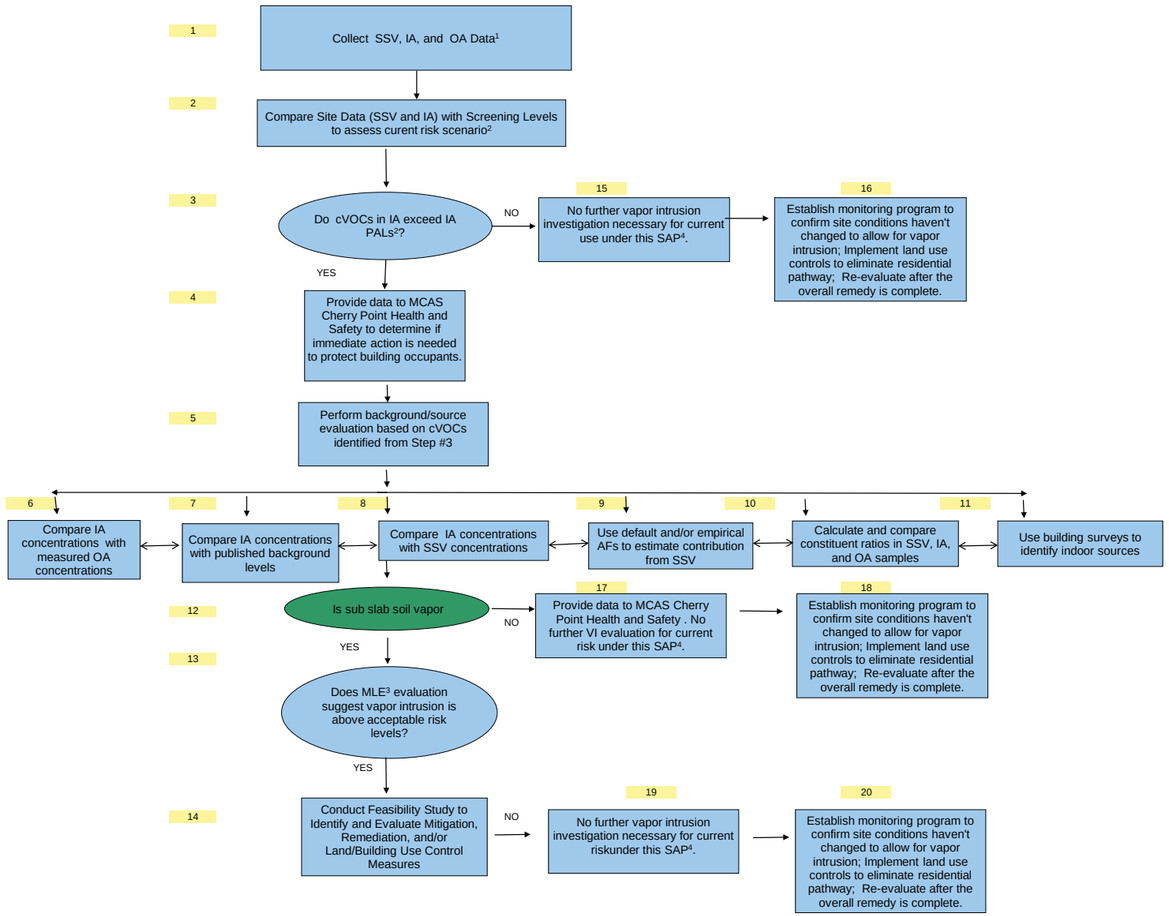
- Existing Subslab Sample Locations
- Proposed Indoor Air Sample Location
- Proposed Sub Slab Soil Gas Sample Location
- Surface Water
- OU1 Boundary
- Buildings with exterior soil vapor concentrations exceeding SVSLs (Soil Vapor Screening Levels)
- Buildings with subslab soil vapor concentrations exceeding SVSLs
- Buildings hydraulically down gradient of soil vapor concentrations exceeding SVSLs
- Buildings within 200 ft. of exterior soil vapor concentrations exceeding SVSLs with no previous soil vapor samples collected
- Buildings retained for sampling due to preferential pathway analysis

N S E

0 300 600 1,200 Feet

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

CH2MHILL

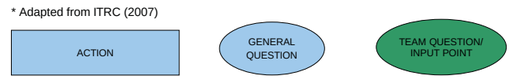


Notes:

1 - SSV sample: subslab soil vapor samples collected immediately under the building foundation; IA sample: indoor air sample collected within the building; OA sample: outdoor air sample collected outside of a building with an associated IA sample.
2 -Industrial soil gas screening levels - Project Action Levels (PAL) for the carcinogenic COCs are the USEPA Regional Screening Levels (indoor air, industrial) multiplied by 10, based on the conservative attenuation factor of 0.1, for which shallow (subslab) soil vapor is conservatively assumed to intrude into indoor air spaces. SG PALs for the non-carcinogenic COCs are the USEPA Regional Screening Levels (indoor air, industrial) adjusted by a Hazard Quotient of 0.1 (divided by 10) to account for additive effects and multiplied by 10 in order to adjust for a conservative attenuation factor of 0.1. IA PALs for carcinogenic COCs are the USEPA Regional Screening Levels (RSLs) and for non-carcinogenic COCs are the USEPA RSL adjusted by a Hazard Quotient of 0.1 (divided by 10) to account for additive effects.

3 - Lines of evidence may include: tracer compounds to develop building specific attenuation factors, constituent ratios within each sample (SSV Ratio, IA Ratio, Upwind OA Ratio, Near-building AA Ratio), national background levels for indoor air, national background levels for outdoor air, magnitude of exceedance of RSL in comparison to IA/OA concentrations, building survey information.
4 - Additional SSV/IA samples may be needed further evaluate vapor intrusion pathway, temporal and spatial variability, and/or to assess the potential for future risk.

* Adapted from ITRC (2007)



Acronyms:

cVOC - chlorinated volatile organic compound
SSV - subslab soil vapor
IA - indoor air
OA - outdoor air
MLE - mulitple lines of evidence
PALs - Project Action Levels
SAP - Sampling and Analysis Plan

NMCPHC - Navy and Marine Corps Public Health Center
PAL - Project Action Limit
SAP - Sampling and Analysis Plan
SG - subslab soil vapor
TAT - turn-around-time

Figure 10
Data Evaluation Strategy
Decision Tree
OU1
MCAS Cherry Point,
North Carolina

\\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_OU1_PHASEII_VI_SAP\FIGURE 11 - BUILDINGS 143_09_PROPOSED_LOCS.MXD CBOWMAN 11/23/2010 17:08:47

OU1-14NS02-5-6-09D	
COPC	Concentration ($\mu g/m^3$)
1,1,2,2-PCA	16

COPC	Shallow (≤ 6 ft) Soil Vapor SL (µg/m3)
1,1,2,2-PCA	2

Legend

- Proposed Indoor Air Sample Location
- Proposed Sub Slab Soil Gas Sample Location
- Near Slab Soil Gas Sample Location
- Sub Slab Soil Gas Sample Location
- Temporary Well Location
- 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
- General Groundwater Flow Direction

Notes:
U - The material was analyzed for but not detected
µg/m3 - Micrograms per Cubic Meter of Air
Bold indicates the analyte was detected
Shading indicates the analyte result exceeded the SL
COPC - constituent of potential concern
cVOC - chlorinated volatile organic compound
SL - screening level
Analytical Results from November 2009

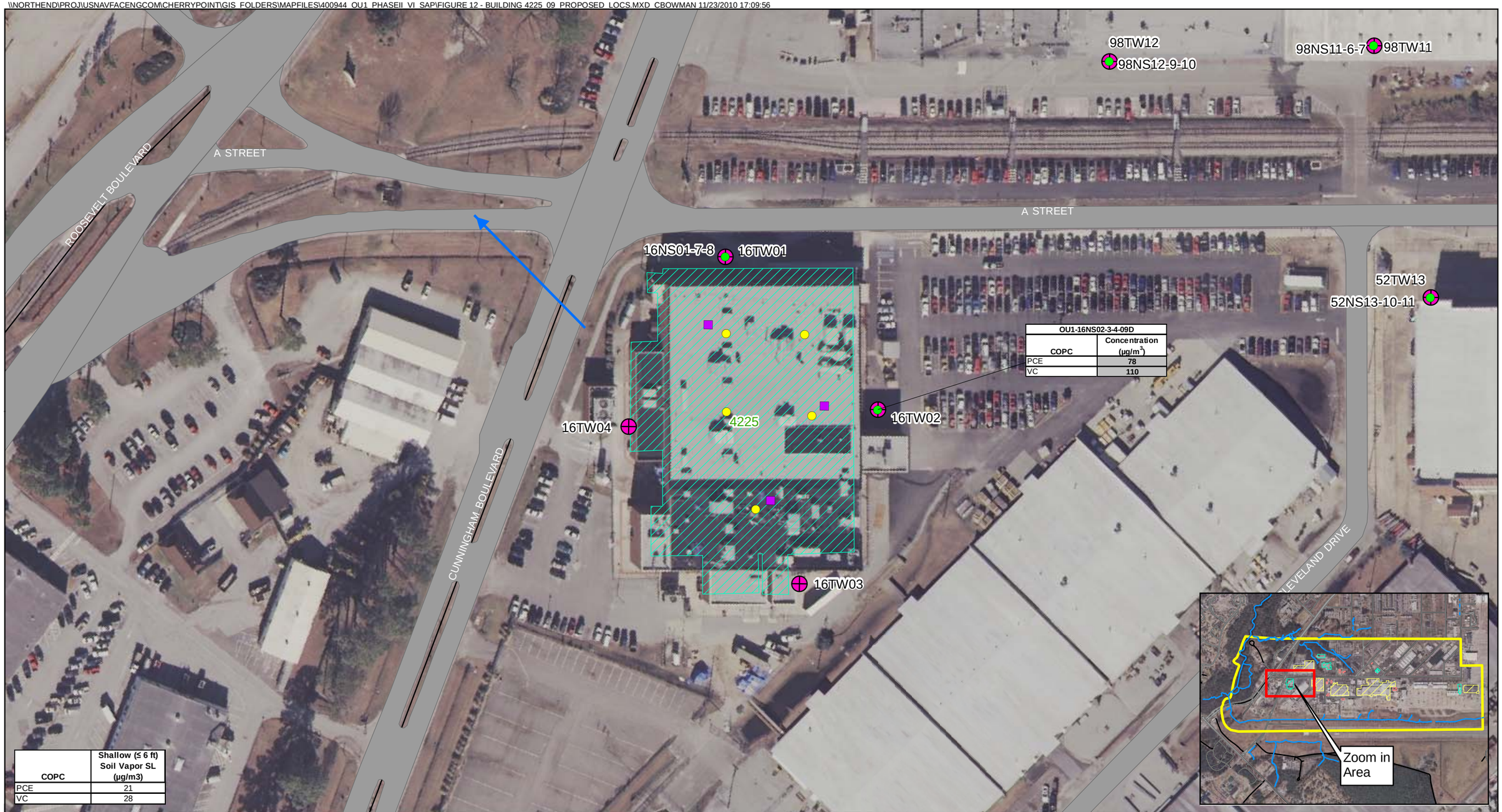
N E S W

0 100 200 Feet

Figure 11
Buildings 143
Proposed Sampling Locations
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL.

\\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_OU1_PHASEII_VI_SAP\FIGURE 12 - BUILDING 4225_09_PROPOSED_LOCS.MXD CBOWMAN 11/23/2010 17:09:56



OU1-16NS02-3-4-09D	
COPC	Concentration (µg/m³)
PCE	78
VC	110

COPC	Shallow (≤ 6 ft) Soil Vapor SL (µg/m3)
PCE	21
VC	28

Legend

- Proposed Indoor Air Sample Location
- Proposed Sub Slab Soil Gas Sample Location
- Near Slab Soil Gas Sample Location
- Sub Slab Soil Gas Sample Location
- Temporary Well Location
- 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
- General Groundwater Flow Direction

Notes:
U - analyte analyzed for but not detected
µg/m3 - Micrograms per Cubic Meter of Air
BOLD indicates the analyte was detected
Shading indicates the analyte result exceeded the SL
COPC - constituent of potential concern
cVOC - chlorinated volatile organic compound
SL - screening level
Analytical Results from November 2009

N W E S

0 100 200 Feet

Figure 12
Building 4225
Proposed Sampling Locations
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL.

\\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_OU1_PHASEII_VI_SAP\FIGURE 13 - BUILDING 4224_09_PROPOSED_LOCS.MXD CBOWMAN 11/23/2010 17:10:25

OU1-52TW11-09D	
COPC	Concentration (ug/L)
VC	4.5

OU1-52NS11-6-7-09D	
COPC	Concentration (µg/m^3)
VC	7,200

COPC	GWSL (ug/L)
VC	2.7

COPC	Deep (> 6 ft) Soil Vapor SL (µg/m3)
VC	280

COPC	Shallow (≤ 6 ft) Soil Vapor SL (µg/m3)
Chloromethane	390
PCE	21
trans-1,2-DCE	260
TCE	61

Legend

- Proposed Indoor Air Sample Location
- Proposed Sub Slab Soil Gas Sample Location
- Near Slab Soil Gas Sample Location
- Sub Slab Soil Gas Sample Location
- Temporary Well Location
- Surface Water
- General Groundwater Flow Direction
- 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
- OU1 Boundary

Notes:
U - The material was analyzed for but not detected
µg/m3 - Micrograms per Cubic Meter of Air
BOLD indicates the analyte was detected
Shading indicates the analyte result exceeded the SL
COPC - constituent of potential concern
cVOC - chlorinated volatile organic compound
SL - screening level
Analytical Results from November 2009

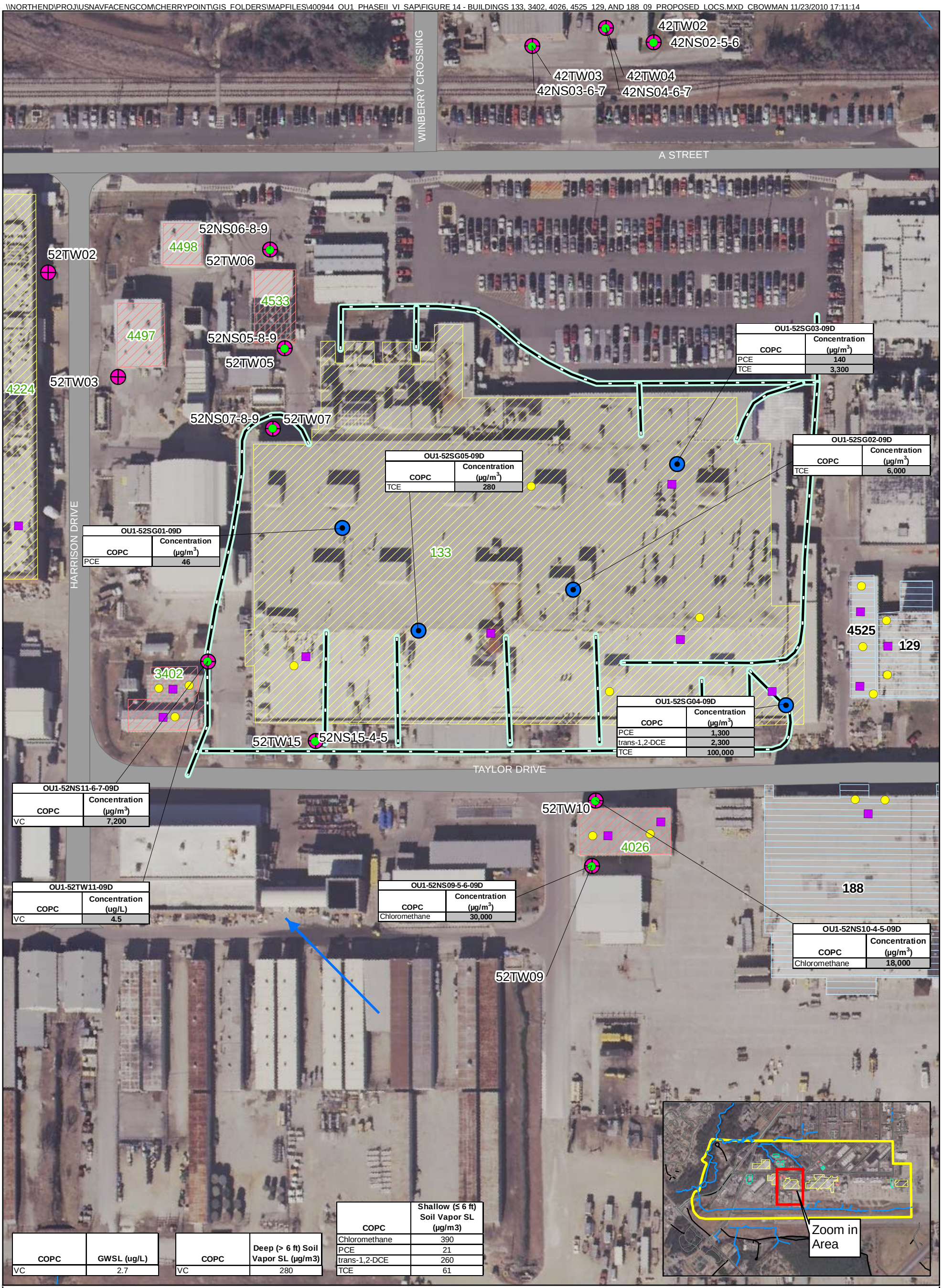
W N S E

0 50 100 Feet

CH2MHILL.

Figure 13
Building 4224
Proposed Sampling Locations
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

\\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_OU1_PHASEII_VI_SAP\FIGURE 14 - BUILDINGS 133, 3402, 4026, 4525_129, AND 188_09_PROPOSED_LOCS.MXD CBOWMAN 11/23/2010 17:11:14



OU1-52SG03-09D	
COPC	Concentration (µg/m³)
PCE	140
TCE	3,300

OU1-52SG02-09D	
COPC	Concentration (µg/m³)
TCE	6,000

OU1-52SG05-09D	
COPC	Concentration (µg/m³)
TCE	280

OU1-52SG01-09D	
COPC	Concentration (µg/m³)
PCE	46

OU1-52SG04-09D	
COPC	Concentration (µg/m³)
PCE	1,300
trans-1,2-DCE	2,300
TCE	100,000

OU1-52NS11-6-7-09D	
COPC	Concentration (µg/m³)
VC	7,200

OU1-52TW11-09D	
COPC	Concentration (ug/L)
VC	4.5

OU1-52NS09-5-6-09D	
COPC	Concentration (µg/m³)
Chloromethane	30,000

OU1-52NS10-4-5-09D	
COPC	Concentration (µg/m³)
Chloromethane	18,000

COPC	GWSL (ug/L)
VC	2.7

COPC	Deep (> 6 ft) Soil Vapor SL (µg/m3)
VC	280

COPC	Shallow (≤ 6 ft) Soil Vapor SL (µg/m3)
Chloromethane	390
PCE	21
trans-1,2-DCE	260
TCE	61

Legend

- Proposed Indoor Air Sample Location
- Proposed Sub Slab Soil Gas Sample Location
- Near Slab Soil Gas Sample Location
- Sub Slab Soil Gas Sample Location
- Temporary Well Location
- Surface Water
- Buildings recommended for sampling due to preferential pathway analysis
- General Groundwater Flow Direction
- Conceptual Locations of 1940s storm drainage
- 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
- OU1 Boundary

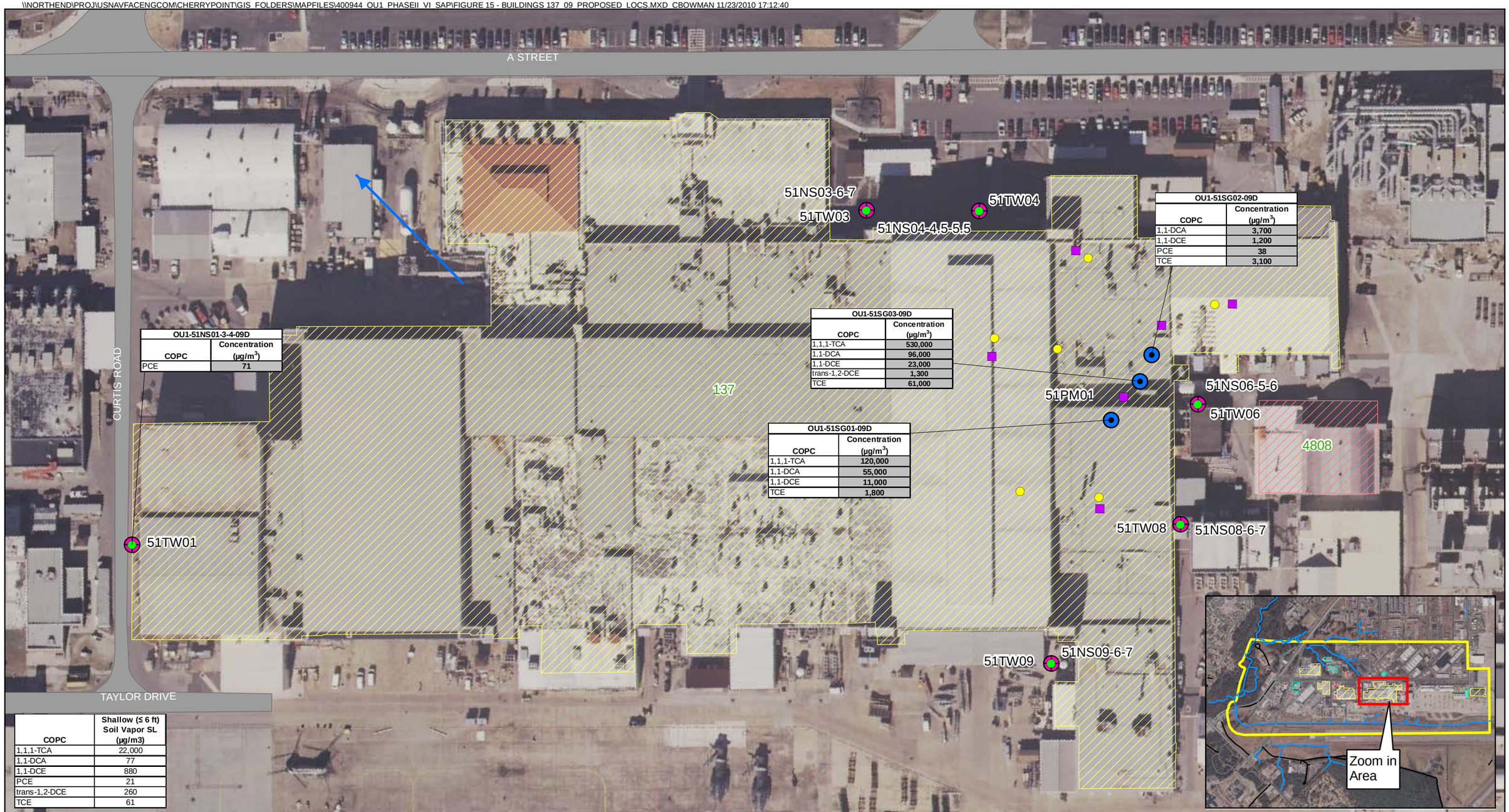
Notes:
U - analyte analyzed for but not detected
J - Analyte present but value estimated
µg/m3 - Micrograms per Cubic Meter of Air
BOLD indicates the analyte was detected
Shading indicates the analyte result exceeded the SL
COPC - constituent of potential concern
cVOC - chlorinated volatile organic compound
SL - screening level
Analytical Results from November 2009

Figure 14
Buildings 133, 3402, 4026, 4525/129, & 188
Proposed Sampling Locations
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

0 50 100 Feet

CH2MHILL

\\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_OU1_PHASEII_VI_SAP\FIGURE 15 - BUILDINGS 137_09_PROPOSED_LOCS.MXD CBOWMAN 11/23/2010 17:12:40



OU1-51NS01-3-4-09D	
COPC	Concentration (µg/m^3)
PCE	71

OU1-51SG03-09D	
COPC	Concentration (µg/m^3)
1,1,1-TCA	530,000
1,1-DCA	96,000
1,1-DCE	23,000
trans-1,2-DCE	1,300
TCE	61,000

OU1-51SG01-09D	
COPC	Concentration (µg/m^3)
1,1,1-TCA	120,000
1,1-DCA	55,000
1,1-DCE	11,000
TCE	1,800

OU1-51SG02-09D	
COPC	Concentration (µg/m^3)
1,1-DCA	3,700
1,1-DCE	1,200
PCE	38
TCE	3,100

COPC	Shallow (≤ 6 ft) Soil Vapor SL (µg/m3)
1,1,1-TCA	22,000
1,1-DCA	77
1,1-DCE	880
PCE	21
trans-1,2-DCE	260
TCE	61

Legend

- Proposed Indoor Air Sample Location
- Proposed Sub Slab Soil Gas Sample Location
- Near Slab Soil Gas Sample Location
- Sub Slab Soil Gas Sample Location
- Temporary Well Location
- 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
- General Groundwater Flow Direction

Notes:
U - The material was analyzed for but not detected
µg/m3 - Micrograms per Cubic Meter of Air
Bold indicates the analyte was detected
Shading indicates the analyte result exceeded the SL
COPC - constituent of potential concern
cVOC - chlorinated volatile organic compound
SL - screening level
Analytical Results from November 2009

N W E S

0 100 200 Feet

Figure 15
Buildings 137
Proposed Sampling Locations
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL.

\\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_OU1_PHASEII_VI_SAP\FIGURE 16 - BUILDINGS 131 & 3997_09_PROPOSED_LOCS.MXD CBOWMAN 11/23/2010 17:15:08

OU1-74NS02-6-7-09D	
COPC	Concentration (µg/m3)
Freon-113	**11,000,000**
1,1-DCA	**140,000**
1,1-DCE	**9,900**

OU1-74TW02-09D	
COPC	Concentration (µg/L)
1,1-DCA	**210**

COPC	GWSL (ug/L)
1,1-DCA	39

COPC	Deep (> 6 ft) Soil Vapor SL (µg/m3)
Freon-113	1,300,000
1,1-DCA	770
1,1-DCE	8,800

Legend

- Proposed Indoor Air Sample Location
- Proposed Sub Slab Soil Gas Sample Location
- Near Slab Soil Gas Sample Location
- Sub Slab Soil Gas Sample Location
- Temporary Well Location
- 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
- General Groundwater Flow Direction

Notes:
U - The material was analyzed for but not detected
µg/m3 - Micrograms per Cubic Meter of Air
Bold indicates the analyte was detected
Shading indicates the analyte result exceeded the SL
COPC - constituent of potential concern
cVOC - chlorinated volatile organic compound
SL - screening level
Analytical Results from November 2009

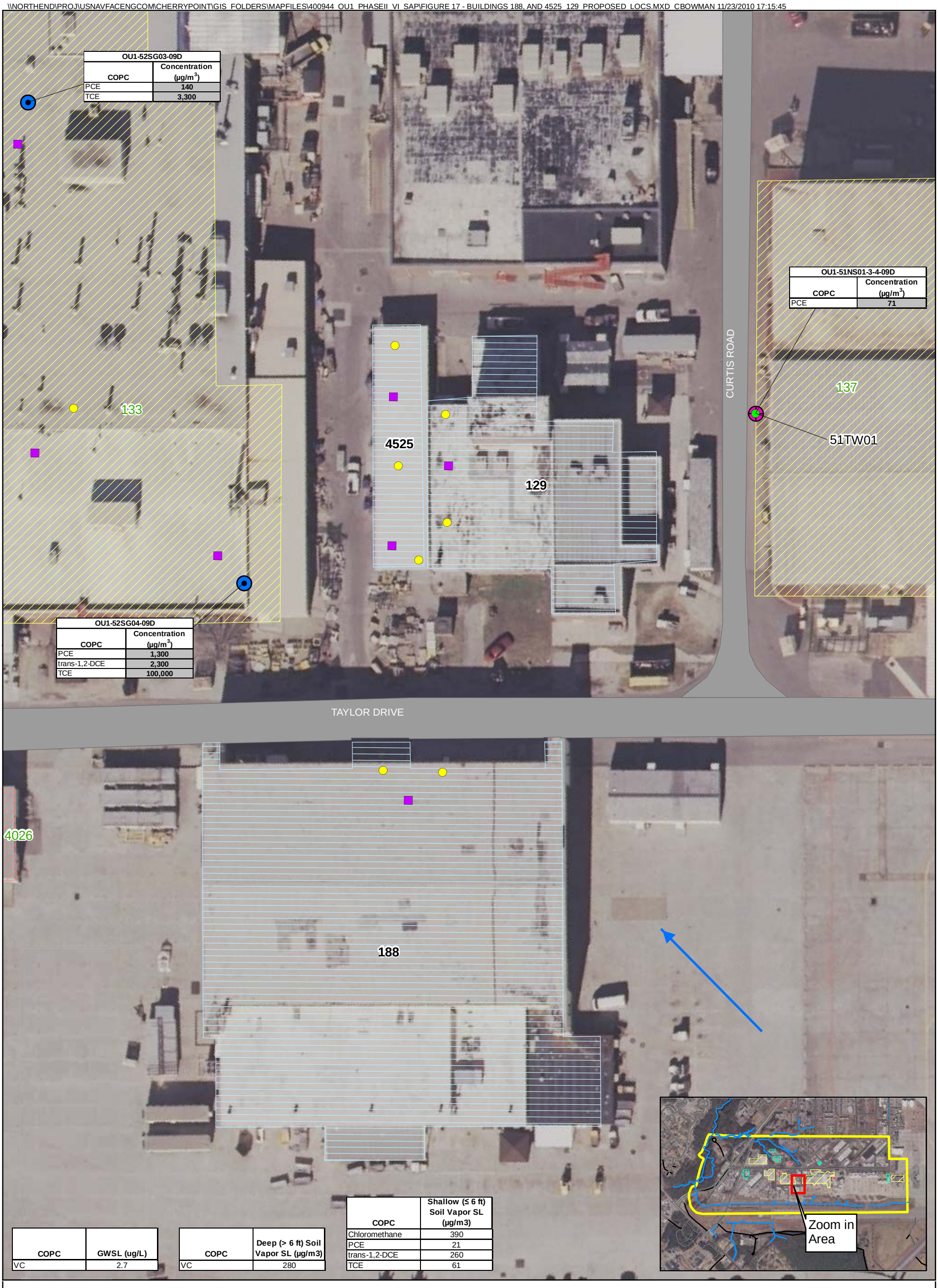
N W E S

0 100 200 Feet

Figure 16
Buildings 131 & 3997
Proposed Sampling Locations
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina

CH2MHILL.

\\NORTHEND\PROJ\USNAVFACENGCOM\CHERRYPOINT\GIS_FOLDERS\MAPFILES\400944_OU1_PHASEII_VI_SAP\FIGURE 17 - BUILDINGS 188, AND 4525_129_PROPOSED_LOCS.MXD CBOWMAN 11/23/2010 17:15:45



OU1-52SG03-09D	
COPC	Concentration (µg/m³)
PCE	140
TCE	3,300

OU1-52SG04-09D	
COPC	Concentration (µg/m³)
PCE	1,300
trans-1,2-DCE	2,300
TCE	100,000

OU1-51NS01-3-4-09D	
COPC	Concentration (µg/m³)
PCE	71

COPC	GWSL (ug/L)
VC	2.7

COPC	Deep (> 6 ft) Soil Vapor SL (µg/m3)
VC	280

COPC	Shallow (≤ 6 ft) Soil Vapor SL (µg/m3)
Chloromethane	390
PCE	21
trans-1,2-DCE	260
TCE	61

Legend

- Proposed Indoor Air Sample Location
- Proposed Sub Slab Soil Gas Sample Location
- Near Slab Soil Gas Sample Location
- Sub Slab Soil Gas Sample Location
- Temporary Well Location
- Surface Water
- General Groundwater Flow Direction
- OU1 Boundary
- Buildings recommended for sampling due to preferential pathway analysis
- 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

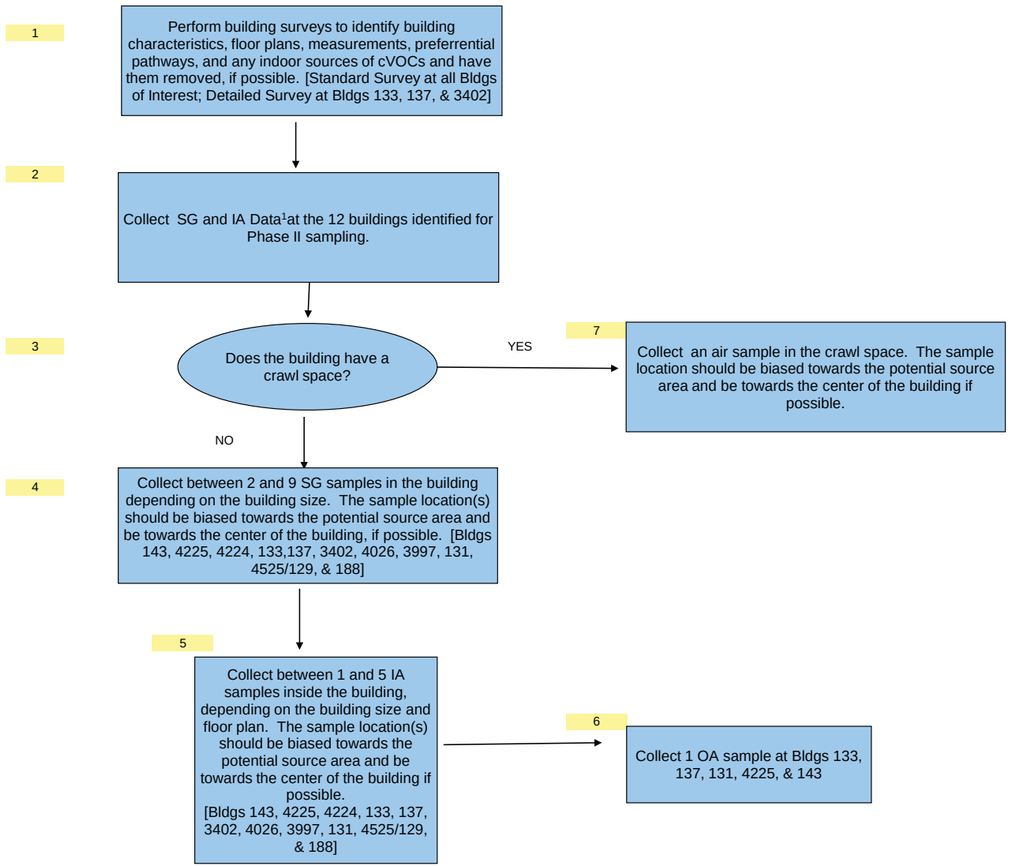
Notes:
U - analyte analyzed for but not detected
J - Analyte present but value estimated
µg/m3 - Micrograms per Cubic Meter of Air
BOLD indicates the analyte was detected
Shading indicates the analyte result exceeded the SL
COPC - constituent of potential concern
cVOC - chlorinated volatile organic compound
SL - screening level
Analytical Results from November 2009

N W E S

0 25 50 Feet

CH2MHILL

Figure 17
Buildings 4525/129 & 188
Proposed Sampling Locations
Marine Corps Air Station Cherry Point
Cherry Point, North Carolina



Notes:

1 - SG sample: subslab soil gas samples collected immediately under the building foundation; IA sample: indoor air sample collected within the building; OA sample: outdoor air sample
2 -Industrial soil gas screening levels - Project Action Levels (PAL) for the carcinogenic COCs are the USEPA Regional Screening Levels (indoor air, industrial) multiplied by 10, based on
3 - Lines of evidence may include: tracer compounds to develop building specific attenuation factors, constituent ratios within each sample (SSV Ratio, IA Ratio, Upwind OA Ratio, Near-
4 - Additional SG/IA samples may be needed post remedial action to monitor remedy effectiveness.
5 - Lines of Evidence may include: Constituent ratios within each sample (GW ratio [considering vaporization potential of COCs], IA Ratio, Upwind OA Ratio, Near-building OA Ratio),

ACTION

GENERAL

Acronyms:

OA - outdoor air
SG - subslab soil gas
IA - indoor air

Figure 18
Field Sampling Strategy
Decision Tree
OU1
MCAS Cherry Point,
North Carolina

Appendix A
Health and Safety Plan

Health and Safety Plan
Vapor Intrusion Investigation
Operable Unit

Marine Corps Air Station
Cherry Point, North Carolina

Contract No. N62470-02-D-3052
Contract Task Order – 097
Revision No. 01

January 2011

Submitted to:

Department of the Navy
Naval Facilities Engineering Command
Mid-Atlantic

Prepared by:

CH2MHILL

Virginia Beach, Virginia

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4 Project H&S Forms/Permits
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6 Chemical-Specific Training Form and Project-Specific Chemical Product Hazard Communication Form
7 Activity Hazard Analyses (AHAs)
8 Pre-Task Safety Plan (PTSP)
9 Loss Prevention Observation (LPO) Form
10 Incident Report Form
Loss/Near Loss Incident Report Form
11 Emergency Contact List
12 Hurricane Preparedness Plan

Acronyms and Abbreviations

AHA	Activity Hazard Analysis
APP	Accident Prevention Plan
BBLPS	Behavior Based Loss Prevention System
CFR	Code of Federal Regulation
CIH	Certified Industrial Hygienist
CLEAN	Comprehensive Long-Term Environmental Action
COC	chemical of concern; constituent of concern; contaminant of concern
CPR	cardiopulmonary resuscitation
CRZ	contamination reduction zone
CS	Core Standards
CSE	Confined Space Entry
DCE	dichloroethene
DEET	N-diethyl-meta-polyamide
DFWP	Drug Free Workplace Program
DOT	U.S. Department of Transportation
DPT	Direct Push Technology
EZ	exclusion zone
FTL	Field Team Leader
GFCI	ground fault circuit interrupters
H&S	Health and Safety
HAZWOPER	Hazardous Waste Operations
HBV	Hepatitis B virus
HITS	Hours & Incident Tracking System
HIV	Human Immunodeficiency Virus
HPP	Hurricane Preparedness Plan
HR	heart rate
HS&E	Health, Safety, and Environment

HSM	health and safety manager
HSP	Health and Safety Plan
IRF	Incident Report Form
IWTP	Industrial Wastewater Treatment Plant
LPO	Loss Prevention Observation
MSDS	material safety data sheet
NAVFAC	Naval Facilities Engineering Command
OEL	Occupational Exposure Limit
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
PID	Photo Ionization Detector
PPE	personal protective equipment
PTSP	Pre-Task Safety Plan
RF	radio frequency
SOP	Standard Operating Procedure
SSC	Site Safety Coordinator
SSHO	Site Safety and Health Officer
SVE	soil vapor extraction
SWO	Stop Work Order
TCE	trichloroethene
TSCA	Toxic Substances Control Act
UL	Underwriters Laboratory
VOC	volatile organic compound

SECTION 1

Introduction

CH2M HILL has been contracted by the United States Navy, Naval Facilities Engineering Command (NAVFAC), to conduct a vapor intrusion investigation at Operable Unit (OU1) located within MCAS Cherry Point, North Carolina. This Health and Safety Plan (HSP) was prepared under the Navy Comprehensive Long-Term Environmental Action (CLEAN) III Contract N62470-02-D-3052, Contract Task Order 0177.

This HSP will be kept on the site during field activities and will be reviewed as necessary. The plan will be amended or revised as project activities or conditions change or when supplemental information becomes available. The plan adopts, by reference, the Enterprise-wide Core Standards (CS) and Standard Operating Procedures (SOPs), as appropriate. In addition, this plan adopts procedures in the project Work Plan. The Safety Coordinator is to be familiar with the CSs and SOPs and the contents of these instructions. CH2M HILL 's personnel and subcontractors must be trained on this plan and sign the Employee Signoff Form (**Attachment 1**).

The Accident Prevention Plan (APP) for this investigation is included in **Attachment 2** of this HSP. This HSP and APP shall be collectively referenced as the HSP throughout, but implemented together as a single document in their entirety.

The vapor intrusion investigation will be conducted in accordance with the document titled *Final Sampling and Analysis Plan, Vapor Intrusion Investigation Phase II, Operable Unit 1* (CH2M HILL , 2009).

1.1 Site Background

OU1 is an industrial area within the southern portion of MCAS Cherry Point that covers approximately 565 acres. 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. OU1 includes the Fleet Readiness Center East, 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 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 volatile organic compound (VOC) groundwater contamination at OU1.

1.1.1 Release History

Chlorinated VOC groundwater contamination consists primarily of trichloroethene (TCE), 1,2-dichloroethene (DCE), and vinyl chloride within the surficial aquifer at OU1. The potential

sources of the groundwater contamination, from most upgradient to downgradient, include Site 51 (Building 137), Site 42 (Industrial Wastewater Treatment Plant), and Site 52 (Building 13).

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 17,000 and 1,900 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 and Sandy Branch.

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 plume is believed to mix with the larger groundwater plume emanating from Building 133, and discharges at Sandy Branch.

1.1.2 Receptors

As part of the OU1 RI Addendum, a Human Health Risk Assessment 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. Potential receptors that may be exposed to OU1 vapor intrusion include current and future industrial workers and future unrestricted use receptors.

1.2 General Task Order Scope of Work

The objective of this 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. Eleven buildings were retained as buildings of interest for this investigation.

The investigation will consist of the collection of co-located groundwater and near-slab soil vapor samples, subslab soil vapor samples, and indoor and outdoor air samples adjacent to or within buildings of interest. Groundwater/near-slab soil vapor samples will be collected within 5 to 15 feet (laterally) of buildings of interest and will consist of a groundwater sample collected within the top 5 feet below the water table and a near-slab soil vapor sample collected 1 to 2 feet above the water table. Subslab soil vapor samples will be collected within all Buildings of interest (143, 4225, 4224, 3402, 133, 4026, 137, 3997, 131, 4525/129, and 188) immediately beneath the building slab. Indoor and outdoor air samples will be collected at all buildings of interest.

1.3 Health and Safety Plan Assumption Set

The assumption set for the development of this HSP is that CH2M HILL site personnel and CH2M HILL controlled subcontractors, who may be covered by this HSP, will not be

exposed to identified chemicals of concern (COCs), or chemical products that may be used in operational processes, in excess of established Occupational Exposure Limits (OELs) while executing their assigned tasks. This assumption is based on the following:

- Site personnel shall execute good personal hygiene practices to facilitate a negative exposure to identified site COCs via incidental dermal or ingestion exposure vectors.
- Where use of personal protective equipment (PPE) equipment is specified, it will be used in accordance with Section 5 of this HSP.
- Where the use of air monitoring equipment is specified, it shall be in accordance with Section 6 of this HSP. Action levels and action level responses defined by this HSP shall be adhered to. Air monitoring data collected during the execution of the task order work phases shall be documented and included for the project file.
- Work is being performed in an open air, well ventilated environment. This in combination with the low risk potential for exposure to site COCs containing VOCS within the limited or small surface areas that these COCs may be encountered during current and future land use scenarios.

In the event that the above assumption set is not verified, the conditions of this HSP will be re-evaluated and amended as necessary to address applicable hazards that maybe associated with newly encountered project conditions or newly defined project tasks. In the event that recorded air monitoring data indicates that site workers are or may be exposed to site COC concentrations in excess of established OELs, work shall immediately cease until such engineering or administrative control measures and/or PPE are implemented to reduce potential worker exposures to acceptable levels.

1.4 HAZWOPER-Regulated Tasks

Where certain work tasks include the handling, removal, containment, investigation, or other physical site management of hazardous waste/material or other regulated materials, execution of such tasks and potential employee exposure to chemical hazards associated with these tasks may be regulated under 29 Code of Federal Regulation (CFR) 1910.120/29 CFR 1926.65. For this task order, following activities will be considered Hazardous Waste Operations (HAZWOPER)-regulated tasks because of the potential worker exposure to identified site contaminants.

- Air sampling
- Groundwater sampling
- Hand augering and use of jackhammer through concrete
- Drilling using Direct Push Technology (DPT)
- Investigative Derived Waste Management
- Investigative Derived Waste Sampling (Drum) and Disposal
- Observation of material loading for offsite disposal
- Equipment Decontamination
- Demobilization

1.5 Non-HAZWOPER-Regulated Tasks

Under specific circumstances, the training and medical monitoring requirements of HAZWOPER regulations under 29 CFR 1910.120/29 CFR 1926.65 may be not applicable. Where this is considered, it must be demonstrated that the assigned tasks can be performed without the possibility of exposure to chemical hazards in order to use personnel who do not meet the criteria established by these standards. A determination from the Health and Safety Manager is required before project tasks are conducted by personnel who do not meet the requirements of 29 CFR 1910.120/29 CFR 1926.65 and where there is question to potential exposure to chemical hazards. Where it is unlikely or not possible that workers could not be exposed to site chemical hazards during the normal execution of assigned tasks, the task can be considered a Non-HAZWOPER Regulated Task. For this project, the following activities can be considered Non-HAZWOPER Regulated Tasks.

- Land and Utility Survey Activities to support the remedial objectives
- Mobilization operations
- Demobilization (no contact w/site COCs)

1.6 Activity Hazard Analysis Basis

Table 1-1 below summarizes identified hazards associated with the phases of work anticipated with the project execution. Table 1-1 provides the basis for the development of Activity Hazard Analysis documents, which must be implemented as part of the CH2M HILL Health and Safety Program, Behavior Based Loss Prevention System (BBLPS). Please refer to Section 4 of this HSP for additional detail on the BBLPS.

Attachment 7 of HSP contains applicable Activity Hazard Analysis (AHA) documents, which in addition to the content of this HSP/APP, are intended to reinforce project or program requirements and present project control measures for anticipated or encountered hazards that may occur during the execution of an employee's assigned tasks.

Potential Hazards	Mobilize and Demob.	Land and Utility Surveys	DPT Drilling/ Concrete Coring	Soil Vapor Sampling	Indoor/ Outdoor Air Sampling	Groundwater Sampling	Equipment Decontamination	Investigative-Derived Waste Management	Investigative-Derived Waste (Drum) Sampling and Disposal	Observation of Material Loading for Offsite Disposal	Utility Clearance
Adverse weather	X	X	X	X	X	X	X	X	X	X	X
Biological	X	X	X	X	X	X	X	X	X	X	X
Buried utilities		X	X	X		X					
Chemical hazards			X	X	X	X	X	X	X	X	
Compressed gas cylinders				X	X						
Cuts/abrasions	X	X	X	X	X	X	X	X	X	X	X
Electrical safety	X		X			X	X				X
Drilling (HSA/DPT)			X								
Fall protection			X								
Fire/explosion hazards			X	X	X	X	X				X
Fire prevention	X		X	X	X	X	X				
Hand and power tools	X	X	X	X	X	X	X	X	X	X	X
Haul truck operations	X		X				X	X	X	X	
Heat stress	X	X	X	X	X	X	X	X	X	X	X
Housekeeping	X	X	X	X	X	X	X	X	X	X	X
Manual lifting	X	X	X	X	X	X	X	X	X	X	X
Material handling			X	X	X	X	X	X	X	X	X
Machine guarding			X	X	X	X	X				
Noise	X		X	X	X	X	X				
Overhead utilities	X		X								X
Pinch/struck by/caught	X	X	X	X	X	X	X	X	X	X	
Pressure washing							X				
Pressurized lines/equip.			X	X	X	X	X				
Slips/trips/falls	X	X	X	X	X	X	X	X	X	X	X
Spill prevention			X	X	X	X	X	X	X	X	
Vehicle traffic	X	X	X	X	X	X	X	X	X	X	X
Visible lighting	X	X	X	X	X	X	X	X	X	X	X

SECTION 2

Project Organization and Personnel

2.1 Employee Medical Surveillance and Training

The employees listed below are enrolled in a Comprehensive Health and Safety Program and meet state and federal hazardous waste operations requirements for 40-hour initial training, 3-day on-the-job experience, and 8-hour annual refresher training. Employees designated as a Site Safety and Health Officer (SSHO), (synonymous with Site Safety Coordinator [SSC] or Site health and Safety Specialist), have completed a 12-hour SSC course, or equivalent, and have documented requisite field experience. An SSHO/SSC with a level designation (D, C, B) equal to or greater than the level of protection being used must be present during all tasks performed in exclusion or decontamination zones. Employees designated "FA-CPR" are currently certified by the American Red Cross, or equivalent, in first aid and cardiopulmonary resuscitation (CPR). At least one FA-CPR designated employee must be present during all tasks performed in exclusion or decontamination zones. However, when a medical facility or physician is not accessible within 5 minutes of an injury to a group of two or more employees for treatment of injuries, at least two employees on each shift shall be trained to administer First Aid and CPR.

The employees listed below are currently active in a medical surveillance program that meets state and federal regulatory requirements for hazardous waste operations. In addition, employees performing certain assigned tasks (e.g., confined-space entry) or being exposed to constituents of concern (e.g., lead) will involve additional training and medical monitoring requirements.

Pregnant employees are to be informed of and are to follow the procedures in the CH2M HILL, Inc. SOP HSE-120, *Reproduction Protection*, including obtaining a physician's statement of the employee's ability to perform hazardous activities before being assigned fieldwork.

Employee Name	Responsibility	Relevant Training
Keri Hallberg	Project Manager (Overall)	SSC-C, FA-CPR, SC-HW {29CFR1910.120(e)(4)} 29CFR1910.120(e)(3), e(8)
Kimberly Stokes	Task Manager	FA-CPR, SC-HW {29CFR1910.120(e)(4)} 29CFR1910.120(e)(3), e(8)
Margaret Radford	Field Team Leader (FTL)	FA-CPR, SC-HW {29CFR1910.120(e)(4)} 29CFR1910.120(e)(3), e(8)
TBD	Field Staff	

2.2 Project Safety Responsibilities

The Project Manager has the overall responsibility for this project and will ensure that the requirements of the contract are attained in a manner consistent with this HSP and other contract-specific requirements. The Project Manager will coordinate and verify with the SSHO to ensure that the executed work is completed in a manner that is consistent with this HSP and the procedures adopted by the CH2M HILL Navy Clean Program.

The SSHO will be the main contact in any onsite emergency situation and will ensure offsite emergency agencies have been contacted prior to the start of work.

The Health and Safety Manageris responsible for formulating and reviewing the HSP and ensuring that the HSP is complete and accurate. The HSMalso provides technical and administrative support for the CH2M HILL Health and Safety Program and will be available for consultation when required. The HSM shall review and "approve" the HSP for field implementation and also be available for consultation project Industrial Hygiene and worker exposure matters, as may be required by the project team.

Each employee is responsible for their personal safety as well as the safety of others in the work area.

2.2.1 Key Safety Personnel

The following individuals CH2M HILL share responsibility for health and safety at the site:

- **CH2M HILL Project Manager**
  Keri Hallberg: (704) 543-3260 / (704) 975 -9381 (cell)
- **CH2M HILL Health and Safety Manager**
  Mark Orman CSP: (414) 847-0597 / (414) 712-4138 (cell)
- **CH2M HILL Task Manager**
  Kimberly Stokes: (214) 998-4839
- **CH2M HILL Field Team Leader**
  Margaret Radford: (919) 749-9479

2.2.1.1 Project Manager

The CH2M HILL Project Manager is responsible for providing adequate resources (budget and staff) for project-specific implementation of the Health, Safety, and Environment (HS&E) management process. The Project Manager has overall management responsibility for the project tasks identified herein. The Project Manager may explicitly delegate specific tasks to other staff, as described in sections that follow, but retains ultimate responsibility for completion of the following in accordance with this HSP.

- Include standard terms and conditions, and contract-specific HS&E roles and responsibilities in contract and subcontract agreements (including flow-down requirements to lower-tier subcontractors).

- Select safe and competent subcontractors by:
  - Obtaining, reviewing, and accepting or rejecting subcontractor pre-qualification questionnaires.
  - Ensuring that acceptable certificates of insurance, including CH2M HILL as named additional insured, are secured as a condition of subcontract award.
  - Including HS&E submittals checklist in subcontract agreements, and ensuring that appropriate site-specific safety procedures, training and medical monitoring records are reviewed and accepted prior to the start of subcontractor's field operations.
- Maintain copies of subcontracts and subcontractor certificates of insurance (including CH2M HILL as named additional insured), bond, contractor's license, training and medical monitoring records, and site-specific safety procedures in the project file accessible to site personnel.
- Provide oversight of subcontractor HS&E practices per the site-specific safety plan.
- Manage the site and interface with third parties in a manner consistent with our contract and subcontract agreements and the applicable standard of reasonable care.
- Ensure that both the overall and job-specific HS&E goals are fully and consistently implemented.

2.2.1.2 Health and Safety Manager

The HSPA's responsibilities include the following:

- Develop and/or review the project HSP for final approval.
- Review and accept or reject subcontractor pre-qualification questionnaires that fall outside the performance range delegated to the Contracts Administrator.
- Review and accept or reject subcontractor training records and site-specific safety procedures prior to start of subcontractor's field operations.
- Support the SSHO's oversight of subcontractor (and lower-tier subcontractors) Health, Safety, and Environment (HS&E) practices and interfaces with third parties, as necessary.
- Support and assist program staff in executing the HS&E policies and procedures adopted by the program for implementation, including the program BBLPS. Provide consultation and direction to project staff with regard to HS&E project and program requirements and industrial hygiene practices.

2.2.1.3 Field Team Leader and Site Safety

The FTL is responsible for verifying that the project is conducted in a safe manner including the following specific obligations:

- Verify this HSP remains current and amended when project activities or conditions change.

- Verify CH2M HILL site personnel and subcontractor personnel read, or have been briefed on the contents of this HSP, and sign **Attachment 1** "Employee Signoff Form" prior to commencing field activities.
- Verify CH2M HILL site personnel and subcontractor personnel have completed any required specialty training (e.g., fall protection, confined space entry) and medical surveillance as identified in Section 2, and maintain the Subcontractor H&S Tracking Form, where applicable (**Attachment 3**).
- Verify adherence with the requirements of this HSP and applicable the subcontractor's health and safety plan(s).
- Act as the project "Hazard Communication Coordinator".
- Act as the project "Emergency Coordinator" and perform the responsibilities outlined in this HSP or as maybe required to properly coordinate the on-site response of emergencies, as they arise.
- Verify that safety meetings are conducted at least daily or more frequently as project tasks or hazards change and documented for the project record in accordance with the requirements of the BBLPS.
- Verify that project H&S forms and permits, found in **Attachment 4**, are being used as intended.
- Verify that Project Activity Self-Assessment Checklists, found in the CH2M HILL, Inc. SOPs referenced in this HSP, are being used as intended.
- Implement the Drug-Free Workplace Program.
- Verify that project files available to site personnel include copies of executed subcontracts and subcontractor certificates of insurance (including named additional insured), bond, contractor's license, training and medical monitoring records, and site-specific safety procedures prior to start of subcontractor's field operations.
- Manage interface with third parties in a manner consistent with our contract/subcontract agreements and the applicable standard of reasonable care.
- Ensure that the overall, job-specific, HS&E goals are fully and continuously implemented.

The training required for the SSHO is as follows:

- 12-hour course Site Safety Coordinator (or equivalent) for construction related projects.
- Safety Coordinator - Hazardous Waste (or equivalent), for Hazwoper related projects.
- 40-hour Occupational Safety and Health Administration (OSHA) 1910.120 training course and 8-hour refresher classes (as applicable).
- First Aid and CPR

- Relevant Competent Person Courses (excavation, confined space, scaffold, fall protection, etc.)

The FTL is responsible for coordinating with the CH2M HILL Project Manager, as necessary. In general, the Project Manager will contact the client in the event accidents, injuries or property damage occurs on the project site.

2.3 Subcontractors

Subcontractors covered by this HSP must be provided a copy of it to read and accept prior to initiating work on this site. However, this plan does not address hazards associated with the tasks and equipment that the subcontractor has expertise in (e.g., electrical, excavation, demolition). Subcontractors are responsible for the health and safety procedures specific to their work, and are required to submit these procedures to CH2M HILL for review before the start of field work. It is critical that subcontractor work be performed in a manner that is consistent with applicable OSHA standards (29CFR1910, 29CFR1926), EM 385 1-1 or other applicable health and safety plan(s)/protocols. The CH2M HILL FTL should verify that subcontractor employee training, medical clearance, and fit test records are current and must monitor and enforce compliance with the established plan(s). CH2M HILL oversight does not relieve subcontractors of their responsibility for effective implementation and compliance with the established plan(s), protocols, or established safety regulations.

CH2M HILL should continuously endeavor to observe subcontractors' safety performance. This goal should be reasonable, and include observing for hazards or practices and procedures that are not consistent with established Health and Safety requirements that are both readily observable and occur in common work areas. CH2M HILL is not responsible for exhaustive observation for hazards and unsafe practices. In addition to this level of observation, the SSHO is responsible for confirming CH2M HILL subcontractor performance against both the subcontractor's safety plan and applicable self-assessment measures. Project Activity Self-Assessment Checklists contained in referenced CH2M HILL, Inc. SOP documents are to be used by the SSHO to review subcontractor performance.

Health and safety related communications with CH2M HILL subcontractors should be conducted as follows:

- Request subcontractor personnel to read the HSP and then require them to sign the Employee Signoff Form included in Attachment 1 of this HSP.
- Request subcontractor(s) to brief the project team on the hazards and precautions related to their work.
- When apparent conditions, actions, or practices are observed that are not consistent with this HSP, CH2M HILL Health and Safety Program, or other Health and Safety protocols, notify the subcontractor safety representative and require corrective action—the subcontractor is responsible for determining and implementing necessary controls and corrective actions.
- When identified conditions or practices/actions that are not consistent with CH2M HILL HS&E policies and procedures, or other applicable Health and Safety

protocols are repeated or persist, notify the subcontractor safety representative and stop affected work until adequate corrective measures are implemented. See Stop Work Order (SWO) Form in **Attachment 4** of this HSP.

- When an apparent imminent danger exists, immediately remove all affected CH2M HILL employees and subcontractors, notify subcontractor safety representative, and stop affected work until adequate corrective measures are implemented (see SWO form). Notify the Project Manager as appropriate.
- Document all oral health and safety related communications in project field logbook, daily reports, or other records.
- Subcontractor Management requirements are also defined in Section 5.0 of the APP (**Attachment 2** of this HSP).

SECTION 3

Project-Specific Hazards

Exposure to certain project specific hazards in the work place may include injury/ accidents or property damage due to execution of a variety of assigned tasks or as a result of existing site conditions. This section of the HSP is provided to aid in the recognition of potential specific and general project hazards and identify procedures and practices to be implemented on the job site that may reduce or eliminate accidents/ injuries and property damage that may be attributed to these hazards. All CH2M HILL personnel are required to contact the designated HSPA identified in this HSP regarding any questions or concerns to ensure the execution of this task order in a healthy and safe manner.

The following areas/activities are not specifically covered under this HSP and must not be performed unless this HSP is amended and approved accordingly.

- Areas presenting exposed energized electrical equipment.
- Areas where there is an unprotected (e.g., no guardrail) fall exposure greater than 4 feet.
- Areas where Unexploded Ordinance / Munitions and Explosives of Concern may be encountered.
- Activities requiring the use of scaffolding or hoisted personal platforms.
- Confined Space Entry (CSE) operations
- Activities where potential radiological exposure hazards may exist

3.1 Adverse Weather

Sudden inclement weather can rapidly encroach upon field personnel. Field crew members performing work outdoors should carry clothing appropriate for bad weather. In severe weather conditions, (i.e., high wind or electrical storms), the field crews should leave the area and find safe shelter until the weather abates and until a decision is made to resume the field activities. The following field procedures should be exercised where adverse weather is encountered or is expected to occur.

- Frequently observe the skyline for developing rain squalls, thunder storms or other severe weather systems that may be developing. Check internet, local TV weather or radio channels for daily forecasts and plan daily work activities accordingly. Have a portable radio available on-site to monitoring local weather or marine forecasts. If not check with home office support personnel who may be able to determine the severity of developing storm systems through internet access or other methods.
- Preparedness and caution are the best defenses against lightning. Many lightning deaths and injuries happen before or after a thunderstorm's peak. The FTL shall monitor weather forecasts for predictions of electrical storms in the area. At first sight of lightning, operations shall be stopped and only resumed when conditions permit. The

FTL shall monitor weather conditions to determine when it is appropriate to resume work. The lightning safety recommendation is 30-30: Seek refuge when thunder sounds within 30 seconds after a lightning flash; and do not resume activity until 30 minutes after the last thunder clap. Some other general precautions include:

- Know where to go and how long it will take to get there. If possible, take refuge in a large building or rubber tired vehicle. Do not go into a shed in an open area.
- The inclination to see trees as enormous umbrellas is the most frequent and most deadly mistake. Do not go under a large tree that is standing alone. Likewise, avoid poles, antennae, and towers.
- Stay away from lakes, streams, pools, or any water.
- Stay away from railroad tracks that can carry lightning charges for long distances.
- If the area is wide open, go to a valley or ravine, but be aware of flash flooding. Do not stand on top of a hill.
- If you are caught in a level open area during an electrical storm and you feel your hair stand on end, drop to your knees, bend forward and put your hands on your knees or crouch. The idea is to make your body less vulnerable by being as low to the ground as possible and taking up as little ground space as possible. Lying down is dangerous, since the wet earth can conduct electricity. Do not touch the ground with your hands.
- Do not use telephones during electrical storms, except in the case of emergency.

- Bring clothing suitable for anticipated daily weather conditions.
- Shut down operations during heavy rain/lightning events or high wind conditions.
- Implement the Hurricane Preparedness Plan **(Attachment 12)**, where applicable.

3.2 Aerial Lifts

(Reserved)

3.3 Air Compressor Operations

(Reserved)

3.4 Asbestos

(Reserved)

3.5 Chemical Injections

(Reserved)

3.6 Concrete Work

(Reference SOP # HSE&Q 302, Concrete & Masonry)

(Reserved)

3.7 Confined Space Entry

(Reference SOP # HSE&Q 203, Confined Space Entry)

Confined space entry is not anticipated for this SOW. If required to facilitate installation of components or change out of this plan will be amended and a task specific AHA will be developed.

3.8 Chemicals of Concern

Table 3-1 below identifies the maximum concentration of site COCs that have been identified for the project sites to be accessed under this task order. Established OELs and symptoms and effects of overexposure to such COCs are also identified.

3.8.1 Chemicals of Concern – OU1

Contaminants of concern for **OU1** are listed in Table 3-1.

TABLE 3-1
Constituents of Concern – OU1
(Refer to Project Files for more detailed contaminant information)

Constituents	Sample ID and Maximum Concentration (mg/kg)[a]	Exposure Limit (ppm)[b]	IDLH (ppm)[c]	Symptoms and Effects of Exposure	PIP (ev)[d]
1,1-Dichloroethane	GW:8800 µg/L	100 ppm	3,000	CNS depression, skin irritation; liver, kidney, and lung damage	NA
1,2-Dichloroethylene	GW:16,000 µg/L	1 ppm	50 Ca	CNS depression, nausea, vomiting, dermatitis, eye irritation, liver, kidney, and CNS damage; corneal opacity	NA
Trichloroethylene (TCE)	GW:62,000 µg/L	10 ppm	1,000 Ca	Headache, vertigo, visual disturbance, eye and skin irritation, fatigue, giddiness, tremors, sleepiness, nausea, vomiting, dermatitis, cardiac arrhythmia, paresthesia, liver injury	NA
Vinyl Chloride	GW:8,000 µg/L	1 ppm	NL Ca	Weakness, abdominal pain, gastrointestinal bleeding, enlarged liver, pallor or cyanosis of extremities	NA

[a] Specify sample-designation and media: SB (Soil Boring), A (Air), D (Drums), GW (Groundwater), L (Lagoon), TK (Tank), SS (Surface Soil), SL (Sludge), SW (Surface Water), GW (groundwater)
[b] Appropriate value of PEL, REL, or TLV listed.
[c] IDLH = immediately dangerous to life and health (units are the same as specified "Exposure Limit" units for that contaminant); NL = No limit found in reference materials; CA = Potential occupational carcinogen.
[d] PIP = photoionization potential; NA = Not applicable/available; UK = Unknown.
[e] Denotes a ceiling value (15 minutes) unless otherwise identified and is a value that shall not be exceeded.
[f] Denotes a value established by the ACGIH

3.8.2 Potential Routes of Exposure

- **Dermal:** Contact with contaminated media. This route of exposure is minimized through proper use of PPE, as specified in Section 5.
- **Inhalation:** Contaminated particulates. This route of exposure is minimized through proper respiratory protection and air monitoring, as specified in Sections 5 and 6, respectively.
- **Other:**
  - **Inadvertent ingestion of contaminated media:** This route should not present a concern if good hygiene practices are followed (e.g., wash hands/face before eating drinking or smoking).
  - **Inadvertent injection of contaminated media:** This route should not present a concern unless a puncture of contaminated PPE were to occur that resulted in breaking the employee's skin and the wound came into contact with contaminated media.

3.8.3 Respiratory Protection

(Reference SOP # HSE&Q 121, Respiratory Protection)

Where certain site conditions are encountered the use of respiratory protective equipment may be required or advisable. Under these circumstances, it is essential that the following criteria are met:

- The correct type of respiratory protection equipment is selected and used.
- The selected respiratory protection equipment is clean and in good working order.
- The selected respiratory protection equipment provides an appropriate fit for the user/wearer.
- The user/wear is adequately trained in the use, care, and limitations of the selected respiratory protection device.

To accomplish these requirements, a Respiratory Protection Program must be implemented to facilitate reduction of employee exposure to toxic chemical agents, asbestos, lead based paint, and potentially hazardous work environments and to ensure employees are made aware of and familiar with, respirator use, fit, maintenance, cleaning procedures and associated application limits.

All site personnel who wear a respirator shall be given a medical evaluation prior to such use. A licensed physician must conduct the evaluation and provide written authorization for respirator use and the authorization must be included in the employee's permanent record. At a minimum, the medical evaluation must be repeated annually.

To ensure proper wearer fit, an annual "fit test" must be provided for a specific make, model, and size of a selected respiratory protection device. An additional fit test must be performed whenever the employee reports or the employer or employer's representative makes visual observations of changes in the employee's physical condition that could affect

respirator fit. Such conditions include, but are not limited to, facial scarring, dental changes, cosmetic surgery, or an obvious change in body weight. Fit tests will be repeated, at least, annually or sooner if there is any doubt as to a respirator's fit.

To minimize employee exposure to potentially hazardous chemical substances, the primary objective shall always be to achieve the needed control, whenever feasible, through engineering methods (such as exhaust ventilation) or administrative control. It is recognized, however, that for certain operations, the use of engineering controls may not be feasible or practical. Under these circumstances or during an interim period while engineering controls are being developed or installed, the use of personal respiratory protection equipment may be necessary.

Prior to using any respiratory protective equipment, affected personnel shall review and implement all applicable components of CH2M HILL SOP # HSE&Q-121, Respiratory Protection or implement other company Respiratory Protection Programs that may be more applicable to the employee.

3.8.4 Radiological Hazards and Controls

(Reserved)

3.9 Cranes

(Reference SOP # HSE&Q 303, Cranes)

(Reserved)

3.10 Demolition/Dismantling

(Reference SOP # HSE&Q 305, Demolition)

(Reserved)

3.11 Drilling/Direct Push Technology

During the execution of this task order, hollow stem auger or DPT drilling techniques will be used for soil sampling events. When these operations are implemented at the site, at a minimum, the following drilling practices must be implemented.

- Prior to conducting any onsite intrusive activities, it must be verified that subsurface utilities will not be impacted by proposed site operations. See Procedures for Locating Underground Utilities in this HSP.
- PPE and air monitoring requirements shall be executed in accordance with Sections 5 and 6, respectively, of this HSP in an effort to minimize potential dermal and respiratory exposures to identified site contaminants of concern during all drilling activities. In addition, good personal hygiene practices and procedures must be maintained (see Section 7 of this HSP).

- Drill/DPT rig inspections and maintenance and documentation of such inspections and maintenance shall be performed daily prior to the start of onsite work.
- The drill rig is not to be operated in inclement weather.
- The driller is to verify that the drill/DPT rig is properly leveled and stabilized (extension of stabilizers on firm ground) before raising the mast.
- Personnel should be cleared from the sides and rear of the rig before the mast is raised.
- The driller is not to drive the rig with the mast in the raised position.
- The driller must check for overhead power lines before raising the mast. A minimum distance of 10 feet between mast and overhead lines (<50 kV) is recommended. Increased separation will be required for lines greater than 50 kV. See Electric Safety in this HSP for proper separation requirements and other standard operating procedures associated with working near power transmission lines.
- Personnel should stand clear before equipment startup. Maintain eye contact with operator prior to/while approaching drill rig.
- The driller is to verify that the rig is in neutral when the operator is not at the controls.
- Become familiar with the hazards associated with the drilling method used.
- Do not wear loose-fitting clothing, watches, etc., that may get caught in moving parts.
- Do not smoke or permit other spark-producing equipment around drill rig.
- The drill rig must be equipped with a kill wire or switch and personnel associated with the drilling operation are to be informed of its location.
- For drill/DPT rig where pressurized lines are associated with the operation, safety lashings/whip line checks, clips or other suitable restriction means should be in place on hoses/connections to prevent injury in the event connections become dislodged or hoses ruptures.
- Be aware and stand clear of heavy objects that are hoisted overhead by the drill rig.
- The driller is to verify that all machine guards are in place while the rig is in operation.
- The drill/DPT rig should be equipped with at least one fire extinguisher.
- If the drill rig comes into contact with electrical wires and becomes electrically energized, do not touch any part of the rig or any person in contact with the rig and stay as far away as possible. Notify emergency personnel immediately.
- Where it may be required to limit access and prevent inadvertent entrance of unauthorized and untrained personnel into the active drilling areas, the erection of warning tape, suitable signage, orange safety fencing or other appurtenances around the active drilling area may be necessary.

3.12 Electrical Safety

(Reference SOP # HSE&Q 206, Electrical Safety)

Several types of electrical hazards may be encountered during the execution of the project. These hazards might include, but not be limited to, the use of generators, power cords, and electric hand tools during installation of the irrigation system or inadvertent contact of heavy earthmoving or hauling equipment with overhead or underground electrical or communication utilities or aboveground transformer units. Where electrical exposure hazards are possible in the work environment, the following standard work practices must be implemented.

- **Review and implement all applicable components of CH2M HILL SOP # HSE&Q-206, Electrical Safety, except where other requirements may be more stringent.**
- Do not connect electric sampling or groundwater well purge equipment directly to 12 volt vehicle/tractor/boat batteries as an electrical power source. Use generators and power cords equipped with ground fault circuit interrupters (GFCIs)
- Only qualified personnel (by training, experience, and/or licensure) are permitted to work on electrical systems.
- Do not tamper with or access electrical wiring and equipment unless qualified to do so. All electrical wiring and equipment must be considered energized until hazardous energy control procedures (i.e., lock-out/tag-out) are implemented.
- Inspect electrical equipment, power tools, and extension cords for damage prior to use. Do not use defective electrical equipment and remove from service.
- All temporary wiring, including extension cords and electrical power tools, must have GFCIs installed.
- Extension cords must be:
  - Equipped with third-wire grounding.
  - Covered, elevated, or protected from damage when passing through work areas.
  - Protected from pinching if routed through doorways.
  - Not fastened with staples, hung from nails, or suspended with wire.
- Electrical power tools and equipment must be effectively grounded or double-insulated and Underwriters Laboratory (UL) approved.
- Operate and maintain electric power tools and equipment according to manufacturers' instructions.
- Protect all electrical equipment, tools, switches, and outlets from environmental elements.
- Maintain safe clearance distances between overhead power lines and operating heavy equipment and haul trucks unless the power lines have been verified as being de-energized and grounded or where insulating barriers have been installed to prevent

physical contact. To determine proper clearance from energized overhead electric lines, please consult the reference table below.

Nominal System Voltage (kV)	Minimum Rated Clearance (feet)
0-50	10
51-200	15
201-300	20
301–500	25
501–750	35
751–1000	45

- Do not swing heavy equipment or other components of operating heavy equipment toward overhead utilities. Do not allow haul trucks operators to raise dump bed bodies underneath overhead utilities or haul trucks to pull toward overhead utilities with dump bodies raised.
- Be cognizant of utility pole guy wires in relation to operating heavy equipment and haul trucks.

3.13 Excavation Activities

(Reference SOP # HSE&Q 307, Excavation & Trenching Safety)

(Reserved)

3.14 Fall Protection

(Reference SOP # HSE&Q 308, Fall Protection)

The following guidelines are generic in nature and are provided as guidance for the project. **All personnel who may be potentially exposed to falls from elevated surfaces must review and implement all applicable components of CH2M HILL SOP # HSE&Q 308 Fall Protection, except where other requirements may be more stringent.**

3.14.1 Surfaces or Activities Requiring Fall or Falling Object Protection

- **Unprotected sides or edges –** Personnel exposed to sides or edges of a walking or working surface more than 6 feet above the adjacent surface, and without a minimum 39-inch-high wall or guardrail system shall be protected by a guardrail system, safety net system, personal fall arrest system or fall protection plan.
- **Leading edges –** Personnel exposed to an edge of a walking or working surface under construction that changes location as additional materials are placed or constructed shall be protected by a guardrail system, safety net system, personal fall arrest system, or fall protection plan.

- **Holes –** Any gap or void 2 inches or more in its least dimension in a walking or working surface shall be provided with a cover, guardrail system, or personal fall arrest system.
- **Wall Openings –** Personnel working near wall openings 30 inches or more high and 18 inches or more wide, with a bottom edge at a walking or working surface height of less than 39 inches shall be protected by a guardrail system, a safety net system, or a personal fall arrest system.
- **Walking or working on surfaces not otherwise addressed –** Personnel exposed to falls from surfaces not specifically addressed here shall be protected by a guardrail system, or fall protection plan.

3.14.2 Guardrail Systems

- Personnel shall remain within the guardrail system. Leaning over or stepping across a guardrail system shall not be permitted.
- Personnel shall not stand on objects (boxes, buckets, etc.) or ladders to increase working height on top of platforms protected by guardrails.
- Top-edge height of top rail shall be 38 to 45 inches above the walking or working level.
- Mid-rails, screens, mesh; intermediate vertical members shall be installed between the top rail and the walking or working surface.
- The guardrail system shall be capable of withstanding a force of at least 200 pounds applied in any outward or downward direction.
- Specific requirements for guardrail construction and use can be found in H&S SOP HSE-308 or 29CFR1926.451(g).

3.14.3 Personal Fall Arrest Systems

- Personal Fall Arrest System consist at a minimum of full body harness, shock absorbing lanyard, and anchorage point.
- Personnel shall inspect all personal fall arrest system components prior to each use. Personnel shall not use damaged fall protection components or systems at any time or for any reason.
- Personal fall arrest systems shall be configured so that individuals can neither free-fall more than 6 feet or contact any lower level.
- Personal fall arrest systems shall only be attached to anchorage points capable of supporting at least 5,000 pounds.
- Personal fall arrest systems shall not be attached to guardrail systems or hoists.
- Personal fall arrest systems and components subjected to impact loading shall be immediately removed from service and shall not be used again for fall protection until inspected and determined by a competent person to be undamaged and suitable for reuse.

3.14.4 Protection from Falling Objects

- Personnel exposed to falling objects shall be required to wear hardhats.
- Objects on elevated surfaces shall be positioned far enough away from the surface's edge to prevent those objects from falling over the edge if accidentally displaced.
- In addition to hard hats and object positioning, at least one of the following protective measures shall be implemented to prevent falling objects:
- Erect toe boards, screens, or guardrail systems that prevent objects from falling to lower levels.
- Erect a canopy structure to contain falling objects.
- Barricade the area where objects could fall and prohibit entry into the barricaded area.
- Toe boards, when used as falling object protection, shall be erected along the edge of the overhead walking or working surface for a distance sufficient to protect personnel below. Toe boards shall be a minimum of 3.5 inches in height and shall have not more than a 0.25-inch clearance above the walking or working surface. They shall be solid, or have openings not over 1 inch in greatest dimension.
- Where tools, equipment, or materials are piled higher than the top edge of a toe board, paneling or screening shall be erected from the walking or working surface or toe board to the mid rail or top rail, for a distance sufficient to protect personnel below.
- Guardrail systems, when used as falling object protection, shall have all openings small enough to prevent passage of potential falling objects.
- During the performance of overhand bricklaying work, no materials or equipment except masonry and mortar shall be stored within 4 feet of the working edge; and excess mortar, broken or scattered masonry units, and all other debris shall be kept clear from the work area by removal at regular intervals.
- During the performance of roofing work, materials and equipment shall not be stored within 6 feet of a roof edge unless guardrails are erected at the edge; and materials that are piled, grouped, or stacked near a roof edge shall be stable and self-supporting.
- Canopies, when used as falling-object protection, shall be strong enough to prevent collapse, and prevent penetration by any objects that may fall onto the canopy.

3.14.5 General Fall Protection Evaluation

- Fall protection systems must be used to eliminate fall hazards when performing construction activities at a height of 6 feet or greater and when performing general industry activities at a height of 4 feet or greater.
- Staff exposed to fall hazards must complete the AGVIC-CH2M HILL Fall Protection training course and receive project-specific fall protection training. Do not use fall protection systems on which you have not been trained.

- The Site Supervisor, or other qualified designee, shall act as competent person and shall inspect and oversee the use of fall protection systems. Follow all requirements established by the competent person for the use and limitation of fall protection systems.
- A registered professional engineer shall oversee the use of horizontal lifelines.
- Only one person shall be simultaneously attached to a vertical lifeline.
- Use fall protection equipment for fall protection only and not to hoist materials. Do not use personal fall arrest systems that have been subjected to impact loading.

3.15 Fire Prevention

The information provided below is the minimum Fire Prevention procedures that must be engaged for the project site.

- Be cognizant of and adhere to any specific MCAS Cherry Point Fire Prevention Procedures and Requirements.
- Secure a "hot work permit" from the designated MCAS Cherry Point Fire Department Official, when necessary. This task shall be the responsibility of the CH2M HILL responsible for site activities or SSHO. The CH2M HILL individual responsible for site activities or SSHO shall review established hot work procedures and appropriate emergency contact requirements with the designated MCAS Cherry Point Fire Department and review this information with all site CH2M HILL and applicable subcontractor personnel.
- Fire extinguishers will be provided so that the travel distance from any work area to the nearest extinguisher is less than 100 feet. When 5 gallons or more of a flammable or combustible liquid is being used, an extinguisher must be within 50 feet. Extinguishers must:
  - Be maintained in a fully charged and operable condition.
  - Be visually inspected each month.
  - Undergo a maintenance check each year.
  - The area in front of extinguishers must be kept clear.
- Post "Exit" signs over exiting doors, and post "Fire Extinguisher" signs over extinguisher locations.
- Combustible materials stored outside should be at least 10 feet from any building.
- Solvent waste and oily rags must be kept in a fire-resistant, covered container until removed from the site.
- Flammable/combustible liquids must be kept in approved containers, and must be stored in an approved storage cabinet.

3.16 Flight Line Safety

(Reserved)

3.17 Hand and Power Tools

(Reference SOP # HSE&Q 210, Hand and Power Tools)

Hand and power tools may be during the support of mobilization operations, the installation of Erosion and Sediment Control Measures and installation of irrigation system components. When the use of hand and power tools is necessary to properly complete assigned tasks, the following work practices must be implemented, where applicable.

- Review and implement all applicable components of CH2M HILL SOP # HSE&Q 210, Hand and Power Tools except where other requirements may be more stringent.
- Tools will be inspected prior to use, and damaged tools will be tagged and removed from service.
- Hand tools will be used for their intended use and operated in accordance with manufacturer instructions and design limitations.
- Maintain all hand and power tools in a safe condition.
- Do not set power tools down in muddy or wet areas, which may damage the tool and/or or create a potential for electric shock.
- Use PPE (such as gloves, safety glasses, earplugs, and face shields) when exposed to a hazard from a tool.
- Do not carry or lower a power tool by its cord or hose.
- Portable power tools will be plugged into GFCI-protected outlets.
- Portable power tools will be UL listed and have a three-wire grounded plug or be double insulated.
- Disconnect tools from energy sources when they are not in use, before servicing and cleaning them, and when changing accessories (such as blades, bits, and cutters).
- Safety guards on tools must remain installed while the tool is in use and must be promptly replaced after repair or maintenance has been performed.
- Store tools properly in a place where they will not be damaged or come in contact with hazardous materials.
- If a cordless tool is connected to its recharge unit, both pieces of equipment must conform strictly with electrical standards and manufacturer's specifications.
- Tools used in an explosive environment must be rated for work in that environment (that is, intrinsically safe, spark-proof, etc.).
- When using a knife or blade tool, stroke or cut away from the body with a smooth motion. Be careful not to use excessive force that could damage the tool, the material being cut, or unprotected hands.

- Working with manual and pistol-grip hand tools may involve highly repetitive movement, extended elevation, constrained postures, and/or awkward positioning of body members (for example, hand, wrist, arm, shoulder, neck, etc.). Consider alternative tool designs, improved posture, the selection of appropriate materials, changing work organization, and sequencing to prevent muscular, skeletal, repetitive motion, and cumulative trauma stressors.

3.17.1 Knife Use

Knives (fixed/utility) shall not be used. If it is demonstrated that a knife is the right tool for the job, this plan will be amended and the activity that knife use will be used for shall be reviewed. An AHA shall also be developed to address hazards and subsequent controls, PPE, and training.

3.17.1.1 Responsibilities

- Supervisors with assistance from the FTL/SSHO are responsible for funding and ensuring the correct tool is being used, employees wear the proper PPE when using knives, and they have reviewed this policy.
- Employees are responsible for having and utilizing the proper PPE while performing an activity requiring the use of a knife. Employees are also responsible for understanding the proper use of a knife.

3.17.1.2 Glove Requirements

- In general, Kevlar cut resistant gloves are to be worn when using a knife in an occupational setting.
- Other types of gloves may be required and will be identified within the AHA / written procedure. Example - Leather gloves may be worn when using the acetate sleeve cutter.

3.17.1.3 Standard Control Measures for Knife Use

- All employees that will use a knife must be trained in the proper use.
- When using a knife always cut away from yourself.
- Many tasks using a utility knife require a knife edge but not a sharp point. For these tasks you can add protection against puncture wounds by using a rounded-tip blade.
- If you use a folding knife, it must be a locking blade type.
- Never use a knife that will fold under pressure.
- If you use a fixed blade knife, make sure there is a handle guard to keep your hand from slipping forward. Also, make sure the handle is dry and non- greasy/slippery to assure a better grip.
- When cutting, make the force of the cut carry the blade away from any part of your body. If you have a peculiar situation where this is not possible, protect yourself with a leather apron, or other material placed between you and the blade. Consider putting the material to be cut in a vise, or other holding device.

- If you carry a fixed blade knife, use a sheath or holder.
- Store utility knives safely, retract the blade or sheath an open blade before storing. Never, leave a knife with the blade exposed on the floor, on a pallet, on a work surface, or in a drawer or cabinet.
- Keep your knife sharp. A dull blade requires you to use more force to cut, and consequently increases the risk of slip or mistake.
- Knives used on the job, but not carried with you, must be properly stored when not in use.
- Never use a defective knife.
- Utility knife blades are brittle and can snap easily. Don't bend them or apply side loads to them by using them to open cans or pry loose objects. Use the knife only to cut. It was not designed to work as a pry bar, screw driver, hole punch, and other assorted things that make it seem so easy.
- **Stay focused on the cutting job.** It only takes a second of inattention with a sharp blade to produce a serious cut. Letting the mind wander or talking with others while using a knife greatly increases the risk of an accident and injury. If you are interrupted while working with a knife, stop cutting, retract the blade, and place the knife down on a secure surface before dealing with the interruption. You should never continue cutting while distracted! As always, utilize the hierarchy of controls and first attempt to engineer out the hazard and frequently ask ourselves do we have the right tool for the job.
- If you do get cut, seek medical attention to treat the injury and notify your supervisor. **For CH2M HILL employees** injured on the job, contact WorkCare at 866-893-2514 for assistance with the management of the injury. *For work-related injuries or illnesses to CH2M HILL personnel, inform the CH2M HILL Project Manger (overall) and the CH2M HILL HSMand help Human Resources administrator complete a HITS (Hours & Incident Tracking System) Form. HITS must be completed within 24 hours of incident.

3.17.1.4 Examples of Preferred Tools and Kevlar Cut Resistant Gloves

A safety spring provides for automatic blade "shoot-back" into the handle when contact with cutting surface is lost

3.18 Haul Trucks

Where haul trucks are used on the project, the following work practices shall be implemented.

- All haul trucks must following the designated Haul Route established for the MCAS Cherry Point project sites.
- Haul truck operators should be familiar with their equipment and inspect all equipment before use.
- Haul truck operators should ensure all persons are clear before operating trucks or equipment. Before moving, operators should sound horn or alarm. All equipment should be equipped with an operational backing alarm.
- Haul trucks or equipment with restricted visibility should be equipped with devices that eliminate blind spots.
- Employees shall stay off haul roads. When approaching a haul area, employees should make eye contact and communicate their intentions directly with the equipment operator.
- If possible, minimize steep grades on haul roads.
- Haul roads should be well lit, sufficiently wide (at least 50 percent of the width of the equipment on both sides of road) and equipped with reflectors to indicate access points.
- Haul roads should have adequate right-of-way signs indicating haul directions, where appropriate.
- Ground personnel shall stay well clear of the fill over radius of haul trucks dumping aggregates or common fill materials at eth site.

3.19 Heavy Equipment

(Reference SOP # HSE&Q 306, Earth Moving Equipment)

(Reserved)

3.20 Land Clearing Operations - General

(Reserved)

3.21 Lock-Out/Tag-Out

(Reference SOP # HSE&Q 310, Lock Out Tag Out)

(Reserved)

3.22 Machine Guarding

Machine guarding procedures for the anticipated work will likely be applicable to, power and hand tool use, and certain mechanized equipment that may be used during the course of this project. For these identified activities, the following machine guarding precautions may be applicable to executed work.

- Ensure that all machine guards are in place to prevent contact with drive lines, belts, pinch points, mechanically energized equipment, or any other sources of mechanical injury.
- Unplugging jammed equipment will only be performed when equipment has been shut down, all sources of energy have been isolated, and equipment has been locked/tagged and tested.
- Maintenance and repair of equipment that results in the removal of guards or would otherwise put anyone at risk requires lockout of that equipment prior to work.

3.23 Manual Lifting

(Reference SOP # HSE&Q 112, Manual Lifting)

Manual lifting is likely to occur during many phases of the project. Personnel executing assigned tasks where manual lifting is required should use the following procedures to help reduce the potential for personal injury.

- Review and implement all applicable components of CH2M HILL SOP # HSE&Q 112, Manual Lifting, except where other requirements may be more stringent.
- CH2M HILL personnel should notify supervisors or designated safety representatives of pre-existing medical conditions that may be aggravated or re-injured by lifting activities, such that the CH2M HILL may evaluate safe operational procedures with regard to the required task.
- Proper lifting techniques (use of knees and not back) must be used when lifting any object:
- Plan storage and staging to minimize lifting or carrying distances.

- Use drum dollies/carts with a latching mechanism when handling drums containing groundwater well purge water or other waste. Avoid "chimming" drums wherever possible.
- Split heavy loads into smaller loads.
- Use mechanical lifting aids whenever possible.
- Have someone assist with the lift—especially for heavy (>40 lbs.) or awkward loads. Note: If CH2M HILL personnel are not capable of lifting 40 lbs., seek assistance from a team member to split the load.
- Make sure the path of travel is clear prior to the lift.

3.24 Noise

(Reference SOP # HSE&Q 108, Hearing Conservation Program)

Unprotected exposure to excessive noise levels may lead to gradual and permanent hearing loss. The greater the intensity of a noise and the longer a person is exposed to the noise, the greater the chance of hearing loss. A hearing loss can be permanent or temporary. After certain noise exposures, a person may experience a temporary threshold shift (hearing loss) that results in the inability to hear certain sounds. The ability to hear will usually return. However, repeated or intense noise exposure can prevent this recovery, resulting in permanent hearing loss.

Each employee is responsible for the following:

- Review and implement all applicable components of CH2M HILL SOP # HSE&Q 108, Hearing Conservation Program, or implement other Hearing Conservation Programs may be applicable to the employee.
- Notify the SSHO of high-noise-level areas.
- Wear hearing protection when required.
- Complete noise training and audiometric testing (as required).
- Hearing protection is required in work environments exceeding 85 decibels (dB).
- Hearing protection will be worn when operations occur within or adjacent to high-noise sources (i.e. potentially exceeding 85 dB).

3.25 Powered Industrial Trucks

(Reference HSE-309, Forklifts)

(Reserved)

3.26 Pressure Washing Operations

Pressure washing operations may occur prior to the final demobilization of equipment used at the site, which may be contaminated with site COCs. Whenever pressure washing operations are performed at the site, the following procedures must be implemented.

- Rain gear (disposal coated chemical suits for Hazwoper operations), 16-inch-high, steel-toed rubber boots, safety glasses, hard hat with face shield, and inner and outer nitrile gloves should be worn, at a minimum during pressure washing operations.
- Only trained, authorized personnel may operate the high-pressure washer.
- Rinse waste from pressure washing operations must be collected and properly disposed.
- Follow manufacturer's safety and operating instructions.
- Inspect pressure washer before use and confirm dead man switch fully operational.
- The wand must always be pointed at the work area.
- The trigger should never be tied down
- Never point the wand at yourself or another worker.
- The wand must be at least 42 inches from the trigger to the tip.
- The operator must maintain good footing.
- Non-operators must remain a safe distance from the operator.
- No unauthorized attachment may be made to the unit.
- Do not modify the wand.
- All leaks or malfunctioning equipment must be repaired immediately or the unit taken out-of-service.

3.27 Sample Collection or Handling

Sample handling, packaging, and preservation will be conducted in support of this project. When employees perform sample collection or handling activities, the work practices and procedures identified below must be followed.

- Skin contact with water, soil, sediment, or debris of undetermined chemical characterization shall be avoided at all times.
- PPE and air monitoring requirements shall be executed in accordance with Sections 5 and 6, respectively, of this HSP to minimize potential dermal and respiratory exposures to identified site contaminants of concern while conducting sample collection. In addition, good personal hygiene practices and procedures must be maintained (see Section 7 of this HSP).
- Caution should be exercised when filling bottles containing acid or base preservatives. Both liquid and vapor phases of acid can cause severe burns.

- Following sample collection, sample container lids should be tightened securely to prevent any leaks, and the containers should be rinsed with clean water to ensure that they are free of chemical constituents.

3.27.1 Handling or Sampling of Drummed Waste

During the execution of the contract, various types and quantities of generated waste materials will be generated and may include, but not be limited to PPE, soil cuttings and decontamination fluids. Personnel are permitted to handle and/or sample drums containing known waste sources/materials, but handling or sampling of other drums (unknowns) requires a HSP revision or amendment approved by the CH2M HILL HSM. The following control measures must be taken when managing drums containing waste sources/materials:

- Minimize transportation of drums or other containers with generated waste materials. However, where this is deemed necessary appropriate drum "dollys"/hand trucks or other suitable material handling equipment shall be used to transfer drums of generated waste materials.
- **Sample or open only labeled drums or drums known to contain generated waste materials. Unknown drums or drums that show evidence of excessive buckling/ bulging, corrosion, vapors, crystallization, unusual discoloration or other abnormalities may not be sampled without the evaluation of engineering controls, proper PPE air monitoring equipment and the use properly trained personnel familiar with the sampling of unknown drum contents. If there is any question to the proper handling or opening of drums.**
- Use caution when sampling bulging or swollen drums. Relieve pressure slowly and step away from the drum as pressure is being released.
- If drums contain, or potentially contain, flammable materials, use non-sparking (i.e., brass) tools to open the drum.
- Picks, chisels, and firearms may not be used to open drums.
- Reseal bung holes or plugs whenever possible.
- Avoid mixing incompatible drum contents.
- Sample drums without leaning over the drum opening.
- Transfer the content of drums using a method that minimizes contact with material.
- PPE and air monitoring requirements shall be executed in accordance with Sections 5 and 6, respectively, of this HSP in an effort to minimize potential dermal and respiratory exposures to identified site contaminants of concern. In addition, good personal hygiene practices and procedures must be maintained (see Section 7 of this HSP).
- Spill-containment procedures specified in Section 8 of this HSP must be appropriate for the material to be handled.

3.28 Stairways and Ladders

(Reference SOP # HSE&Q 214, Stairways and Ladders)

(Reserved)

3.29 Unknown or Suspect Objects/Materials

If unknown or suspect objects/materials are encountered (i.e. exposed or partially buried drums, tanks, biological waste, cylinders, munitions of explosive concern, unusually stained/discolored soil) are encountered during site operations, ongoing activities shall be immediately suspended. CH2M HILL or subcontractor personnel encountering unknown or suspect objects/materials shall (1) secure the area and identify the location of the object/material to the extent possible, without causing bodily injury to yourself or others and without disturbing the object, (2) evacuate the work area, (3) immediately notify the project manager of the encountered condition and (4) not cause additional disturbance to or otherwise handle the suspect object/material. The site supervisor, SHSO, or FTL shall contact the Project Manager and the HSM to evaluate potential hazards associated with the specific situation encountered. The project team will then address the need for the use of special procedures, engineering controls, PPE, or specialized subcontract personnel to safely mitigate the situation.

3.29.1 Munitions and Explosives of Concern

(Reserved)

3.30 Vacuum Truck Operations

(Reserved)

3.31 (Exposure to) Vehicular Traffic

(Reference SOP # HSE&Q 216, Traffic Control)

The following standard work practices must be exercised when personnel are working in or around haul truck routes or near an area where traffic controls have been established:

- Review and implement all applicable components of CH2M HILL SOP # HSE&Q 216, Traffic Control, except where other requirements may be more stringent.
- When parking your vehicle, park in a manner that will allow for safe exit from vehicle, and where practicable, park vehicle so it can serve as a barrier.
- Shut off and secure site vehicles prior to exiting them. Park on level ground where possible. If parking on an incline, engage parking brake. If the vehicle has a manual transmission, ensure the transmission is in gear (not neutral) and the parking brake is engaged before exiting the vehicle.

- Exercise caution when exiting traveled way or parking along street—avoid sudden stops, use flashers, etc.
- All staff working adjacent to traveled way or within work area must wear reflective/high-visibility safety vests.
- Eye protection should be worn to protect from flying debris.
- Remain aware of factors that influence traffic-related hazards and required controls—sun glare, rain, wind, limited sight-distance, hills etc.
- Always remain aware of an escape route, such as behind an established barrier or parked vehicle.
- Always pay attention to moving traffic—never assume drivers are looking out for you.
- Work as far from traveled way as possible to avoid creating confusion for drivers.
- When workers must face away from a haul truck to perform assigned duties, a "buddy system" should be used, where one worker is looking toward traffic.
- Work area should be protected by a physical barrier.
- Lookouts should be used when physical barriers are not available or practical.

In addition to the above work practices, CH2M HILL personnel and CH2M HILL subcontractors shall adhere to the following procedures while operating motor vehicles or other motorized equipment on military/government facilities.

- Always use a seat belt while driving on military/government facilities
- Always observe posted speed limits, traffic signs and signals
- Never use a cell phone or two-way radio while driving on military/government facilities

Violating these requirements may result in loss of military/government facility driving privileges.

3.32 Visible Lighting

Site work should be performed during daylight hours whenever possible. Work conducted during hours of darkness (including dusk and dawn) requires the set-up of supplemental lighting equipment. (Note: A general "rule of thumb" is that the illumination intensity must be sufficient to read a newspaper without difficulty). The chart below provides a reference for illumination requirements for various construction related work environments.

Illumination		
(foot-candles)	(lux)	Area of Operation
5	~ 55	General construction area lighting
3	~ 33	General construction areas, concrete placement, excavation and waste areas, access ways, active storage areas, loading platforms, refueling, and field maintenance areas
5	~ 55	Indoors: warehouses, corridors, hallways, and exit ways
5	~ 55	Tunnels, shafts, and general underground work areas: (Exception: minimum of 10 foot-candles is required at tunnel and shaft heading during drilling, mucking, and scaling. Bureau of Mines approved caplights shall be acceptable for use in the tunnel heading)
10	~ 108	General construction plant and shops (e.g., batch plants, screening plants, mechanical and electrical equipment rooms, carpenter shops, rigging lofts and active store rooms, mess halls and indoor toilets and workrooms.)
30	~ 323	First aid stations, infirmaries, and offices

Notes:

A **foot candle** is a unit of illumination on a surface that is everywhere 1 foot from a point source of one candle. A **lux** is a unit of measurement of the intensity of light. It is equal to the illumination of a surface 1 meter away from a single candle.

Conversions:

Foot-candles (FC) = Lux × 0.0929
Lux = Foot candles × 10.76 - (i.e.: 50 FC = 538 lux)

The following safe work practices shall be considered with regard to lighting in the workplace:

- Do not enter poorly lit areas without first providing portable illumination.
- Do not use non-explosion proof lighting in areas of flammable or combustible gases or liquids.

3.33 Welding or Cutting Operations

(Reference SOP # HSE&Q 314, Welding & Cutting)

(Reserved)

3.34 Working Alone

(Reserved)

3.35 Working Around Material Handling Equipment

(Reserved)

3.36 Working on or Over Water

(Reserved)

3.37 General Hazards

3.37.1 General Practices and Housekeeping

- Maintain good housekeeping at all times in all project work areas.
- Establish common paths of travel and keep them free from the accumulation of materials.
- Keep access to aisles, exits, ladders, stairways, scaffolding, and emergency equipment free from obstructions.
- Provide slip-resistant surfaces, ropes, and/or other devices to be used.
- Designate specific areas for the proper storage of materials.
- Store tools, equipment, materials, and supplies in an orderly manner.
- As work progresses, neatly store scrap and unessential materials or remove them from the work area.
- Provide containers for collecting trash and other debris and remove them at regular intervals.
- Clean up all spills quickly. Clean oil and grease from walking and working surfaces.

3.37.2 Hazard Communication

The SSHO or designee will serve as the Hazard Communication Coordinator, and will perform the following:

- Review the COC information contained this HSP.
- Complete an inventory of chemicals brought onsite. See **Attachment 6** of this HSP. Give employees required chemical-specific HAZCOM training information using the format included in **Attachment 6** of this HSP.
- Confirm that an inventory of chemicals brought onsite is available.
- Request or confirm locations of material safety data sheets (MSDSs) from the client, contractors, and subcontractors or material vendors for chemicals to which CH2M HILL employees are potentially exposed. Maintain MSDSs in this HSP (**Attachment 5**).
- Before or as chemicals arrive onsite, obtain an MSDS for each hazardous chemical.
- Label chemical containers with the identity of the chemical and with hazard warnings, and store properly.
- Store all materials properly, giving consideration to compatibility, quantity limits, secondary containment, fire prevention, and environmental conditions.

3.37.3 Shipping and Transportation of Chemical Products

Chemicals brought to the site might be defined as hazardous materials by the U.S. Department of Transportation (DOT). All staff who ship the materials or transport them by road must receive training in shipping dangerous goods. All hazardous materials that are shipped (e.g., via Federal Express) or are transported by road must be properly identified, labeled, packed, and documented by trained staff. Contact the CH2M HILL Project Manager, HSPA/CIH or program regulatory specialist for additional information.

3.37.4 Heat Stress

- It is recommended that personnel drink 16 ounces of water before beginning work. Disposable cups and water maintained at 50 to 60°F should be available. Under severe conditions, drink 1 to 2 cups every 20 minutes, for a total of 1 to 2 gallons per day. Do not use alcohol in place of water or other nonalcoholic fluids. Decrease your intake of coffee and caffeinated soft drinks during working hours.
- Acclimate yourself by slowly increasing workloads (e.g., do not begin with extremely demanding activities).
- Use cooling devices, such as cooling vests, to aid natural body ventilation. These devices add weight, so their use should be balanced against efficiency.
- Use mobile showers or hose-down facilities to reduce body temperature and cool protective clothing.
- Conduct field activities in the early morning or evening and rotate shifts of workers, if possible.
- Whenever possible, avoid direct sun, which can decrease physical efficiency and increase the probability of heat stress. Take regular breaks in a cool, shaded area. Use a wide-brim hat or an umbrella when working under direct sun for extended periods.
- Provide adequate shelter/shade to protect personnel against radiant heat (sun, flames, hot metal).
- Maintain good hygiene standards by frequently changing clothing and showering.
- Observe one another for signs of heat stress. Persons who experience signs of heat syncope, heat rash, or heat cramps should consult the SSHO to avoid progression of heat-related illness.
- To counteract the onset of heat stress symptoms, a work-break regimen must be established during the executed work. Workers in Level C PPE shall be allowed to rest and lower core body temperature to normal status when any one condition is exceeded:
  - Visual signs and symptoms of heat stress are present in a worker.
  - It is determined that a worker's core body temperature exceeds 100.4°F.
  - Active work duration in Level C PPE in ambient temperatures in excess of 73°F (without regard to humidity evaluation) occurs for more than 1 hour.

SYMPTOMS AND TREATMENT OF HEAT STRESS

	Heat Syncope	Heat Rash	Heat Cramps	Heat Exhaustion	Heat Stroke
Signs and Symptoms	Sluggishness or fainting while standing erect or immobile in heat.	Profuse tiny raised red blister-like vesicles on affected areas, along with prickling sensations during heat exposure.	Painful spasms in muscles used during work (arms, legs, or abdomen); onset during or after work hours.	Fatigue, nausea, headache, giddiness; skin clammy and moist; complexion pale, muddy, or flushed; may faint on standing; rapid thready pulse and low blood pressure; oral temperature normal or low	Red, hot, dry skin; dizziness; confusion; rapid breathing and pulse; high oral temperature.
Treatment	Remove to cooler area. Rest lying down. Increase fluid intake. Recovery usually is prompt and complete.	Use mild drying lotions and powders, and keep skin clean for drying skin and preventing infection.	Remove to cooler area. Rest lying down. Increase fluid intake.	Remove to cooler area. Rest lying down, with head in low position. Administer fluids by mouth. Seek medical attention.	Cool rapidly by soaking in cool–but not cold–water. Call ambulance, and get medical attention immediately!

3.37.5 Monitoring Heat Stress

These procedures should be implemented when the ambient air temperature exceeds 73°F, the relative humidity is high (>50 percent), or when workers exhibit symptoms of heat stress.

The heart rate (HR) should be measured by the radial pulse for 30 seconds, as early as possible in the resting period. The HR at the beginning of the rest period should not exceed 100 beats/minute, or 20 beats/minute above resting pulse. If the HR is higher, the next work period should be shortened by 33 percent, while the length of the rest period stays the same. If the pulse rate still exceeds 100 beats/minute at the beginning of the next rest period, the work cycle should be further shortened by 33 percent. The procedure is continued until the rate is maintained below 100 beats/minute, or 20 beats/minute above resting pulse.

When CH2M HILL employees are required to wear Level C PPE and are exposed to ambient air conditions in excess of 73°F, heat stress monitoring shall be facilitated by the use of automatic blood pressure monitors and/or having body temperature measurements monitored with aural or oral thermometers. All temperature measurement devices shall be affixed with disposable covers or protectors to ensure exposure to bloodborne pathogens does not occur.

3.37.6 Cold Stress

(Reserved)

3.38 Procedures for Locating Buried Objects/Utilities

Name: NC One-Call Center
Phone: 1.800.632.4949
Website: www2.ncocc.org

Do not begin subsurface construction activities (e.g., excavation) or other ground disturbing activities until a check for underground utilities and similar obstructions has been conducted. The use of as-built drawings and utility company searches must be supplemented with a geophysical or other survey by a qualified, independent survey contractor to identify additional and undiscovered buried utilities. Examples of the type of geophysical technologies include:

- **Ground Penetrating Radar** can detect pipes, including both metallic and non-metallic gas pipes, tanks, conduits, and cables, at depths up to 30 feet depending on equipment. Sensitivity for both minimum object size and maximum depth detectable depends on equipment selected, soil conditions, etc.
- **Radio Frequency (RF)** involves inducing an RF signal in the pipe or cable and using a receiver to trace it. Some electric and telephone lines emit RF naturally and can be detected without an induced signal. This method requires knowing where the conductive utility can be accessed to induce RF field if necessary.
- **Dual RF** is a modified version of RF detection using multiple frequencies to enhance sensitivity but with similar limitations to RF.
- **Ferromagnetic Detectors** are metal detectors that will detect ferrous and non-ferrous utilities. Sensitivity is limited, e.g., a 100-mm iron disk to a depth of about 1 meter or a 25-mm steel paper clip to a depth of about 20 cm.
- **Electronic markers** are emerging technologies that impart a unique electronic signature to materials such as polyethylene pipe to facilitate location and tracing after installation. Promising for future installations but not of help for most existing utilities already in place.

3.38.1 Procedure

- The following procedures shall be used to identify and mark underground utilities during subsurface construction activities on the project.
- The survey subcontractor shall determine the most appropriate geophysical technique or combinations of techniques to identify the buried utilities on the project, based on the survey contractor's experience and expertise, types of utilities anticipated to be present, and specific site conditions.
- The survey contractor shall employ the same geophysical techniques used on the project to identify the buried utilities, to survey the proposed path of subsurface construction work to confirm no buried utilities are present.

- Identify customer specific permit and/or procedural requirements for excavation and drilling activities. For military installations, contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.
- Contact utility companies or the state/regional utility protection service at least three working days prior to excavation activities to advise of the proposed work, and ask them to establish the location of the utility underground installations prior to the start of actual excavation.
- Schedule the independent survey.
- Obtain utility clearances for subsurface work on both public and private property.
- Clearances are to be in writing, signed by the party conducting the clearance.
- Underground utility locations must be physically verified by hand digging using wood or fiberglass-handled tools when any adjacent subsurface construction activity (e.g., mechanical drilling, excavating) work is expected to come within 5 feet of the marked underground system. If subsurface construction activity is within 5 feet and parallel to a marked existing utility, the utility location must be exposed and verified by hand digging every 100 feet.
- Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, the Project Manager must notify the utility company or utility protection service to inform them that the markings have been destroyed.
- Conduct a site briefing for employees regarding the hazards associated with working near the utilities and the means by which the operation will maintain a safe working environment. Detail the method used to isolate the utility and the hazards presented by breaching the isolation.
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon during drilling or change in color, texture, or density during excavation that could indicate the ground has been previously disturbed).
- In addition to the information contained in this section, personnel performing hand auguring operations should use a fiberglass ground probe to search ahead to the next sample interval prior to advancing the hand auger. When performing environmental sampling, decontamination of the fiberglass ground probe shall apply.
- When the client or other onsite party is responsible for determining the presence and locations of buried utilities, the CH2M HILL individual responsible for site operations shall confirm the arrangement and be available onsite to verify the location of underground utilities or identified subsurface anomalies that may be in question and require further investigation measures.

3.39 Biological Hazards and Controls

The following sections provide information on potential biological hazards. Site personnel shall notify their overall supervisors and their project site supervisor of any potential allergic reactions that may occur as a result of contact with biological hazards in the workplace. If employee antidotes are required to counteract allergic reactions from biological hazard exposure, employees shall make personnel, who may be required to administer personal antidotes, aware of the location, type, and quantity of antidotes needed to counteract any potential allergic reaction(s).

3.39.1 Venomous Snakes

Although the potential exposure to poisonous snakes during the execution of this Task Order is considered to be negligible, this information is included for the purposes of providing employee awareness.

Snakes typically are found in underbrush, tall grassy areas, near cover such as fallen logs, brush piles, rock walls, abandoned foundations, or rock ledges. They may be resting or waiting for prey. Watch where you place your hands and feet! Walk around, rather than over, fallen logs. When traveling through areas thought to contain venomous snakes, you can minimize the possibility of an encounter by using common sense. If you encounter a snake do your best to stay calm and look around as there may be other snakes. Turn around and walk away on the same path you used to approach the area. If a person is bitten by a snake, wash and immobilize the injured area, keeping it lower than the heart if possible. Seek medical attention immediately. **DO NOT apply ice, cut the wound, or apply a tourniquet**. Try to identify the type of snake: note color, size, patterns, and markings to assist medical personnel with proper treatment measures (see below – Identification of Venomous Snakes). Try to identify the type of snake: note color, size, patterns, and markings to assist medical personnel with proper treatment measures (see below – Identification of Venomous Snakes). Note: Rattlesnakes do not always rattle when a "threat" is near.

1. Northern Copperhead

2. Canebrake Rattlesnake (Timber Rattler)

3. Eastern Diamondback Rattlesnake

4. Pigmy Rattlesnake (Southeast NC)

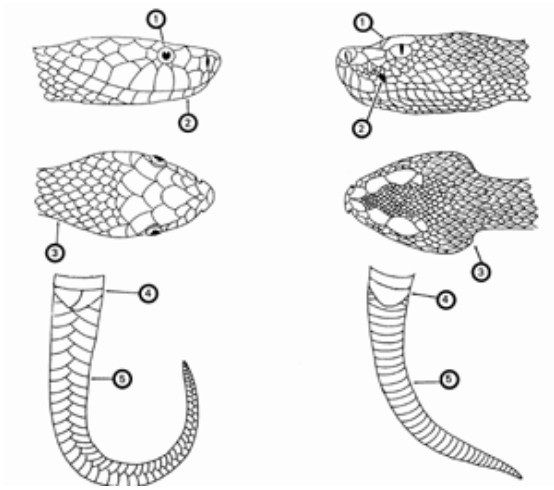
5. Cottonmouth (aka Water Moccasin)

6. Coral Snake

IDENTIFICATION OF VENOMOUS SNAKES

Major Identification Features

Non-venomous Snake	
1. Round pupils	
2. No sensing pit	
3. Head slightly wider than neck	
4. Divided anal plate	
5. Double row of scales on the underside of the tail	
Venomous Snake	
1. Elliptical pupils	
2. Sensing pit between eye and nostril	
3. Head much wider than neck	
4. Single anal plate	
5. Single scales on the underside of the tail	



3.39.2 Poisonous Plants

Poison ivy, poison oak, and poison sumac typically are found in brush or wooded areas. They are more commonly found in moist areas or along the edges of wooded areas. Shrubs

are usually 12 to 30 inches high, or can also be a tree-climbing vine, with triple leaflets and short, smooth hair underneath. Plants are red and dark green in Spring and Summer, with yellowing leaves anytime especially in dry areas. Leaves may achieve bright reds in Fall, but plants loses its (yellowed, then brown) leaves in Winter, leaving toxic stems. All parts of the plant remain toxic throughout the seasons.

Become familiar with the identity of these plants (see below). Wear protective clothing that covers exposed skin and clothes. Avoid contact with plants and the outside of protective clothing. If skin contacts a plant, wash the area with soap and water immediately. If the reaction is severe or worsens, seek medical attention.

Poison Ivy

Poison Sumac

Poison Oak

3.39.2.1 Exposure

Contamination with poison oak, ivy, or sumac can happen through several pathways. These include

- Direct skin contact with any part of the plant.
- Contact with clothing that has been contaminated
- Contact from removing shoes that have been contaminated. (your shoes are coated with oil)
- Sitting in a vehicle that has become contaminated
- Contact with any objects or tools that have become contaminated.

Exposure to poison oak, ivy, or sumac often becomes an OSHA recordable illness. Take proper action if you are potential contaminated. The dermatitis is so severe that many people seek medical care and get prescription cortisone creams or steroid shots to reduce the suffering caused by the itch.

For CH2M HILL employees exposed on the job, contact WorkCare at (866) 893-2514 for assistance with the management of the exposure. For work-related injuries or illnesses to CH2M HILL personnel, inform the CH2M HILL Project Manger (overall) and the CH2M HILL health and safety manager (HSM) and help the Human Resources administrator complete a HITS (Hours & Incident Tracking System) Form. HITS must be completed within 24 hours of incident.

3.39.2.2 Best Work Practices

If you must work on a site that has been identified to potentially contain poison oak, ivy, or sumac, the following precautions are necessary:

- Identify plants containing urushiol – The best way to prevent exposure is to recognize the plant and avoid working in areas where poison oak, ivy, or sumac is present.
- If you must work in areas with urushiol containing plants, contact you project manager and health and safety manager to determine the best procedures to prevent contamination.
- Do not drive vehicles onto the site where it will come into contact with poison oak, ivy, or sumac. Vehicles which need to work in the area, such as drill rigs or heavy equipment must be washed and decontaminated as soon as possible after leaving the site.
- All tools used in the area, including those used to cut back the plants, surveying instruments used in the area, air monitoring equipment or other test apparatus must be decontaminated before they are placed back into the site vehicle. If on-site decontamination is not possible, use plastic to wrap any tools or equipment until they can be decontaminated. If working on or near the ground surface, place plastic on the ground to cover the grass and foliage.
- PPE, including Tyvek coveralls, gloves, and boot covers must be worn. PPE and plastic used to cover the ground must be placed into separate plastic bags and sealed if they are not disposed immediately into a trash receptacle.
- Shower as soon as possible to remove any potential contamination. Any body part with suspected or actual exposure should be washed with "Tecnu" or other product designed for removing urushiol. If you do not have Tecnu wash with cold water. Do not take a bath, as the oils can form and invisible film on top of the water and contaminate your entire body upon exiting the bath.
- Zanfel™ may also be used to treat exposed areas that are experiencing signs and symptoms of poison oak, ivy, or sumac contamination. The CH2M HILL warehouses carry Zanfel™ products, which must be carried in First Aid Kits as deemed appropriate. Refer to the Zanfel™ information guide below for specific product and contact information.
- Use products such as IvyBlockTM to prevent poison oak, ivy and sumac contamination. IvyBlockTM is approved by the FDA to prevent the rash caused by poison oak, ivy, and sumac.

3.39.2.3 Poison Oak, Ivy, and Sumac First Aid

If there is exposure use the following first aid procedures, or others you may find to alleviate the pain and itching.

Are there any of these problems?

- Swelling in the throat, tongue and/or lips
- A hard time breathing or swallowing
- Weakness, dizziness
- Bluish lips and mouth
- Unconsciousness

YES

Use emergency kit with adrenalin, if available, and Get Emergency Care.

NO

Do you have any of these problems?

- Skin that is very bright red.
- Pus.
- Rash that has spread to the mouth, eyes or genitals.
- Rash on large areas of the body or the face.

YES

Give first aid before seeing doctor:

- Take a hot shower (only after rash develops), put the rash area in hot water or pour hot water over it. Make sure the water is not too hot to burn the skin. The hot water causes itching at first, but brings relief later. Do not use soap.
- Take an over-the-counter antihistamine, such as Benadryl, as stated on the label.
- For weeping blisters:
- Mix 2 teaspoons of baking soda in 1 quarter (4 cups) of water.
- Dip squares of gauze in this mixture.
- Cover the blisters with the wet gauze for 10 minutes, four times a day. (Do not apply this to the eyes.)

NO

Self-Care/First Aid

- Wash (decontaminate) all affected areas with warm water and a strong soap.
- Keep your hands away from your eyes, mouth and face.
- Do not scratch or rub the rash.
- Apply any of these to the skin rash:
- Calamine (not Caladryl) lotion
- Zanfel™ lotion
- Zinc oxide ointment
- Paste made with baking soda - mix 3 teaspoons of baking soda with 1 teaspoon of water
- Take an over-the-counter antihistamine such as Benadryl, as stated on the label
- If self-care/first aid measures don't bring relief, notify your supervisor.

3.39.2.4 Urushiol Plant Facts

Urushiol Oil is Potent

- Only 1 nanogram (billionth of a gram) needed to cause rash
- Average is 100 nanograms for most people
- 0.25 ounce of urushiol is all that is needed to cause a rash in every person on earth
- 500 people could itch from the amount covering the head of a pin
- Specimens of urushiol several centuries old have found to cause dermatitis in sensitive people.
- 1 to 5 years is normal for urushiol oil to stay active on any surface including dead plants
- Derived from **urushi**, Japanese name for lacquer

Myth	Fact
Poison oak, ivy, and sumac are contagious	Rubbing the rashes won't spread poison ivy to other parts of your body (or to another person). You spread the rash only if **urushiol oil**--the sticky, resinlike substance that causes the rash -- has been left on your hands.
You can catch poison ivy simply by being near the plants	Direct contact is needed to release urusiol oil. Stay away from forest fires, direct burning, or anything else that can cause the oil to become airborne such as a lawnmower, trimmer, etc.
Leaves of three, let them be	Poison sumac has 7 to 13 leaves on a branch, although poison ivy and oak have 3 leaves per cluster
Do not worry about dead plants	Urushiol oil stays active on any surface, including dead plants, for up to 5 years.
Breaking the blisters releases urushiol oil that can spread	Not true. But your wounds can become infected and you may make the scarring worse. In very extreme cases, excessive fluid may need to be withdrawn by a doctor.

3.39.2.5 New Cream to Treat Exposure to Poison Plants

Exposure to poison oak, ivy, and sumac can be uncomfortable, and in some cases the rash can become so severe that medical care is required. A relatively new product is available Zanfel™ (www.zanfel.com) that helps prevent blistering and itching from becoming severe. If you are working in an area with poison oak, ivy or sumac, you can obtain this cream by contacting CH2M HILL 's regional warehouse or notify your supervisor of the need to purchase this material. :

Please remember, the cream does not replace preventative measures, including:

- Avoiding contact with poison oak, ivy and sumac.
- Wearing Tyvek coveralls and gloves to prevent contact.
- Washing with Tecnu® (or a similar product) after potential exposure.
- Washing clothing and decontaminating equipment with an oil-cutting detergent.

3.39.2.6 More Information about Zanfel (from Zanfel):

Zanfel™ is an effective wash for urushiol-induced contact dermatitis. Urushiol is the toxin known to cause the itching and rash associated with poison oak, ivy, sumac, poisonwood, and related plants. Zanfel works by surrounding urushiol and bonding with it, thereby enabling it to be rinsed away. Unlike some products that require use within 10 to 20 minutes of contact or that required continued use until the rash is gone (which can take up to 5 weeks), Zanfel offers relief at any stages of the reaction and often with only one wash. Individuals with particularly severe reactions may require additional washes. Most individuals experience relief from the itching within 30 seconds of application. The rash will begin to subside within hours if the reaction is mild to moderate. Severe and systemic cases will still require medical attention. Severe cases are defined as breakouts that are present on more than 15 percent of the body, and new breakouts continue to develop after day 4.

3.39.3 Ticks

Every year employees are exposed to tick bites at work and at home putting them at risk of illness. Ticks typically are in wooded areas, bushes, tall grass, and brush. Ticks are black, black and red, or brown and can be up to one-quarter inch in size.

In some geographic areas exposure is not easily avoided. Wear tightly woven light-colored clothing with long sleeves and pant legs tucked into boots; spray **only outside** of clothing with permethrin or permanone and spray skin with only DEET; and check yourself frequently for ticks.

Where site conditions warrant (vegetation above knee height, tick endemic area) or when tasks warrant (e.g., having to sit/kneel in vegetation) that diminish the effectiveness of the other controls mentioned above, bug-out suits (obtained from MKE warehouse)/Tyvek shall be used. Bug-out suits are more breathable than Tyvek.

Take precautions to avoid exposure by including pre-planning measures for biological hazards prior to starting field work. Contact the MKE Warehouse for preventative equipment such as repellants, protective clothing and tick removal kits. Use the buddy system and perform tick inspections prior to entering the field vehicle. If ticks were not

planned to be encountered and are observed, do not continue field work until these controls can be implemented.

See Tick Fact Sheet attached to this HSP for further precautions and controls to implement when ticks are present. Information includes the procedure for submitting a removed tick for testing. If bitten by a tick, follow the removal procedures found in the tick fact sheet, call the occupational nurse at 1-866-893-2514.

Be aware of the symptoms of Lyme disease or Rocky Mountain spotted fever (RMSF). Lyme: a rash might appear that looks like a bullseye with a small welt in the center. RMSF: a rash of red spots under the skin 3 to 10 days after the tick bite. In both RMSF and Lyme disease, chills, fever, headache, fatigue, stiff neck, and bone pain may develop. If symptoms appear, again contact the occupational nurse at 1-866-893-2514.

3.39.3.1 Hazard Control

The methods for controlling exposure to ticks include, in order of most-preferred to least:

- Avoiding tick habitats and ceasing operations in heavily infested areas
- Reducing tick abundance through habitat disruption or application of acracide
- Personal protection through use of repellants and protective clothing
- Frequent tick inspections and proper hygiene

Vaccinations are not available and preventive antibiotic treatment after a bite is generally not recommended.

3.39.3.2 Tick Identification

There are five varieties of hard-bodied ticks that have been associated with tick-borne pathogens. These tick varieties include:

- Deer (black legged) tick (eastern and Pacific varieties)
- Lone star tick
- Dog tick (American and brown)
- Rocky Mountain wood tick
- Western black-legged tick

3.39.3.3 Illnesses and Signs/Symptoms

There are six distinguishable tick-borne pathogens that cause human illness in the United States. These pathogens may be transmitted during a tick bite— normally hours after attachment. The illnesses, presented in approximate order of most common to least, include:

1. Lyme (bacteria)
2. Rocky Mountain spotted fever (bacteria)
3. Ehrlichiosis (bacteria)
4. Southern tick-associated rash illness (bacteria)
5. Tularemia (rabbit fever) (bacteria)
6. Babesia (protozoan parasite)

Symptoms will vary based on the illness, and may develop in infected individuals typically between 3 and 30 days after transmission. Some infected individuals will not become ill or

may develop only mild symptoms. These illnesses present with some or all of the following signs and symptoms: fever, headache, muscle aches, stiff neck, joint aches, nausea, vomiting, abdominal pain, diarrhea, malaise, weakness, and small solid, ring-like, or spotted rashes. The bite site may be red, swollen, or develop ulceration or lesions. A variety of long-term symptoms may result when untreated, including debilitating effects and death.

3.39.3.4 Tick Removal

1. Use fine-tipped tweezers or shield your fingers with a tissue, paper towel, or nitrile gloves.
2. Grasp the tick as close to the skin surface as possible and pull upward with steady, even pressure. Do not twist or jerk the tick; this may cause the mouthparts to break off and remain in the skin. (If this happens, remove mouthparts with tweezers. Consult your healthcare provider if infection occurs.)
3. Do not squeeze, crush, or puncture the body of the tick because its fluids (saliva, hemolymph, and gut contents) may contain infectious organisms. Releasing these organisms to the outside of the tick's body or into the bite area may increase the chance of infectious organism transmission.
4. Do not handle the tick with bare hands because infectious agents may enter through mucous membranes or breaks in the skin. This precaution is particularly directed to individuals who remove ticks from domestic animals with unprotected fingers. Children, elderly persons, and immunocompromised persons may be at greater risk of infection and should avoid this procedure.
5. After removing the tick, thoroughly disinfect the bite site and wash your hands with soap and water.
6. You may wish to save the tick for identification in case you become ill. Your doctor can use the information to assist in making an accurate diagnosis. Place the tick in a plastic bag and put it in your freezer. Write the date of the bite on a piece of paper with a pencil and place it in the bag. See "First Aid and Medical Treatment" information below.

Note: Folklore remedies such as petroleum jelly or hot matches do little to encourage a tick to detach from skin. In fact, they may make matters worse by irritating the tick and stimulating it to release additional saliva, increasing the chances of transmitting the pathogen. These methods of tick removal should be avoided. In addition, a number of tick removal devices have been marketed, but none are better than a plain set of fine tipped tweezers.

Previously infected individuals are not conferred immunity— re-infection from future tick bites can occur even after a person has contracted a tick-borne disease.

3.39.3.5 First-Aid and Medical Treatment

Tick bites should always be treated with first-aid. Clean and wash hands and disinfect the bite site after removing embedded tick. Consult a healthcare professional if infection or symptoms and effects of tick-borne illnesses are developing.

Medical treatments for tick-borne infections include antibiotics and other medical interventions. Diagnosis of specific illness involves both clinical and laboratory confirmations. Preventive antibiotic treatment in non-ill individuals who have had a recent tick bite is recommended in specific cases only.

For CH2M HILL employees who have experienced a tick bite due to work-related activities, CH2M HILL has a protocol in place to test ticks that have been removed from an employee's body for the presence of Borrelia burgdorferi. Employees should contact the IMRTW at WorkCare at (866) 893-2514 for assistance with the management of the tick bite. (See **Attachment 11** of this HSP, for details). The employee will be given instructions on how to send the tick to the Clongen Laboratory for analysis as determined by Work Care. If the results indicate that the tick is positive for Lyme disease, they will be referred to a medical provider for further medical evaluation and treatment. WorkCare will follow up with each CH2M HILL employee who reports a tick bite and is at risk of developing Lyme disease to monitor for symptoms and refer them to a medical provider for evaluation and treatment as necessary.

Tick Analysis Procedure for Lyme disease:

- For tick removal, follow the instructions in your tick removal kit using a fine pointed pair of tweezers. If the tick is alive, place it in two layered zip-lock bags. It is highly recommended that you wear gloves when removing the tick from the skin to avoid infection.
- It is important to remove the entire tick and place it in a zip-lock bag.
- Place the zip-lock bag in an envelope and fill out the sample Clongen submission form included in **Attachment 11** of this HSP as directed by Work Care. Please identify yourself as a CH2M HILL employee by completing all the contact information in the form. The cost of the analysis will be paid for by CH2M HILL ; you do not have to use a credit card or check. The account has an assigned purchase order that is billed directly to Work Care for payment.

Within 1 to 3 days, you will be contacted by Work Care to discuss the tick analysis results, and to discuss any further need for medical evaluation.

*For work-related injuries or illnesses to CH2M HILL personnel, inform the CH2M HILL Project Manger (overall) and the CH2M HILL HSM and help Human Resources administrator complete a HITS (Hours & Incident Tracking System) Form. HITS must be completed within 24 hours of incident.

3.39.4 Fire Ants

(Reserved)

3.39.5 Spiders - Brown Recluse

It is regarded by many as the most dangerous spider in the United States. Although Virginia is generally not a known habitat of the brown recluse, because of interstate shipping/transportation the Brown Recluse spider can be found most anywhere in the

United States. Specific reports of the recluse presence have been identified for North Carolina.

Brown Recluse Spiders are usually 1 inch or larger in size, including the legs and can grow as large as 3 inches. Young Brown Recluse spiders are smaller and somewhat lighter in color. Brown recluse spider bites don't always hurt right away.

In fact, you may not know that you have been bitten until other symptoms appear. Symptoms of a brown recluse spider bite may include the following:

- Reddened skin followed by a blister that forms at the bite site.
- Mild to intense pain and itching for 2 to 8 hours following the bite.
- An open sore with a breakdown of tissue (necrosis) that develops within a few hours to 3 to 4 days following the bite and the area may become painful, itchy, hot, swollen, red and tender. An irregular ulcerous sore, caused by necrosis, will often appear that is from 0.25 to 10 inches in diameter. Prompt attention is the best defense against preventing the necrosis. The wound is often described as being reddish and surrounded by a bluish area with a narrow whitish separation in between the red and the blue. This gives it the famous “bull’s eye” pattern. In just hours, a bite from the highly venomous brown recluse spider can create blisters and cause tissue damage.

Some people have a severe, systemic (whole-body) reaction to brown recluse spider bites, including the rapid destruction of red blood cells and anemia. Signs and symptoms include: Fever and chills.

- Skin rash all over the body with many tiny, flat purple and red spots
- Nausea or vomiting
- Joint pain

If you think you have been bitten by a brown recluse spider:

- Remain calm. Too much excitement or movement will increase the flow of venom into the blood.
- Try to collect the spider, without being bitten, (even a mangled specimen has diagnostic value), if possible, for positive identification by a spider expert. A plastic bag, small jar, or pill vial is useful and no preservative is necessary, but rubbing alcohol helps to preserve the spider.
- Apply a cool, wet cloth to the bite or cover the bite with a cloth and apply an ice bag to the bite.
- Do not apply a tourniquet. It may cause more harm than benefit.
- Try to positively identify the spider to confirm its type.
- Seek prompt medical attention.

A brown recluse bite can be serious and will likely require immediate medical care. Seek medical attention if you believe you have been bitten by a recluse spider, especially if severe symptoms develop throughout your body or an open sore and necrosis develop. A brown recluse spider bite is diagnosed through a physical examination and questions about the bite. You should be prepared to describe the spider, where and when the bite took place, and what you were doing at the time. Your health professional will ask what your main symptoms are, when they began, and how they have developed, progressed, or changed since the bite.

3.39.6 Spiders - Widow

There are four identified widow species that maybe encountered at the site location, are as follows: the Southern Black, Northern Black, Brown and Red widows. Females range from 8 to 15 mm in body length; males are smaller, sometimes very small (2 mm). Most have globose, shiny abdomens that are predominantly black with red markings (although some may be pale and/or have lateral stripes), with moderately long, slender legs. These spiders are nocturnal and build a three-dimensional tangled web, often with a conical tent of dense silk in a corner where the spider hides during the day. In nature, most species are found under rocks and logs, but they readily adapt to human-altered environments, where they are most commonly found in outbuildings (sheds, barns, privies), water meter holes, nursery cans, and under any item or structure (e.g., barbeque grill, slide, sand box) that has been undisturbed for a lengthy period. Formerly, most bites by black widows (almost all by female spiders) occurred in outhouses, but presently, widow bites occur most frequently when the spider is trapped against human skin, either by reaching under objects where the spider is hiding or when putting on clothing, gloves, or shoes containing the spider. Widow spiders are generally very timid and only bite in self-defense when they accidentally contact humans.

Southern Widow

Red Widow

Brown Widow

Note: The northern widow is similar to the southern widow except the telltale red markings are shaped slightly different.

Bite symptoms are systemic, spreading through the lymphatic system, and usually start about 1 to 3 hours after the bite. The most common symptoms are intense pain, rigid abdominal muscles, muscle cramping, malaise, local sweating, nausea, vomiting, and hypertension. Other symptoms may include tremors, labored breathing, restlessness, increased blood pressure, and fever. If left untreated, widow bite symptoms usually last 3 to 5 days.

If bitten, remain calm, and immediately seek medical attention (contact your physician, hospital and/or poison control center). Apply an ice pack directly to the bite area to relieve

swelling and pain. Try to collect the spider, without being bitten, (even a mangled specimen has diagnostic value), if possible, for positive identification by a spider expert. A plastic bag, small jar, or pill vial is useful and no preservative is necessary, but rubbing alcohol helps to preserve the spider. A hospital stay may be recommended, particularly for those with a heart condition or with health problems. A physician may administer a specific antivenin to counteract the venom or calcium gluconate to relieve pain. Calcium gluconate and/or antivenin may be administered to relieve or counteract symptoms.

3.39.7 Bloodborne Pathogens

(Reference SOP HSE-202, *Bloodborne Pathogens*)

Bloodborne pathogens are pathogenic microorganisms present in human blood or other potentially infectious material that can cause disease. These pathogens include, but are not limited to, the Hepatitis B Virus (HBV) and the Human Immunodeficiency Virus (HIV). Other potentially infectious material includes any human body fluid that is visibly contaminated with blood, such as saliva or vomit. It also includes all body fluids in situations where it is difficult or impossible to differentiate between body fluids, such as during an emergency response and any unfixed tissue (other than intact skin) from a human (living or dead).

In emergency medical situations, certain employees may need to render first aid as a collateral duty in response to workplace accidents or injuries. This category includes the SSHO (also SSCs), site managers/supervisors, or individuals certified in FA and CPR. Worker exposure to bloodborne pathogens may also occur when coming into contact with landfill waste or other waste streams containing potentially infectious material.

To eliminate or minimize employee exposure to bloodborne pathogens, workers who may be exposed to bloodborne pathogens or potentially infectious material must implement the following hazard control measures.

Employees expected to render first aid shall be cognizant of and adhere to the following with regard to potential exposure to bloodborne pathogens:

- First aid kits and a Bloodborne Pathogens Protection Kit shall be immediately available at the site. The kit is commercially available through most safety or medical supply vendors.
- These kits shall contain gloves, masks, CPR protectors, biohazard disposal bags, antiseptic cleanser, splash-proof goggles, towels, wipes, and an absorbent powder to clean up spills. Gloves, masks, and other PPE measures must be donned by personnel responding to emergency or first aid situations where exposure to Bloodborne Pathogens could occur.
- A portable eye wash station or means of conducting eye washing or flushing shall be readily available at each designated project site location.
- Always wash your hands and face with antiseptic soap and running water after contacting potentially infectious material. If washing facilities are unavailable, use an antiseptic cleanser with clean paper towels or moist towelettes. When antiseptic cleansers or towelettes are used, always rewash your hands and face with soap and

running water as soon as available. **Do not consume food or beverages, smoke, chew tobacco, or perform another hand to eye/face/mouth activity until after thoroughly cleaning your hand (with antiseptic soap and water), then your face and only after the employee has removed themselves from the designated work area that contains materials that can be reasonably considered being contaminated with bloodborne pathogens.**

- Use universal precautions when dealing with materials or situations where there is a potential for bloodborne pathogens. Universal precaution is an approach to infection control whereby all human blood and potentially infectious material are treated as if known to be infectious for HIV, HBV, and other bloodborne pathogens.

Personnel who may be exposed to Bloodborne Pathogens should **review and implement all applicable components of CH2M HILL SOP # HSE&Q 202, Bloodborne Pathogens, except where other requirements may be more stringent.**

3.39.8 Mosquito Bites

Because of the recent detection of the West Nile Virus in the southeastern United States, it is recommended that **preventive measures** be taken to reduce the probability of being bitten by mosquitoes whenever possible. Mosquitoes are believed to be the primary source for exposure to the West Nile Virus as well as several other types of encephalitis. The following guidelines should be followed to reduce the risk of these concerns for working in areas where mosquitoes are prevalent:

- Stay indoors at dawn, dusk, and in the early evening.
- Wear long-sleeved shirts and long pants whenever you are outdoors.
- Spray clothing with repellents containing pyrethrum or DEET because mosquitoes may bite through thin clothing.
- Apply insect repellent sparingly to exposed skin. An effective repellent will contain 35 percent DEET. DEET in high concentrations (greater than 35 percent) provides no additional protection.
- Repellents may irritate the eyes and mouth, so avoid applying repellent to the hands.
- Whenever you use an insecticide or insect repellent, be sure to read and follow the manufacturer's DIRECTIONS FOR USE, as printed on the product.

Note: Vitamin B and "ultrasonic" devices are NOT effective in preventing mosquito bites.

3.39.8.1 Symptoms of Exposure to the West Nile Virus

Most infections are mild, and symptoms include fever, headache, and body aches, occasionally with skin rash and swollen lymph glands. More severe infection may be marked by headache, high fever, neck stiffness, stupor, disorientation, coma, tremors, convulsions, muscle weakness, paralysis, and, rarely, death.

The West Nile virus incubation period is from 3 to 15 days.

If you have any questions or to report any suspicious symptoms, contact the project Health and Safety Manager.

3.39.9 Rabid Animals

Encounters with a rabid animal can lead to rabies transmission when virus from the animal's saliva, brain tissue, or spinal fluid enters open cuts or wounds in skin or mucous membranes. Therefore, not every encounter with a rabid animal is a true exposure requiring intervention. Treatment is often provided unnecessarily to people who have encountered but had no true exposure to a potentially rabid animal.

Any penetration of the skin by an animal's teeth is considered a "bite exposure." Local wound care should be performed immediately on anyone bitten by an animal. Local treatment of wounds involving immediate and extensive washing of all bite wounds, scratches, or other sites of potential exposure for 10 minutes with soap and water is arguably the most important measure for preventing rabies following an exposure to a rabid animal. Experiments done in animals suggest that thorough and vigorous cleansing to the depth of the wound with a 20 percent soap solution can reduce the risk of developing rabies. Tetanus booster vaccine (Td) should be given if indicated. A health care provider should be consulted to determine whether other measures are necessary. When a bite exposure has been determined, laboratory testing of the animal, if available, may be indicated depending upon the circumstances of the exposure (such as whether it was provoked or not) and the species involved. The risks associated with bites from different animals vary from place to place. For work on this particular contract, contact with rabid dogs, cats, raccoons, and rats could be possible.

"Non-bite exposures" include any scratches, abrasions, or contamination of mucous membranes by an infected animal's saliva, brain tissue, or spinal fluid. Other types of contacts (such as with the blood, urine, feces, or fur of an animal) would not by themselves be considered exposures capable of transmitting rabies even if the animal were known to be rabid. The virus is not hardy; once dry, saliva containing rabies virus is considered non-infectious.

SECTION 4

Behavior Based Loss Prevention System

(Reference SOP # HSE&Q 103, Behavior Based Loss Prevention System)

A Behavior Based Loss Prevention System (BBLPS) has been implemented on this project. BBLPS is a system to prevent or reduce losses using behavior-based tools and proven management techniques to focus on behaviors or acts that could lead to losses.

The four basic loss prevention tools that will be used to implement the BBLPS on this project include:

- Activity Hazard Analysis (AHA)
- Pre-Task Safety Plans (PTSP)
- Loss Prevention Observations (LPO)
- Loss and Near Loss Investigations
- Drug Free Workplace Program (DFWP)

The Project Manager and/or CH2M HILL individual responsible for site operations (site supervisor) are responsible for implementing the BBLPS on the project site and ensuring that project team members have received the BBLPS training prior to initiating field activities. These personnel typically delegate authority to the SSHO for the project specific implementation of the BBLPS, but the Project Manager and/or individual responsible for site operations remains accountable for its implementation. The SSHO will only verify the subcontractor's implementation of their AHAs and PTSPs for their assigned work.

Should it be determined that CH2M HILL project personnel have not received a BBLPS orientation, the Superintendent or Project Manger shall contact their designated safety representative so this orientation can be provided. Subcontractors may not necessarily be required to receive this CH2M HILL BBLPS orientation, but shall be informed of, be covered by, or separately implement the four basic loss prevention tools of the BBLPS.

In an effort to provide a safe and healthy workplace for all program participants, CH2M HILL promotes and implements a Drug DFWP. All CH2M HILL personnel must participate in and adhere to the requirements of the DFWP.

4.1 Activity Hazard Analysis

An AHA defines the activity being performed, the hazards posed, and control measures required to perform the work safely. Workers are briefed on the AHA before doing the work and their input is solicited before, during, and after the performance of work to further identify the hazards posed and control measures required.

AHA will be implemented before beginning each project activity posing H&S hazards to project personnel using the AHA forms provided in **Attachment 7**. The AHA will identify the work tasks required to perform each activity, along with potential H&S hazards and recommended control measures for each work task. In addition, a listing of the equipment

to be used to perform the activity, inspection requirements and training requirements for the safe operation of the equipment listed must be identified.

An AHA will be prepared for all field activities performed by CH2M HIL Land subcontractors during the course of the project and should be reviewed and accepted by the Health and Safety Manager or other designated program H&S professional. The Project-Specific, General, and Biological Hazards, the Hazard Analysis Table (Table 1-1) and respective applicable CH2M HILL partner SOPs should be used as a basis for preparing these AHAs.

CH2M HILL subcontractors will be required to provide AHAs specific to their scope of work on the project for acceptance by the SSHO. Each subcontractor will submit AHAs for their field activities, as defined in their work plan/scope of work, along with their project-specific HSP. Additions or changes in CH2M HILL or subcontractor field activities, equipment, tools or material to perform work, or additional/different hazard encountered that require additional/different hazard control measures requires either a new AHA to be prepared or an existing AHA to be revised.

4.2 Pre-Task Safety Plans

Daily safety meetings are held with all project personnel in attendance to review the hazards posed and required H&S procedures/AHAs that apply for each day's project activities. The PTSPs serve the same purpose as these general assembly safety meetings, but the PTSPs are held between the crew supervisor and their work crews to focus on those hazards posed to individual work crews. At the start of each day's activities, the crew supervisor completes the PTSP, provided in **Attachment 8**, with input from the work crew, during their daily safety meeting. The day's tasks, personnel, tools, and equipment that will be used to perform these tasks are listed, along with the hazards posed and required H&S procedures, as identified in the AHA. The use of PTSPs better promotes worker participation in the hazard recognition and control process, while reinforcing the task-specific hazard and required H&S procedures with the crew each day. The use of PTSPs is a common safety practice in the construction industry.

4.3 Safe Behavior Observations

SBOs will be conducted by the CH2M HILL individual responsible for site operations/SSHO for specific work tasks or operations comparing the actual work process against established safe work procedures identified in the project-specific HSP and AHAs. SBOs are a tool to be used by supervisors to provide positive reinforcement for work practices performed correctly, while also identifying and eliminating deviations from safe work procedures that could result in a loss. The CH2M HILL individual responsible for site operations/SSHO will perform at least one SBO each week for tasks/operations addressed in the project-specific HSP or AHA. The CH2M HILL individual responsible for site operations/SSHO will complete the LPO form in **Attachment 9** for the task/operation being observed, following the process below and forward to the "SER SBO Mailbox" weekly.

4.4 Loss/Near-Loss Investigations

Loss/near-loss investigations will be performed for the all CH2M HILL and subcontractor incidents involving:

- Person injuries/illnesses and near-miss injuries
- Equipment/property damage
- Spills, leaks, regulatory violations
- Motor vehicle accidents

The causes of loss and near-loss incidents are similar, so by identifying and correcting the causes of near-loss incidents, future loss incidents may be prevented. The following is the loss/near-loss investigation process:

- Gather all relevant facts, focusing on fact-finding, not fault-finding, while answering the who, what, when, where, and how questions.
- Draw conclusions, putting facts together into a probable scenario.
- Determine incident root cause(s), which are basic causes on why an unsafe act/ condition existed.
- Develop and implement solutions, matching all identified root causes with solutions.
- Communicate incident as a lesson learned to all project personnel.
- File follow-up on implemented corrective action to confirm solution is appropriate.

Site Supervisors/SSHO will perform an incident investigation as soon as practical after incident occurrence during the day of the incident, for all loss and near-loss incidents that occur on the project. Loss and near-loss incident investigations will be performed using the following incident investigation forms provided in **Attachment 10**:

- Incident Report Form (IRF) *
- Incident Investigation Form
- Root Cause Analysis Form

*For work-related injuries or illnesses to CH2M HILL personnel, Inform CH2M HILL Project Manger overall and CH2M HILL HSM contact and help Human Resources administrator complete a HITS (Hours and Incident Tracking System) Form. HITS must be completed within 24 hours of incident.

All loss and near-loss incidents involving personal injury, property damage or near-loss incidents that could have resulted in serious consequences will be investigated by completing the incident investigation forms and submitting them to the Project Manager and HSPA within 24 hours of incident occurrence. A preliminary Incident Investigation and Root Cause Analysis will be submitted to the Project Manager and HSM within 24 hours of incident occurrence. The final Incident Investigation and Root Cause Analysis will be submitted after completing a comprehensive investigation of the incident.

4.5 Drug-Free Workplace Program

(Reference SOP # HSE&Q 105, Drug Free Workplace)

CH2M HILL does not tolerate illegal drugs, or any use of drugs, controlled substances, or alcohol that impairs an employees work performance or behavior. CH2M HILL has established a policy that its employees and subcontractors will not be involved in any manner with the unlawful manufacture, distribution, dispensation, possession, sale, or use of illegal drugs in the workplace. The use or possession of alcohol in the workplace is also prohibited. Any violation of these prohibitions may result in discipline or immediate discharge.

In order to remain consistent with the requirements of the DFWP, review CH2M HILL , Inc. Standard of Practice HSE 105, *Drug-Free Workplace*, for more information.

CH2M HILL reserves the right to randomly test program participants in accordance with the conditions of the DFWP.

SECTION 5

Personal Protective Equipment

Personal protective equipment (PPE) specifications are listed in Table 5-1 for anticipated Project Operations.

TABLE 5-1
Personal Protective Equipment[a]

Task	Level	Body	Head	Respirator b
• Mobilization/Demobilization • Land and Utility Clearance Surveys • Observation of material loading for offsite disposal	D	• Designated and appropriate work clothes • Steel toe work boots that provide sufficient ankle support • Work gloves (cut resistant), reflective safety vest, chainsaw chaps, and snake guards • Reflective traffic vest	• Hardhat [c] • Safety glasses • Hearing protection (as applicable)[d]	None required
Any function identified in this HSP where potential dermal contact with site COCs is limited to the hands only. • • Soil Vapor sampling	Modified D_1	• Designated and appropriate work clothes; • Steel toe work boots that provide sufficient ankle support (preferable leather) • Work gloves (cut resistant) • Reflective safety vest; • Inner surgical-style nitrile and outer chemical resistant nitrile gloves.	• Hardhat [c] • Safety glasses • Ear protection (as applicable) [d] • Face shields (as applicable)	None required.
Any function identified in this HSP where potential dermal contact with site COCs is **NOT** limited to the hands only. • Soil Sampling • Waste characterization • Drilling using Direct Push Technology (DPT) • Investigative Derived Waste Management • Investigative Derived Waste Sampling (Drum) and Disposal • Groundwater sampling • Hand augering and use of jackhammer through concrete • Equipment Decontamination (pressure washing)*	Modified D_2	• **Coveralls:** uncoated Tyvek® chemical resistant disposable coveralls. * Polycoated tyvek • **Boots:** Hard toe work boots that provide sufficient ankle support (preferable leather); with outer rubber boot covers or hard toe chemically resistant rubber boots with steel shank • **Gloves:** Inner and Outer surgical-style nitrile chemical-resistant nitrile gloves.	• Hardhat [c] • Safety glasses (non chemical injections) • Ear protection (as applicable) [d] • Face shields and goggles (as applicable))	None required.
Contact HSPA/CIH prior to implementing Level C PPE upgrade. • Site conditions where defined action levels are exceeded or where unknown site conditions are encountered and confirmed by CH2M HILL HSM that Level C PPE is required to ensure a negative exposure to site workers. Contact CH2M HILL HSM prior to upgrading to Level C PPE.	C	• **Coveralls:** uncoated Tyvek® • **Boots:** Steel-toe, chemical-resistant boots OR steel-toe, leather work boots with outer rubber boot covers • **Gloves:** Inner surgical-style nitrile and outer chemical resistant nitrile gloves.	• Hardhat [cc] • Ear protection (as applicable) [d] • Spectacle inserts (as applicable)	APR, full face, MSA Ultratwin or equivalent; with GME cartridges or equivalent, as applicable to appropriate respiratory protection measures for specific site compounds or with P100 HEPA cartridges for particulate exposures.

Reasons for Upgrading or Downgrading Level of Protection:

Upgrade[f]

- Request from individual performing tasks.
- Change in work tasks that will increase contact or potential contact with hazardous materials.
- Occurrence or likely occurrence of gas or vapor emission.
- Known or suspected presence of dermal hazards.
- Instrument action levels exceeded (when implemented).

Downgrade

- New information indicating that situation is less hazardous than originally thought.
- Change in site conditions that decrease the hazard.
- Change in work task that will reduce contact with hazardous materials.

[a] Modifications are as indicated. CH2M HILL will provide PPE only to CH2M HILL employees.
[b] No facial hair that would interfere with respirator fit is permitted.
[c] Hardhat and splash-shield areas are to be determined by the SSHO.
[d] Ear protection should be worn when conversations cannot be held at distances of 3 feet or less without shouting.
[e] Cartridge change-out schedule is at least every 8 hours (or one work day), except if relative humidity is > 85%, or if organic vapor measurements are > midpoint of Level C range --then at least every 4 hours. If encountered conditions are different than those anticipated in this contact the HSPA/CIH. **Where CH2M HILL personnel are required to use a respirator to provide respiratory protection, CH2M HILL personnel shall receive respiratory protection awareness training. Contact the HSM to receive this training, prior to using any respiratory protective device.**
[f] Performing a task that requires an upgrade to a higher level of protection (e.g., Level D to Level D modified/Level C) is permitted only when the PPE requirements have been approved by the HSM, and an SSHO qualified at that level is present.

SECTION 6

Air Monitoring

Air monitoring requirements for anticipated project activities are listed in Table 6-1.

TABLE 6-1
Air Monitoring Equipment Specifications

Instrument	Tasks	Action Levels[a]	Level of Protection or Action	Frequency [b]	Calibration
Dust Monitor – Visual	• Waste characterization • When unusual odors are observed • Soil Vapor sampling • Jack hammer • Intrusive ops.	No visible dust	Level D, Modified D1, or D2 as identified by Table 5-1 for dermal protection. Continue work	Whenever visual dust is observed	Daily
		Visible dust	Level D, Modified D1, or D2 as identified by Table 5-1 for dermal protection. Suspend operations, institute dust control measures (water application) until visible dust is abated. If dust can not controlled to an acceptable condition (no visible dust), contact the HSPA/CIH before implementing respiratory protection devices.		
Photo Ionization Detector (PID)	• Waste characterization • When unusual odors are observed • Soil vapor, GW sampling • Intrusive ops. including jackhammer	0–1 ppm (in worker BZ)	Level D, Modified D1, or D2 as identified by Table 5-1 for dermal protection	1. Initially during start up of a task, upon opening ground of each water monitoring well heads/cover, 2. During any activity where unusual odors, vapors, discolored soil/sediment or free phase product is observed during the execution of tasks.	Daily
		1-10 ppm (sustained 5 mins in worker BZ)	Level C, consult HSPA/CIH for proper engineering and/or administrative controls and PPE requirements.	1. Continuously until PID/FID level is below 1 ppm, 2. Compound specific action level is exceeded that would result in work stoppage	
		>10 ppm (sustained 5 mins. in worker BZ)	Stop work. Evacuate area for 10 minutes and recheck BZ and work area. If levels persist, consult HSPA/CIH for proper engineering and/or administrative controls and PPE requirements or before working in environments were COCs are potentially in excess of established OELs.	1. Continuously upon re-start of work to verify PID/FID level 0-1 ppm in WBZ, and 2. Until it is determined that compound specific concentrations are less than the established Action Level.	
LEL	• Waste characterization • When unusual odors are observed • Soil vapor sampling • Intrusive ops. including jackhammer	0-10% :	No explosion hazard	Initially and periodically	Daily
		10% LEL:	Explosion hazard; evacuate or vent		
Colormetric Tube: Vinyl chloride specific (0.5 to 30 ppm range) with pre-tube, or equivalent	• Waste characterization • When unusual odors are observed • Soil vapor sampling • Intrusive ops.....	<0.5 ppm 0.5-10 ppm >10 ppm	Level D Level C (verify cartridge availability/compatibility) Level B	Initially and periodically when PID/FID >1 ppm	Not applicable

[a] Action levels apply to sustained breathing-zone measurements above background.
[b] The exact frequency of monitoring depends on field conditions and is to be determined by the SSHO; generally, every 5 to 15 minutes if acceptable; more frequently may be appropriate. Monitoring results should be recorded. Documentation should include instrument and calibration information, time, measurement results, personnel monitored, and place/location where measurement is taken (e.g., “Breathing Zone/MW-3”, “at surface/SB-2”, etc.).
[c] If the measured percent of O_2 is less than 10, an accurate LEL reading will not be obtained. Percent LEL and percent O_2 action levels apply only to ambient working atmospheres, and not to confined-space entry. More-stringent percent LEL and O_2 action levels are required for confined-space entry.
[d] Refer to SOP HS-10 for instructions and documentation on radiation monitoring and screening.
[e] Noise monitoring and audiometric testing may also required.

6.1 Calibration Specifications

Air Monitoring equipment calibration specifications are listed in Table 6-2.

TABLE 6-2
Air Monitoring Equipment Calibration Specifications

Instrument	Gas	Span	Reading	Method
PID	"zero air" gas and 100 ppm isobutylene	RF = 1.0	100 ppm	1.5 lpm reg T-tubing/ tedlar bag "zero air" gas followed by isobutylene
CGI: MSA 260, 261, 360, or 361	0.75% pentane	N/A	50% LEL	1.5 lpm reg
			± 5% LEL	Direct tubing

SECTION 7

Decontamination

For the execution of this contract task order, it is not anticipated that Level C PPE will be required, however, level D modified PPE maybe required to ensure a negative worker exposure to identified site COCs. Regardless of worker PPE requirements, proper site worker hygiene and decontamination (when required) procedures are important to eliminate any inadvertent exposure to unhealthy conditions that could occur but have yet been identified and it is important for site personnel to exercise to the following procedures:

Eating, drinking, smoking and other tobacco use shall only be conducted in designated and unrestricted areas and not in any areas where there is any exposure to hazardous material/waste, flammable/combustible liquids, and gases.

Wash hands and face, if applicable, before eating, drinking, smoking or otherwise using tobacco.

Shower as soon as feasible after completing field activities.

The SSHO must establish and monitor the decontamination procedures and their effectiveness. Decontamination procedures found to be ineffective will be modified by the SSHO. The SSHO must ensure that procedures are established for disposing of materials generated on the site.

7.1 Decontamination Specifications

Where Level D modified or Level C PPE is required for worker protection, it is essential for workers to maintain the good personal hygiene practices. Proper and specific decontamination procedures will be required where Level D modified or Level C PPE is required for this project, to ensure negative worker exposure to any identified contaminants or hazardous materials. These procedures are identified and illustrated below. Contact lenses are not permitted in HAZWOPER exclusion or decontamination zones.

Personnel	Sample Equipment	Heavy Equipment
• Boot wash/rinse • Glove wash/rinse • Outer-glove removal • Body-suit removal • Inner-glove removal • Respirator removal • Hand wash/rinse • Face wash/rinse • Shower ASAP • Dispose of PPE in municipal trash, or contain for disposal • Dispose of personnel rinse water to facility or sanitary sewer, or contain for offsite disposal	• Wash/rinse equipment • Solvent-rinse equipment • Contain solvent waste for offsite disposal	• Power wash • Steam clean • Dispose of equipment rinse water to facility or sanitary sewer, or contain for offsite disposal

7.2 Diagram of Personnel-Decontamination Procedures

Figure 7-1 is a flow chart of the Personnel Decontamination Line. No eating, drinking, or smoking is permitted in contaminated areas and in exclusion or decontamination zones. The SSHO should establish areas for eating, drinking, and smoking. Contact lenses are not permitted in exclusion or decontamination zones. In all cases, whether Level D modified or Level C is required, it is essential for workers to maintain good positive personal hygiene practices.

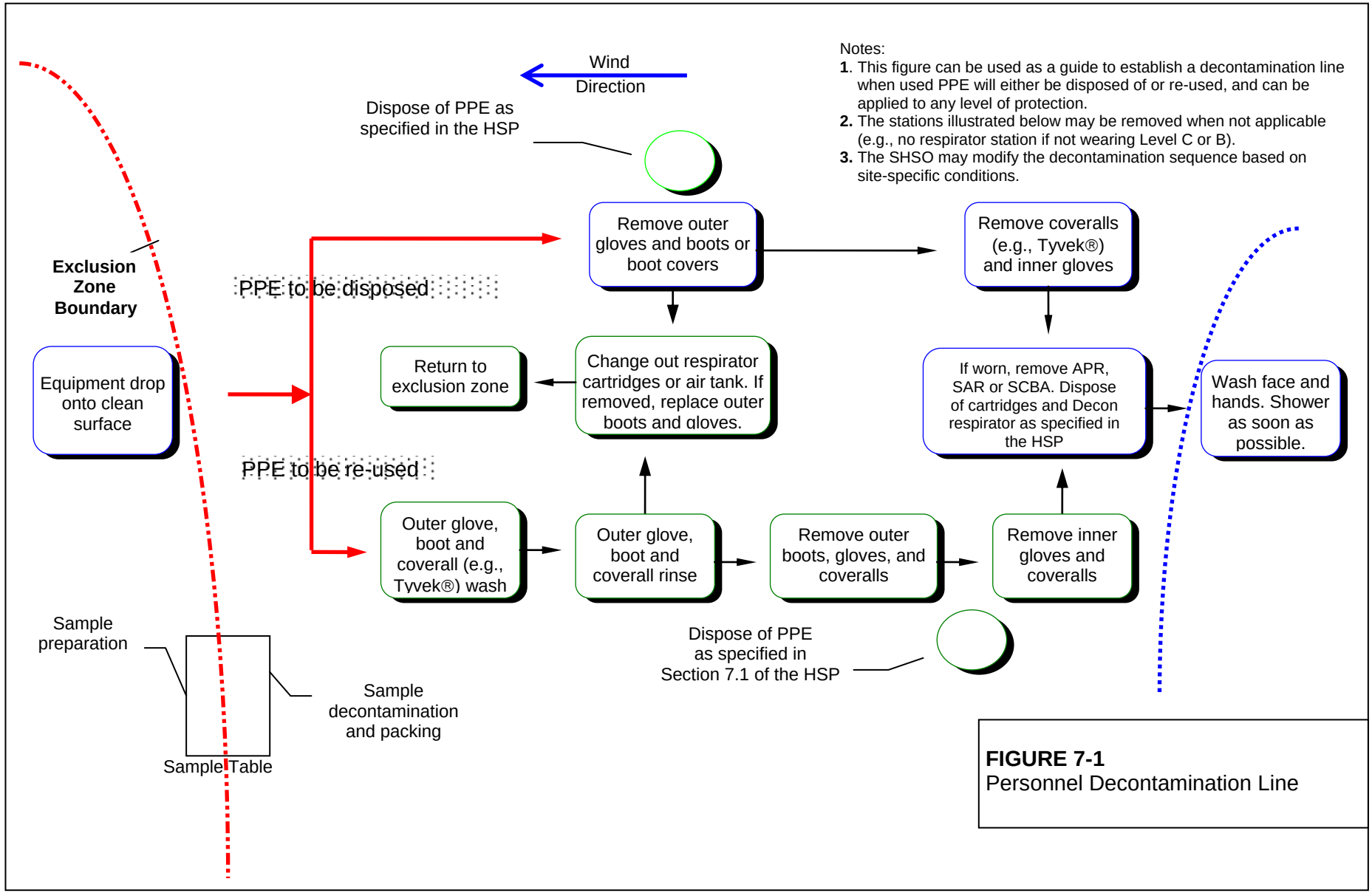


FIGURE 7-1
Personnel Decontamination Line

SECTION 8

Spill-Containment Procedures

Sorbent material will be maintained in the support zone. Incidental spills will be contained with sorbent and disposed of properly.

8.1 Procedure for Containing/Collecting Spills

The initial response to any spill or discharge will be to protect human health and safety, and then the environment. Identification, containment, treatment, and disposal assessment will be the secondary response.

If for some reason a chemical spill is not contained within a dike or sump area, an area of isolation will be established around the spill. The size of the area will generally depend on the size of the spill and the materials involved. If the spill is large (greater than 55 gallons) and involves a tank or a pipeline rupture, an initial isolation of at least 100 feet in all directions will be used. Small spills (less than or equal to 55 gallons) or leaks from a tank or pipe will require evacuation of at least 50 feet in all directions to allow cleanup and repair and to prevent exposure. When any spill occurs, only those persons involved in overseeing or performing emergency operations will be allowed within the designated hazard area. If possible, the area will be roped off or otherwise blocked.

If the spill results in the formation of a toxic vapor cloud (by reaction with surrounding materials or by outbreak of fire) and its release (due to high vapor pressures under ambient conditions), further evacuation must be engaged. In general, an area at least 500 feet wide and 1,000 feet long will be evacuated downwind if volatile materials are spilled. (Consult the DOT Emergency Response Guide for isolation distances for listed hazardous materials.)

If an incident may threaten the health or safety of the surrounding community, the public will be informed (via proper local and state emergency management planning agencies) and possibly evacuated from the area. The onsite emergency coordinator will inform the proper agencies in the event this is necessary. A Project Emergency Contact List is provided in **Attachment 11**.

As called for in regulations developed under the comprehensive Environmental Response Compensation Liability Act of 1980, CH2M HILL 's practice is to report a spill of a pound or more of any hazardous material for which a reportable quantity has not been established and which is listed under the Solid Waste Disposal Act, Clean Air Act, Clean Water Act, or the Toxic Substances Control Act (TSCA). TSCA also follows the same practice for any substances not listed in the Acts noted above but which can be classified as a hazardous waste under Resource Conservation and Recovery Act.

Response/containment personnel shall take the following measures:

- Immediately warn any nearby workers and notify individual responsible for site operations.

- Assess the spill area to ensure that it is safe to respond.
- Evacuate area if spill presents an emergency.
- Ensure all unnecessary persons are removed from the hazard area.
- Put on protective clothing and equipment.
- If a flammable material is involved, remove all ignition sources, and use only spark- and explosion-proof equipment for recovery of material.
- Remove all surrounding materials that could be especially reactive with materials in the waste. Determine the major components in the waste at the time of the spill.
- Stop source of spill.
- Establish site control for spill area.
- If wastes reach a storm sewer, dam the outfall by using sand, earth, sandbags, etc. Pump this material out into a temporary holding tank or drums as soon as possible.
- Place all small quantities of recovered liquid wastes (55 gallons or less) and contaminated soil into drums for incineration or removal to an approved disposal site.
- Spray the spill area with foam, if available, if volatile emissions may occur.
- Apply appropriate spill control media (e.g., clay, sand, lime) to absorb discharged liquids.
- For large spills, establish diking around leading edge of spill using booms, sand, clay, or other appropriate material. If possible, use diaphragm pump to transfer discharged liquid to drums or holding tank. Follow proper ground and bonding procedures of equipment during recovery efforts. Intrinsically safe equipment must be used in recovery operations.

8.2 Anticipated Hazardous Materials

The following is a list of hazardous materials or chemicals that may be brought onsite and incorporated as part of the final completion of the work, generated during the execution of the work for offsite disposal or recycling or otherwise used to facilitate site work. These hazardous materials or chemicals may require spill prevention and countermeasure control processes to ensure sensitive environmental receptors are not adversely impacted in the event of a spill or release of these materials.

- Gasoline (small metal safety containers for fueling small engine equipment).
- Diesel fuel in heavy equipment.
- Minor quantities of sample preservatives (e.g., nitric acid, hydrochloric acid, sulfuric acid, sodium hydroxide/zinc acetate, phosphoric acid).
- Groundwater well purge water and PPE impacted by site COCs

8.3 Notification

In the event a spill occurs that requires notification, a project person shall follow the CH2M HILL Incident Notification Process and Chain of Command" structure identified in Figure 10-2, of this HSP.

In addition, the CH2M HILL overall Project Manager shall make notification to the designated NAVFAC Remedial Project Manager or Resident Officer In Charge of Construction or other designated client POC, as applicable, such that additional appropriate community and/or federal/state agencies may be engaged and notified, as applicable. The CH2M HILL Project Manager (overall) shall coordinate with the designated Project Environmental Compliance Manager for support with regard to adhering to local, state, or federal regulations for spill notification clean-up and closure requirements.

SECTION 9

Site-Control Plan

9.1 Site-Control Procedures

Project managers and team leaders are to perform the following tasks:

- Evaluate and ensure worker safety in remote/secluded work areas.
- Confirm if potentially dangerous activities (such as hunting seasons, live ordinance use, military field exercises/activities, transfer of dangerous or explosive cargo/materials, location of explosive arc zones) could be occurring in or adjacent to any CH2M HILL work areas that may jeopardize worker health and safety.
- Reschedule field activities when potentially dangerous activities are occurring adjacent to CH2M HILL work locations. Ensure proper two-way communications with workers in remote work areas. Use the buddy system.
- **Designate an emergency evacuation route.**
- **Designate an evacuation assembly area.**
- The SSHO, or designee, will conduct a site safety briefing (see below) before starting field activities or as tasks and site conditions change.
- Topics for briefing on site safety: general discussion of Health and Safety Plan, site-specific hazards, locations of work zones, PPE requirements, equipment, special procedures, emergencies.
- The SSHO records safety briefing attendance in a logbook and documents the topics discussed.
- Ensure that applicable CH2M HILL personnel have received the BBLPS Training
- Be aware of any potential for hazardous chemical exposure and know what precautions/training are required.
- Establish support, decontamination, and exclusion zones. Delineate with flags or cones as appropriate. Support zone should be upwind of the site. Use access control at entry and exit from each work zone.
- Know how an emergency should be reported.
- Identify exact facility location and position (where possible) when contacting EMS/Fire Dispatch.
- Have readily available copy of the Hospital Route Map.

- Establish onsite communication consisting of the following:
  - Line-of-sight and hand signals
  - Air horn
  - Two-way radio or cellular telephone if available
- Establish offsite communication.
- Establish and maintain the "buddy system."
- Know how, what, when injuries/accidents are reported and treated.
- Initial air monitoring is conducted by the SSHO in appropriate level of protection.
- The SSHO or other authorized designee is to conduct periodic inspections of work practices to determine the effectiveness of this plan. Such inspections should identify site conditions or actions that are not consistent with the policies and procedures of the H&S program, report to the CH2M HILL Project Manager and the CH2M HILL HSM. The project team shall develop and implement corrective action procedures in a timely manner.

9.2 Specific Site Control Measures

To prevent both exposure of unprotected personnel and migration of contamination, work areas and personal protective equipment requirements will be clearly identified when operations that fall under the requirements of 29 CFR 1910.120/29 CFR 19126.65 are executed. This HSP recommends that the area surrounding each of the work areas be divided into three distinct zones; the exclusion zone (EZ), the contamination reduction zone (CRZ), and the support zone.

Only individuals who meet the requirements of 29 CFR 1910.120/29 CFR 1926.65 and who are authorized by the CH2M HILL individual responsible for site operations (i.e., site supervisor) or the SSHO shall be allowed entry into the EZ and CRZ. Suitable means and methods (high visibility fencing, caution tape signage, other physical barriers) shall be employed to demarcate the EZ and CRZ boundaries at this site to prevent unauthorized entry into these controlled work zones. A CRZ for decontamination shall be established adjacent to the EZ. The SZ shall be kept free from contamination.

A typical EZ/CRZ/SZ representation is illustrated in Section 7 Decontamination, Figure 7-1.

9.2.1 Exclusion Zone

An EZ will be constructed to surround each work area where the greatest potential for worker exposure to identified site COCs may exist. The EZ may need to be transient as the work progresses, depending upon the type of work that is being executed. Because of potential site space limitations, the exclusion zone fencing may also include any available permanent perimeter fencing or other established physical barriers. Note that the term "permanent" is often used to describe the outer limits (or perimeter) of a work site or designated site area. Other temporary barriers (e.g., caution tape, high visibility construction fencing) maybe used to supplement existing permanent barriers to demarcate the EZ to

identify the restricted access. Access to the EZ will be restricted to personnel wearing the prescribed level of protective equipment and meeting the training and medical criteria of this plan.

9.2.2 Contamination Reduction Zone

Each CRZ zone will be a clearly marked corridor between the EZ and the SZ. The CRZ for each area will be located immediately adjacent to the EZ. This area will be identified with yellow tape, high visibility construction fencing, or other suitable barriers.

The CRZ is where personnel will begin the sequential decontamination process when exiting the EZ. To prevent cross contamination and for accountability purposes, all personnel must enter and leave the EZ through the CRZ.

Contaminated personnel and equipment will exit the EZ directly to the CRZ. Each CRZ will contain constructed decontamination stations for personnel and equipment. If possible, the CRZ will be located upwind of each EZ; however, due to site constraints, this may not be possible. Temporary support zones for each work area will be located adjacent to the CRZs.

9.2.3 Support Zone

Temporary support zones and staging areas will be established at the entrance of each control area. Potable water, an eye wash, and first aid supplies will be located at each temporary support zone. No hazardous or potentially hazardous materials will be allowed in the support zone unless it is in a properly labeled container that has no external contamination. Eating, drinking and, smoking will only be allowed in this area, at designated locations.

Portable bathroom facilities will be located near the work areas. In addition, potable water and water and soap for hand washing will be available at the support zone, along with containers for solid waste for use by site personnel, in addition to first aid stations and administrative information.

9.3 HAZWOPER Compliance Plan

Certain parts of the site work are covered by state or federal HAZWOPER standards and therefore require training and medical monitoring. Anticipated HAZWOPER tasks (Section 1.4 or otherwise determined) might occur consecutively or concurrently with respect to Non-HAZWOPER tasks. This section outlines procedures to be followed when approved activities specified in Section 1.6 do not require 24- or 40-hour training. Non-HAZWOPER-trained personnel also must be trained in accordance with all other state and federal OSHA requirements.

- In many cases, air sampling, in addition to real-time monitoring, must confirm that there is no exposure to gases or vapors before non-HAZWOPER-trained personnel are allowed on the site, or while non-HAZWOPER-trained staff are working in proximity to HAZWOPER activities. Other data (e.g., soil) also must document that there is no potential for exposure. The HSM must approve the interpretation of these data.

- When non-HAZWOPER-trained personnel are at risk of exposure, the SSHO must post the exclusion zone and inform non-HAZWOPER-trained personnel of the following:
  - Nature of the existing contamination and its locations
  - Limitations of their access
  - Emergency action plan for the site
- Periodic air monitoring with direct-reading instruments conducted during regulated tasks also should be used to ensure that non-HAZWOPER-trained personnel (e.g., in an adjacent area) are not exposed to airborne contaminated media.
- When exposure is possible, non-HAZWOPER-trained personnel must be removed from the site until it can be demonstrated that there is no longer a potential for exposure to health and safety hazards.

SECTION 10

Emergency Response Plan

10.1 Pre-Emergency Planning

(Reference SOP # HSE&Q 106, Emergency Planning)

The SSHO performs the applicable pre-emergency planning tasks before starting field activities and coordinates emergency response with CH2M HILL onsite parties, the facility, and local emergency-service providers as appropriate.

- CH2M HILL personnel shall review and implement all applicable components of CH2M HILL SOP # HSE&Q 106 Emergency Planning, except where other requirements may be more stringent.
- Review the facility emergency and contingency plans where applicable.
- Determine what onsite communication equipment is available (e.g., two-way radio, air horn).
- Determine what offsite communication equipment is needed (e.g., nearest telephone, cell phone).
- Confirm and post emergency telephone numbers, evacuation routes, assembly areas, and route to hospital; communicate the information to onsite personnel.
- Review changed site conditions, onsite operations, and personnel availability in relation to emergency response procedures.
- Where appropriate and acceptable to the client, inform emergency room and ambulance and emergency response teams of anticipated types of site emergencies.
- Designate one vehicle as the emergency vehicle; place hospital directions and map inside; keep keys in ignition during field activities.
- Inventory and check site emergency equipment, supplies, and potable water.
- Communicate emergency procedures for personnel injury, exposures, fires, explosions, and releases.
- Rehearse the emergency response plan before site activities begin, including driving route to hospital.
- Brief new workers on the emergency response plan.

The SSHO will evaluate emergency response actions and initiate appropriate follow-up actions.

10.2 Emergency Equipment and Supplies

The SSHO should mark the locations of emergency equipment on the site map and post the map. Equipment and locations are listed below.

Emergency Equipment and Supplies	Location
20-lb (or two 10-lb) fire extinguisher (A, B, and C classes)	Support Zone/Heavy Equipment
First aid kit	Support Zone/Field Vehicle
Eye wash	Support and Decon Zone/Field Vehicle
Potable water	Support and Decon Zone/Field Vehicle
Bloodborne-pathogen kit	Support Zone/Field Vehicle
Additional equipment (specify): Mobile phone and contact information	Support Zone/Field Vehicle
Spill control/clean-up materials/proper spill response PPE	Support Zone & Decon. Zone and/or active work area(s)

10.3 Incident Reporting, Investigation, and Response

For any accident meeting the definition of **Recordable Occupational Injuries or Illnesses or Significant Accidents**, the NAVFAC Contracting Officer and Navy Technical Representative will be notified by the CH2M HILL Project Manager (overall) soon as practical, **but not later than 4 hours after occurrence.** In the event that the overall CH2M HILL Project Manager is not available, the designated CH2M HILL individual responsible for site operations may make notification, but **only** after consultation with the CH2M HILL Project Manager. All other incidents must be reported to NAVFAC within 24 hours of incident occurrence. Only authorized CH2M HILL personnel may make notification to NAVFAC regarding project accidents, injuries, or illnesses.

In order for the incident to be assessed for the purposes or meeting reporting requirements, it is imperative that **all personal injuries, near misses, or property damage incidents involving** CH2M HILL **or subcontractor project personnel be reported IMMEDIATELY to the chain of command personnel identified in Section 10.7 and Attachment 11 of this HSP.** The following information shall be provided:

- Date and time of incident
- Project name and project number
- Name and worker classification
- Extent of known injuries
- Level of medical attention
- Injury cause
- Witnesses

A written incident investigation will be performed and submitted to the HSM within 24 hours of incident occurrence by the completing the Incident Report, Near-Loss Investigation and Root Cause Analysis provided in the HSP Attachments.

In fires, explosions, or chemical releases, actions to be taken include the following:

- Shut down CH2M HILL operations and evacuate the immediate work area
- Notify appropriate response personnel
- Account for personnel at the designated assembly area(s)
- Assess the need for site evacuation, and evacuate the site as warranted

Instead of implementing a work-area evacuation, small fires or spills posing minimal safety or health hazards may be controlled by onsite personnel, assuming that personnel who respond to these emergencies are properly trained to do so and wearing appropriate PPE to protect themselves against hazards that may be associated with the response.

10.4 Emergency Medical Treatment

The procedures listed below may also be applied to non-emergency incidents. CH2M HILL employee injuries and illnesses must also be reported to the Human Resources contact in **Attachment 11**. If there is doubt about whether medical treatment is necessary, or if the injured person is reluctant to accept medical treatment, contact the designated medical consultant, as applicable. During non-emergencies, follow these procedures as appropriate.

- Notify appropriate emergency response authorities.
- The SSHO will assume charge during a medical emergency until the ambulance arrives or until the injured person is admitted to the emergency room.
- Prevent further injury.
- Initiate first aid and CPR where feasible.
- For life threatening emergencies, get or summon medical attention immediately.
- Perform decontamination where feasible; lifesaving and first aid or medical treatment take priority.
- Make certain that the injured person is accompanied to the emergency room.
- When contacting the medical consultant, give your name and telephone number, the name of the injured person, the extent of the injury or exposure, and the name and location of the medical facility where the injured person was taken.
- Report incident as outlined in Section 10.3.
- **A map showing the route to the local hospital is shown on Figure 10-1.**
- For CH2M HILL personnel who experience a minor non-life threatening emergency that requires medical attention, please refer to **Attachment 11** for the "Emergency Nurse Instructions" and "Initial Medical Treatment Form."

FIGURE 10-1
Hospital Route Map Directions

Local Hospital

Craven Regional Medical Center
2000 Neuse Blvd
New Bern, NC 28560
(Base hospital will accept emergencies)

(757) 398-2200

Directions to Hospital

Directions to Craven RMC:

1. Take Highway 70 West to New Bern
2. Take Glenburnie Road exit (right turn)
3. Take Glenburnie to Neuse Boulevard (turn right)
4. Go two miles, hospital is on the left.

Total 16 miles, 25 minutes

10.5 Evacuation

- Evacuation routes and assembly areas will be specified at the commencement of field work.
- Evacuation route(s) and assembly area(s) will be designated by the SSHO before work begins.
- Personnel will assemble at the assembly area(s) upon hearing the emergency signal for evacuation.
- The SSHO and a "buddy" will remain on the site after the site has been evacuated (if safe) to assist local responders and advise them of the nature and location of the incident.
- The SSHO will account for all personnel in the onsite assembly area.
- A designated person will account for personnel at alternate assembly area(s), as may be established to meet project site conditions.
- Because no temporary construction office or storage facilities will be established for this project and no heavy equipment will be needed for this project "A Hurricane Preparedness Plan" (HPP) has not been prepared for this project. As such, Attachment 12 of this HSP, Hurricane Preparedness Plan is "Reserved."

10.6 Evacuation Signals

Evacuation signals are listed below.

Signal	Meaning
Grasping throat with hand	Emergency-help me.
Thumbs up	OK; understood.
Grasping buddy's wrist	Leave area now.
Continuous sounding of horn	Emergency; leave site now.

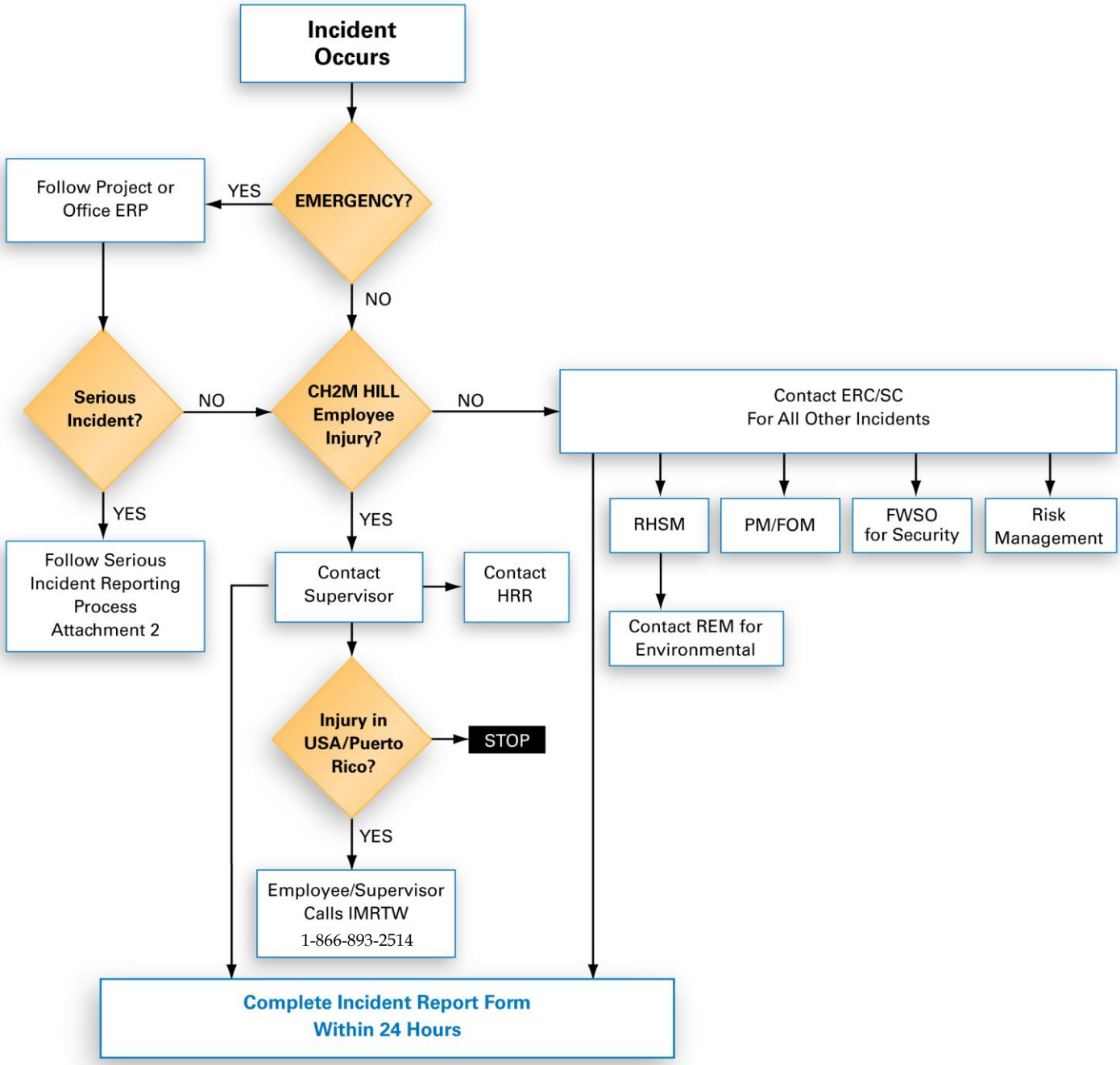
10.7 Incident Notification and Reporting

- Upon any project incident (fire, spill, accident, injury/illness, near miss, property damage, death, etc.), immediately notify the Project Manager and HSM. Figure 10-2 identifies the CH2M HILL Incident Reporting Process.
- For CH2M HILL work-related injuries or illnesses, contact the respective resources on the emergency contact list in **Attachment 11** of this HSP. For CH2M HILL incidents, the SSHO or individual responsible for site operations completes an Incident Report Form

(IRF). In some cases, this can be completed by the employee. The IRF must be completed within 24 hours of incident.

- For CH2M HILL subcontractor incidents, complete the Subcontractor Accident/Illness Report Form and submit to the HSM.

Attachment 1
CH2M HILL Immediate Incident Notification



ERC = Emergency Response Coordinator (designated in Emergency Response Plan)
ERP = Emergency Response Plan
FOM = Facility Office Manager
FWSO = Firm Wide Security Operations
HRR = Human Resources Representative
IMRTW = Injury Management/Return-to-Work
PM = Project Manager
REM = Responsible Environmental Manager
RHSM = Responsible Health & Safety Manager
SC = Safety Coordinator

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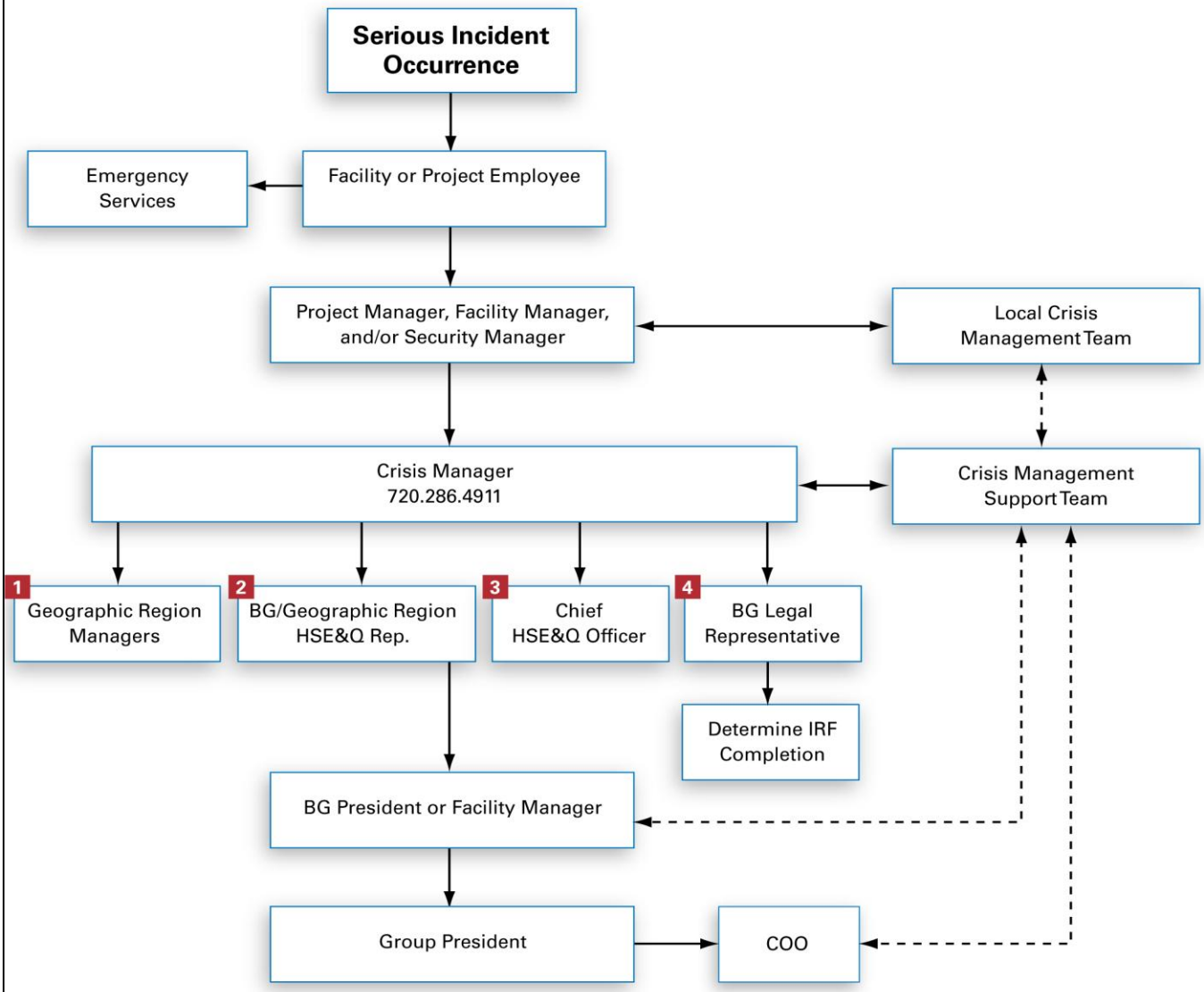
CH2MHILL

Attachment 2
CH2M HILL Serious Incident Notification



LEGEND:

→ Direct line of communication

←- - -→ Indirect line of communication

DEFINITIONS:

Local Crisis Management Team: Team comprised of key facility, project and/or business group personnel. Team is assembled as necessary and as appropriate to effectively manage and respond to a crisis situation (serious incident) at/on scene.

Crisis Management Support Team: Team comprised of key corporate personnel. Team is assembled as necessary and as appropriate to effectively support, direct, and /or supplement a Local Crisis Management Team.

Crisis Manager: Corporate based Crisis Manager, contactable by pager 24/7.

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SECTION 11

Approval

This site-specific Health and Safety Plan has been written for use by CH2M HILL only. CH2M HILL claims no responsibility for its use by others unless that use has been specified and defined in project or contract documents. The plan is written for the specific site conditions, purposes, dates, and personnel specified and must be amended if those conditions change.

11.1 Original Plan

Prepared/Approved By: Mark Orman, CSP **Date: October 10, 2009**
CH2M HILL Constructors, Inc., Health & Safety Manager
(414) 847-0597 / (414) 712-4138 (cell)

Approved By: Bill Hannah, PG **Date: September **, 2009**
OU1 Vapor Intrusion Investigation Project Manager
(757) 671- 6277

11.2 Revisions

Revisions Made By: **Date:**

Revisions to Plan:

Revisions Approved By: **Date:**

Attachment 1
Employee Signoff Form

EMPLOYEE SIGNOFF FORM

Health and Safety Plan

The CH2M HILL project employees and subcontractors listed below have been provided with a copy of this HSP, have read and understood it, and agree to abide by its provisions.

Project Name: MCAS Cherry Point OU1, Vapor Intrusion Investigation

EMPLOYEE NAME (Please print)	**EMPLOYEE SIGNATURE**	**COMPANY**	**DATE**

Attachment 2
Accident Prevention Plan

Appendix B
Field SOPs

MiniRAE 2000

Portable VOC Monitor
PGM-7600

OPERATION AND MAINTENANCE MANUAL

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

RAE SYSTEMS

ISO 9001 CERTIFIED

ATTENTION!

For European Applications

A. CE 0575 Ex 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 équipment 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 reference 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 intrinsique. 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.

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 to10 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

Direct Readout:	Instantaneous, average, STEL and peak value, battery voltage and elapsed time
Intrinsic Safety:	UL & cUL Class 1, Division I, Group A,B,C,D, Temperature Code T3C (US & Canada); CE 0575 Ex 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.

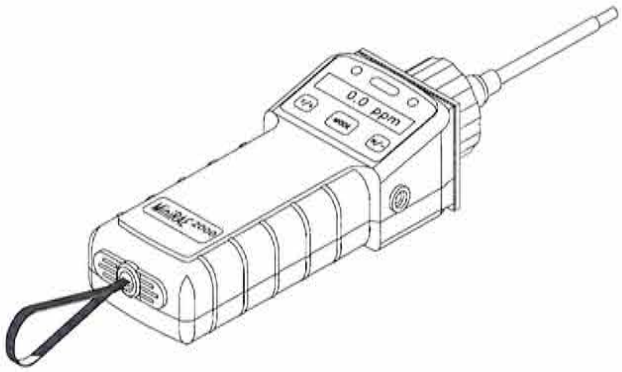


Figure 2-1 MiniRAE 2000

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:

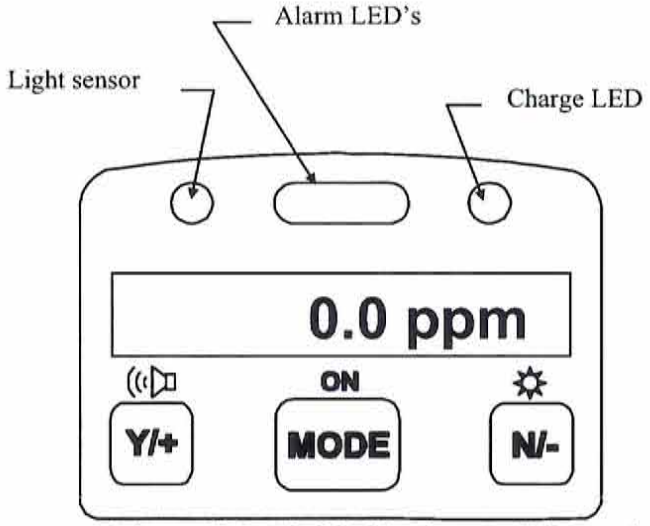


Figure 2-2 LCD Display and Keypad

Key	Function in Normal Operation
[MODE]	-Turn on/off the power* and step through menu items
[N/-]	-Toggle on/off the back light, negative acknowledge, decrease value
[Y/+]	-Start measurement, positive acknowledge, increase value value

* 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

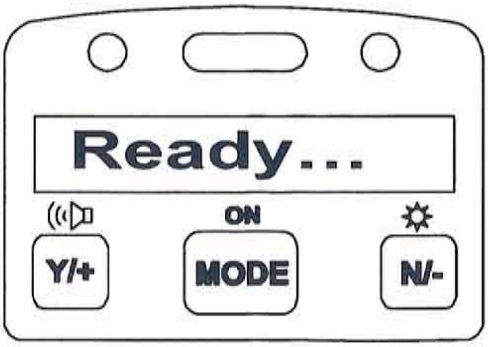
When the monitor is turned off, all the current real time data including last measured value are erased. However, the datalog data is preserved in non-volatile memory. Even if the battery is disconnected, the datalog data will not be lost. While the power is off, the real time clock will continue to 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.

The Main Menu

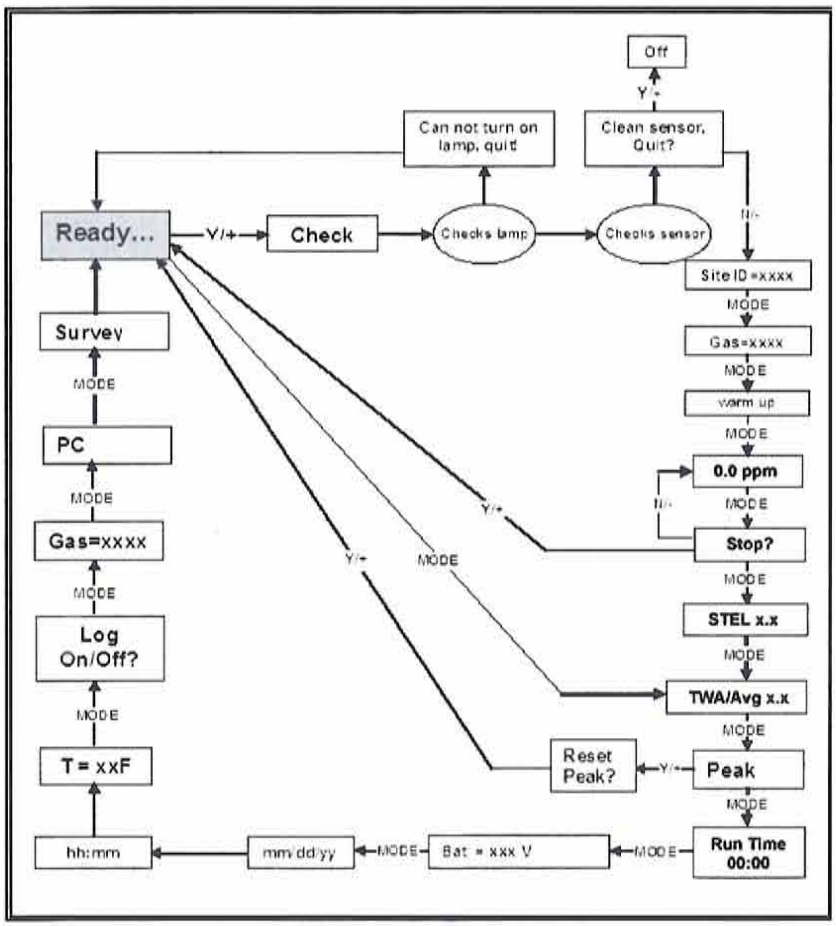
Press the **[MODE]** button to enter the Main Menu. Press the **[Y/+]**, **[MODE]** or **[N/-]** as indicated in the flow chart below to step through the Main Menu. The PID sensor and pump are turned off during this time.

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**

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 cyling 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)

Note: This display appears only after a measurement has been started. It does not appear when the user is cyling 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 cyling 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)

- **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.

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.

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

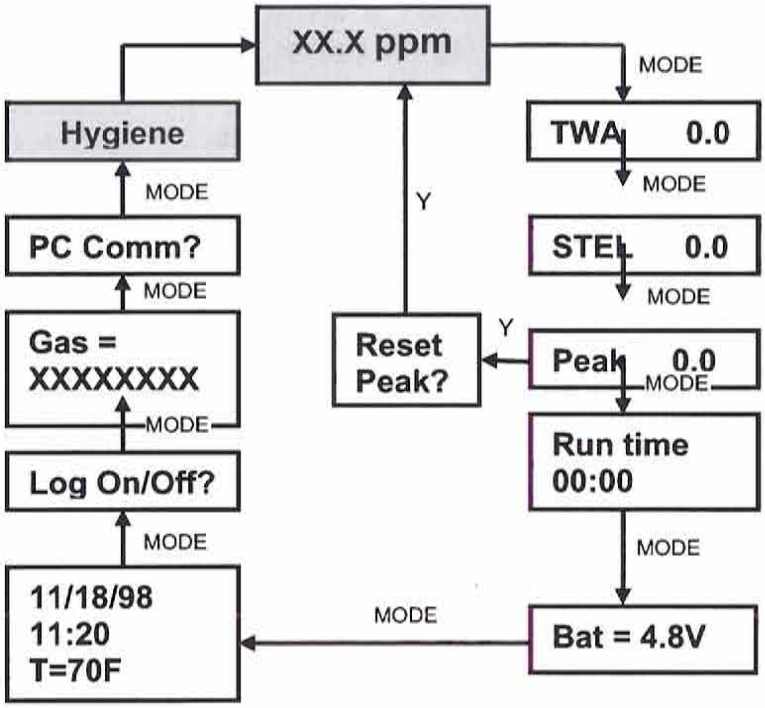
In Hygiene Mode, the unit will continuously taking measurements, once the power is turned on. After the initial start-up sequence displaying the current monitor settings, the LCD displays the instantaneous readings.

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.

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.

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.

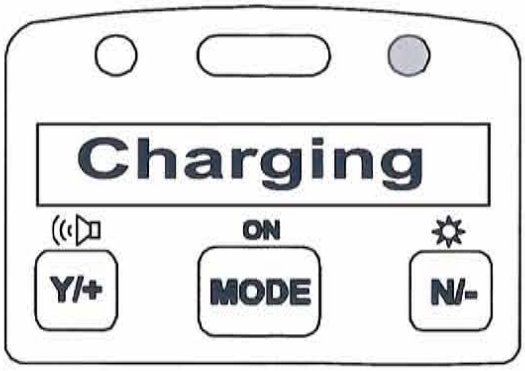
Ne charger les batteries que dans emplacements designés non-dangereuses.

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.

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.

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 re-calibrate 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.

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

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.

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

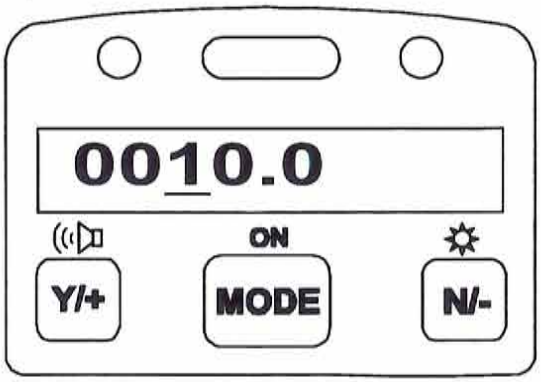
In this menu, the user can change the high and low alarm limits, the STEL limit and the TWA limit (see Table 4.5 below). Press the **[Y/+]** key and the display shows the current gas selected followed by the first sub-menu item below.

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.

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?"
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

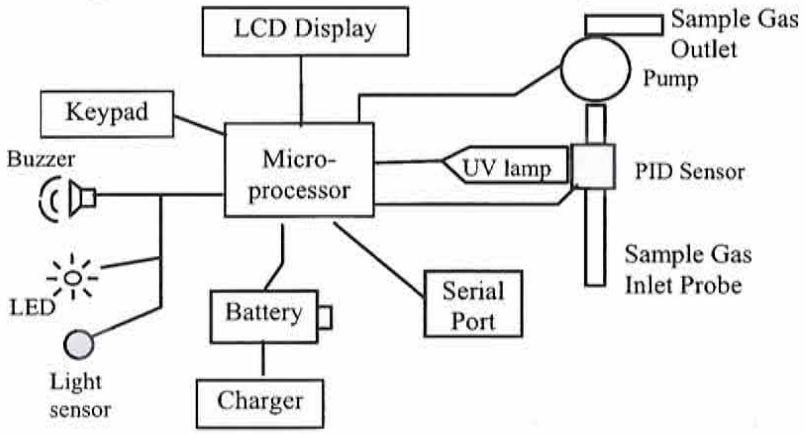
1. To exit programming mode from the first tier menu level, press the **[MODE]** key once.
2. To exit programming mode from 2nd tier sub-menu, press the **[MODE]** key twice.
3. To return to programming mode, press and hold down both the **[MODE]** and **[N/-]** keys for 3 seconds.

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



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

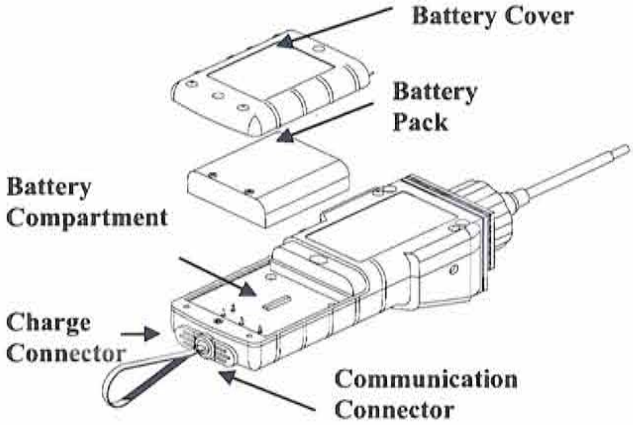


Figure 6-1 Battery Replacement

1.

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.

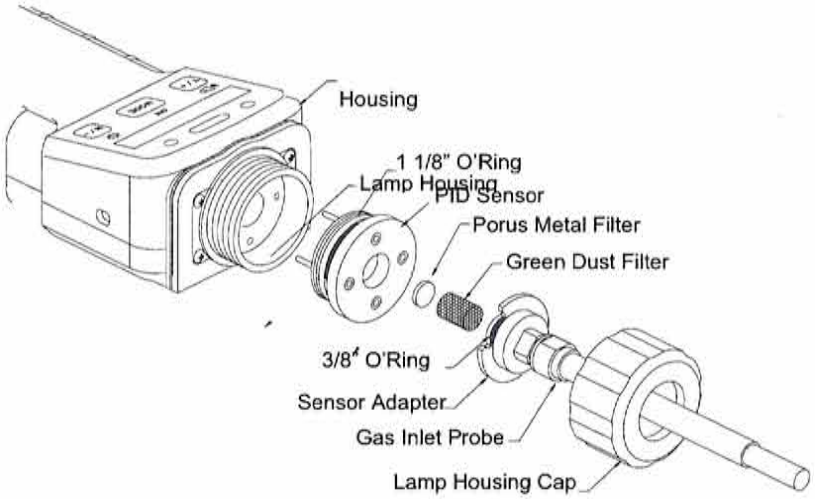


Figure 7-2 Sensor Components

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.

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.

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.

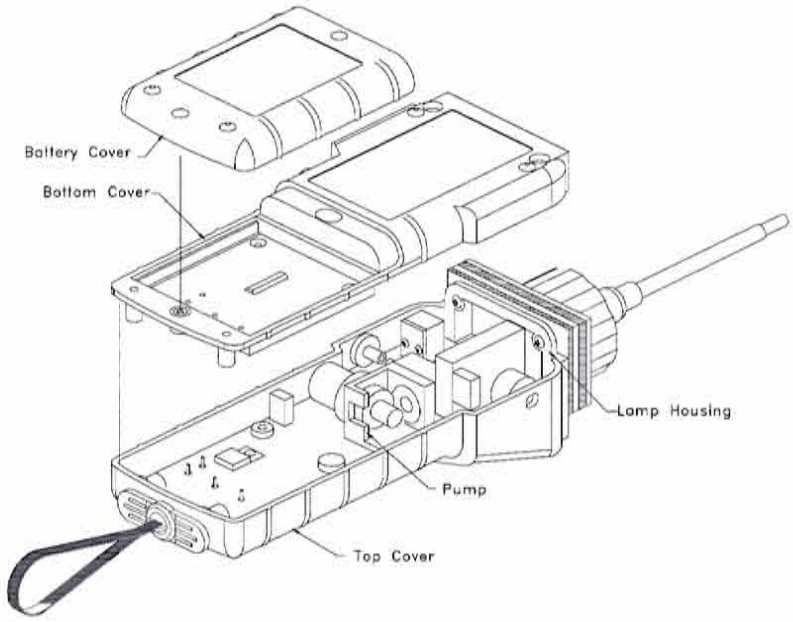


Figure 7-3 Sampling Pump

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.

7.1 Troubleshooting Table

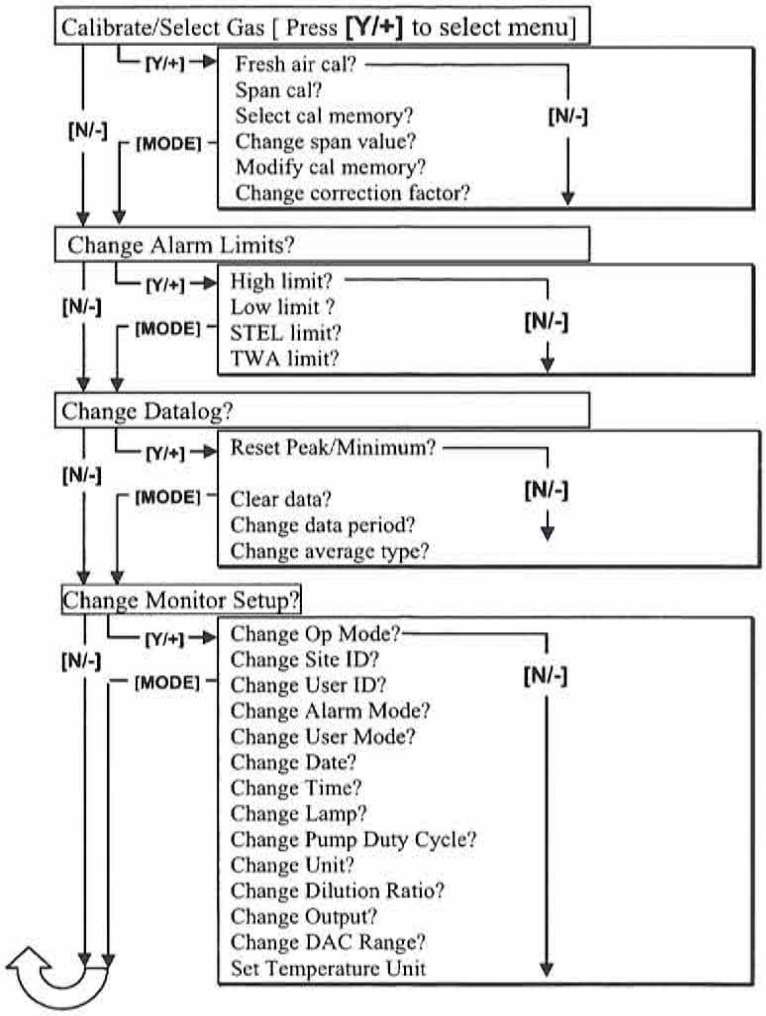
Problem	Possible Reasons & Solutions
Cannot turn on power after charging the battery	**Reasons:** Discharged battery. Defective battery. Microcomputer hang-up. **Solutions:** Charge or replace battery. Disconnect, then connect battery to reset computer.
No LCD back light	**Reasons:** Trigger level too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

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

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.

This SOP is to be used in conjunction with a work plan developed specifically for each project. Please obtain appropriate senior review before implementing this SOP in the field.

Integrated Ambient Indoor, Outdoor, and Crawl Space Air Sampling Method for Trace VOCs Using SUMMA Canisters

1. Scope and Application

This sampling method describes the procedure for collecting ambient air samples for targeted volatile organic compounds (VOCs). Reporting limits for these samples are usually very low and extremely prone to positive bias from interfering VOC sources. The method presented here is based on 'clean' sampling techniques. The requirements of 'clean' sampling dictate that sampling and sample handling are done by trained personnel. A building survey must be performed before sample collection. 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.

2. Summary of Method

A sample of air is withdrawn, using clean technique, into a certified clean and evacuated SUMMA™ canister using a certified clean flow controller. Sample collection can be integrated over time by adjusting the flow controller. Project-specific sample periods as short as 10 minutes to as long as 24 hours can be achieved based on the size of canister used and the sampling rate selected (see Table 1). Generally, 6-liter canisters are used for ambient air sampling. In cases where the crawl space is most conveniently sampled by access through crawl space vents, a sampling probe (sample delivery line made of Teflon or stainless steel) of sufficient length is attached to the inlet of the flow controller.

3. Apparatus and Materials

3.1. Canister, SUMMA™ polished, certified clean and evacuated. (Canisters are typically provided by the laboratory.)

3.2. Flow controller, certified clean and set at desired sampling rate. (Flow controllers are typically provided and set by the laboratory.)

3.3. 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.

3.4. 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 ¼-inch Swagelok® fittings, which most canisters and flow controllers have.

3.5. 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.

3.6. Sampling probe, new Teflon or stainless steel tubing, fitted with compression fittings. (For crawl space samples)

3.7. Sampling cane or similar device for outdoor air sampling to prevent water from entering canister during sampling.

4. Sample Collection

4.1. '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, eating, drinking, perfumes, deodorants, 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.

4.2. 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.***

4.3. Prior to taking indoor air samples, be sure to complete an indoor air building survey [see the vapor intrusion standard operating procedure (SOP) on Building Surveys]. When taking outdoor or crawl space air samples, be sure to note on the field log any items that might bias analytical results (such as gasoline cans, garbage, fresh paint, etc.)

4.4. Inspect the canister for damage and do not use a canister that has visible damage.

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

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

4.5.2. 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.

4.5.3. 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.

4.6. 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.

4.7. In the field log record the canister identification (ID), flow controller ID, initial vacuum, desired flow rate, sample location information, and all other information pertinent to the sampling effort. The indoor and outdoor temperature and barometric pressure should be recorded when sampling begins and is completed.

4.8. Connect the flow controller to the canister.

4.8.1. The flow controller fitting denoted "LP" or "OUT" is connected to the canister. Tighten the fitting to be leak free but <u>do not over-tighten</u> (a ¼ turn past snug is usually enough.) When tightening the fitting, be sure that the valve assembly does not rotate by using your other hand to hold the valve steady.

4.8.2. If an assigned pressure gauge is used for each canister, the pressure gauge should be attached to the canister first and then the flow controller should be attached to the pressure gauge.

4.8.3. When the flow controller and pressure gauge are attached correctly they will not move separately from the canister (they will not spin around).

4.9. For outdoor samples, be sure that the inlet to the flow controller is protected from precipitation. Either place the canister and flow controller under a shelter/enclosure, use a sampling cane provided by the laboratory or use a clean piece of aluminum foil to build a tent over the flow controller inlet.

4.10. For sampling in public areas, outdoor air sample canisters should be secured to an immovable structure to ensure security. A bicycle lock or piece of chain and Master lock can be used. It may be a good idea to attach a label to the canister explaining that it is an

environmental sample and should not be tampered with. The label can also include contact information.

4.11. If crawl spaces are being sampled remotely through a crawl space vent, adjust the length of the sampling probe to achieve the desired sampling location and place an inert spacer (wire clothes hanger) near the end of the probe to keep the probe tip opening suspended ~ 3 inches above the ground level. Now connect the sampling probe to the inlet of the flow controller.

4.12. Remove all work articles from the sampling area.

4.13. To begin sampling, slowly open the canister valve one full turn.

4.14. For canisters with built-in or assigned pressure gauges, monitor the vacuum pressure change several times during the course of the selected sample period to ensure the canister is filling at the desired rate.

4.15. At the end of the sample period, close the canister valve finger tight.

4.16. Remove the flow controller (and assigned pressure gauge) and replace the protective cap on the canister valve fitting.

4.17. If using an external vacuum gauge, re-attach it, open the canister valve, and record the final pressure. Then close the valve, remove the vacuum gauge, and replace the protective cap. Ideal pressure in the canister is between 2 and 10 inches Hg. More than 10 inches Hg can greatly increase reporting limits. No measurable vacuum can invalidate the sample. Immediately consult with the project team if either one of these conditions is encountered.

4.18. If the flow controller is going to be used for more than one sample collection, be sure to purge it between uses. To do this, attach the flow controller to a vacuum source and draw clean air or gas (ultra-high purity) through it for several minutes before attaching it to the canister.

5. Sample Handling and Shipping

5.1. Fill out all appropriate documentation (chain of custody, sample tags) and return canisters and equipment to the laboratory.

5.2. 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.

5.3. 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.

5.4. **Do not place sticky labels or tape on any surface of the canister!**

5.5. Place a custody seal over the openings to the shipping container.

5.6. Make sure to insure the package for the value of the sample containers and flow controllers if corporate card policy does not cover this.

5.7. Ship canisters for overnight delivery.

6. Quality Control

6.1. Canisters 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.

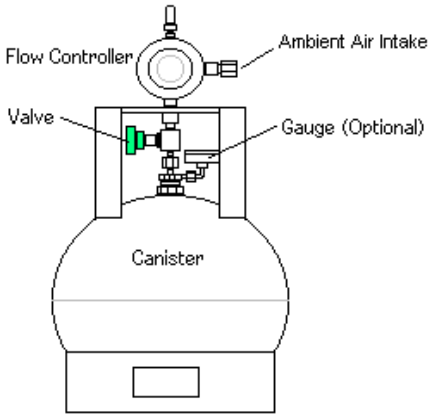
6.2. Flow controllers supplied by the laboratory must follow the performance criteria and QA prescribed in EPA Method TO-14/15 for flow controller cleaning and adjustment. SOPs are required.

Table 1 – Common Sampling Rates for Ambient Air 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

Assembled Canister Sampler for Integrated Sample Collection



This SOP is to be used in conjunction with a work plan developed specifically for each project. Please obtain appropriate senior review before implementing this SOP in the field.

CH2M HILL ***Applied Sciences Laboratory*** Sheet 1 of __

Ambient Air, Outdoor Air & Crawl Space Air Sampling Log (Summa Canister)

Project Information

Project Name: ..... Project # : .....

By: ..... Date: .....

Sampling Data Log

Sample Location	Field ID	Canister ID	Flow Controller ID	Initial Canister Pressure ("Hg)	Initial Flow Controller Rate (ml/min)	Start Date & Time	End Data & Time	Final Pressure ("Hg)	Final Flow Controller Rate (ml/min)

Sample Location Diagram

N

Note:
Draw in outline the structure's foundation and interior walls, identify rooms, and note other defining features. Show location of canister relative to physical objects, etc.

Other Observations and Comments (note any unique circumstances): .....

.....

CH2M HILL *Applied Sciences Laboratory*

Ambient Air, Outdoor Air & Crawl Space Air Sampling Log (Summa Canister)

Project Information

Project Name: _____ Project # : _____

By: _____ Date: _____

Sampling Data Log

Sample Location	Field ID	Canister ID	Flow Controller ID	Initial Canister Pressure ("Hg)	Initial Flow Controller Rate (ml/min)	Start Date & Time	End Data & Time	Final Pressure ("Hg)	Final Flow Controller Rate (ml/min)

Sample Location Diagram

N

Note:

Draw in outline the structure's foundation and interior walls, identify rooms, and note other defining features. Show location of canister relative to physical objects, etc.

Other Observations and Comments (note any unique circumstances): _____

Reviewed 1/17/11 KAS

PMS 219

PMS 1795*

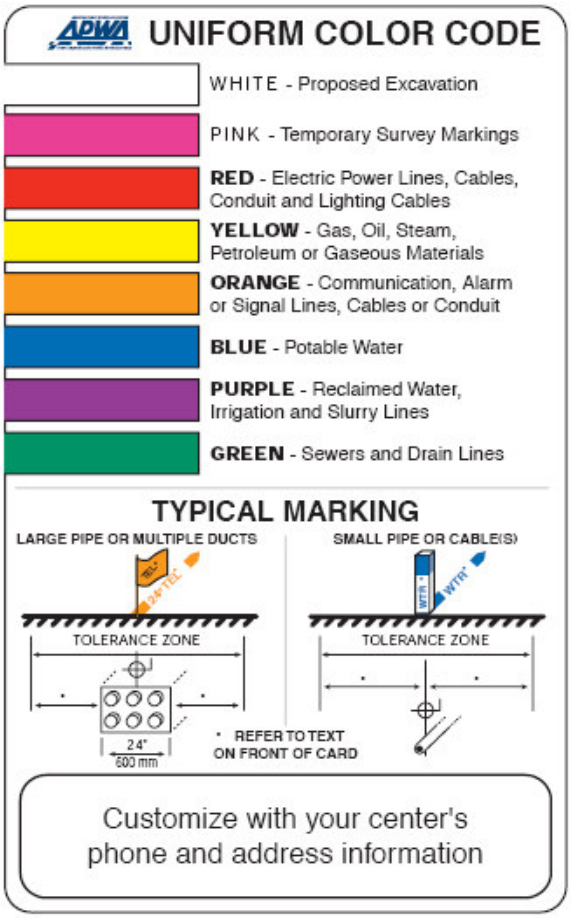
PMS 108

PMS 144*

13.5 parts process
2.5 parts reflex

PMS 253

PMS 3415



GUIDELINES FOR UNIFORM TEMPORARY MARKING OF UNDERGROUND FACILITIES

This marking guide provides for universal use and understanding of the temporary marking of subsurface facilities to prevent accidents and damage or service interruption by contractors, excavators, utility companies, municipalities or any others working on or near underground facilities.

ONE-CALL SYSTEMS
The One-Call damage prevention system shall be contacted prior to excavation.

PROPOSED EXCAVATION
Use white marks to show the location, route or boundary of proposed excavation. Surface marks on roadways do not exceed 1.5" by 18" (40 mm by 450 mm). The facility color and facility owner identity may be added to white flags or stakes.

USE OF TEMPORARY MARKING
Use color-coded surface marks (i.e., paint or chalk) to indicate the location or route of active and out-of-service buried lines. To increase visibility, color coded vertical markers (i.e., stakes or flags) should supplement surface marks. Marks and markers indicate the name, initials or logo of the company that owns or operates the line, and width of the facility if it is greater than 2" (50 mm). Marks placed by other than line owner/operator or its agent indicate the identity of the designating firm. Multiple lines in joint trench are marked in tandem. If the surface over the buried line is to be removed, supplementary offset markings are used. Offset markings are on a uniform alignment and clearly indicate the actual facility is a specific distance away.

TOLERANCE ZONE
Any excavation within the tolerance zone is performed with non-powered hand tools or non-invasive method until the marked facility is exposed. The width of the tolerance zone may be specified in law or code. If not, a tolerance zone including the width of the facility plus 18" (450 mm) measured horizontally from each side of the facility is recommended.

ADOPT UNIFORM COLOR CODE
The American Public Works Association encourages public agencies, utilities, contractors, other associations, manufacturers and all others involved in excavation to adopt the APWA Uniform Color Code, using ANSI standard Z535.1 Safety Colors for temporary marking and facility identification.

Rev. 4/99

Preliminary Building Survey for Vapor Intrusion Investigation

Date: _____

Preparer: _____

Facility: _____

Address: _____

_____

_____

Contact Person: _____

Phone Number: _____

e-mail address: _____

Building Description

Building or Room Identifier: _____

Primary Activity within Building (select one):

☐ Manufacturing ☐ Storage ☐ Other

☐ Chemical processing ☐ Chemical Storage

☐ Administrative ☐ Instrumentation/Control

Historical Activities within Building (if different from above):

_____

_____

Notes: _____

_____

_____

Approximate floor space _____

Number of floors _____

Multi-room building ☐ or Single room ☐

Ceiling height _____

Aboveground Construction ☐ Wood ☐ Concrete

☐ Brick ☐ Cinderblock

☐ Other _____

Floor plan attached? ☐ Yes ☐ No

Notes: _____

_____

QC'ed and revised 1/17/11 KAS

Evaluation of Potential Conduits from Soil

Floor/foundation description (check all that apply)

☐ Wood ☐ Concrete ☐ Elevated above grade?
Feet above grade:_____
☐ Other _____ ☐ Below grade?
Feet above grade:_____
☐ Slab on grade?

Expansion joints present (if concrete floor)?	☐ Yes	☐ No	☐ N/A
Are expansion joints sealed?	☐ Yes	☐ No	☐ N/A
Are sumps or floor drains present?	☐ Yes	☐ No	☐ N/A
Are basements or subsurface vaults present?	☐ Yes	☐ No	☐ N/A
Are there subsurface drainage problems?	☐ Yes	☐ No	☐ N/A

Notes/Explaination for N/A responses: _____

_____

_____

_____

Evaluation of Potential Pathways/Driving Forces

Are there locations with elevated positive or negative pressure (look for doors not opening/closing properly, perceptible airflow, audible fan noise)

Is there one air conditioning zone or multiple zones (if in a multi-room building)?

☐ Single zone ☐ Multi-zone ☐ Other _____

(building management may know; another tip-off is the presence of multiple thermostats = multiple zones)

Sources of outdoor air

☐ Mechanical (air handling unit) ☐ Doors
☐ Windows ☐ Attic Fans

Are windows/doors left open routinely? ☐ Yes ☐ No

Notes: _____

Evaluation of Potential Existing Chemical Sources Indoors

List principal solvent or VOC-containing products used (obtain MSDSs if available)

_____ _____
_____ _____
_____ _____

Are any of the target analytes used in this building/room?

☐ Yes ☐ No

_____ _____
_____ _____

Are pesticides used indoors for pest control? ☐ Yes ☐ No

Names of pesticide products used? _____
_____

Has there been a pesticide application within the past 6 months? ☐ Yes ☐ No

Is smoking permitted in the building? ☐ Yes ☐ No

Description of Vapor Mitigation Systems

Has a radon or vapor mitigation system been installed in this building/room? ☐ Yes ☐ No

Date of installation? _____

Type of system?
☐ Passive venting ☐ Active subslab depressurization
☐ Crack/crevice sealing ☐ Dilution ventilation control
☐ N/A

Notes: _____

Additional Notes

Additional Notes

Date: _____

Preparer: _____

Facility: _____

Description (floor): _____

Floor Plan Information

Buried Utility Location Tracking Form

(Submit to CH2M HILL PM within 24 hrs of location activities)

Project Location:
CH2M HILL Project No.:
CH2M HILL Project Manager: Name/Phone:
Fax:
Email:
CH2M HILL Field Team Leader: Name/Phone:

CH2M HILL Purchase Order:

Utility Location Subcontractor:
Subcontractor POC:

Dates of location activities:

Check each box using an "X" if a buried utility is present within 5 feet of a marked Station ID. If color of the flag or paint differs from listed color, note change in color on the form.

Station ID	Gas (Yellow)	Electric (Red)	Fiber optic (Orange)	Cable (Orange)	Water (Blue)	San. Sewer (Green)	Storm Sewer (Green)	Steam (Yellow)	Petroleum (Yellow)	Compressed air (Yellow)	Other ____	Other ____	Other ____	Other ____	Date completed	Technician initials	Notes (methods/tools used)

The findings of the buried utility location activities summarized herein were conducted in strict accordance with the CH2M HILL scope of work.

Subcontractor's Signature

Date

STANDARD OPERATING PROCEDURE

Decontamination of Personnel and Equipment

I. Purpose

To provide general guidelines for the decontamination of personnel, sampling equipment, and monitoring equipment used in potentially contaminated environments.

II. Scope

This is a general description of decontamination procedures.

III. Equipment and Materials

- Demonstrated analyte-free, deionized ("DI") water (specifically, ASTM Type II water or lab-grade DI water)
- Potable water; must be from a municipal water supplier, otherwise an analysis must be run for appropriate volatile and semivolatile organic compounds and inorganic chemicals (e.g., Target Compound List and Target Analyte List chemicals)
- 2.5% (W/W) Liquinox® (or Alconox®)and water solution
- Concentrated (V/V) pesticide grade methanol (DO NOT USE ACETONE)
- Large plastic pails or tubs for Liquinox® and water, scrub brushes, squirt bottles for Liquinox® solution, methanol and water, plastic bags and sheets
- DOT approved 55-gallon drum for disposal of waste
- Personal Protective Equipment as specified by the Health and Safety Plan
- Decontamination pad and steam cleaner/high pressure cleaner for large equipment

IV. Procedures and Guidelines

A. PERSONNEL DECONTAMINATION

To be performed after completion of tasks whenever potential for contamination exists, and upon leaving the exclusion zone.

1. Wash boots in Liquinox® solution, then rinse with water. If disposable latex booties are worn over boots in the work area, rinse with Liquinox® solution, remove, and discard into DOT-approved 55-gallon drum.

2. Wash outer gloves in Liquinox® solution, rinse, remove, and discard into DOT-approved 55-gallon drum.

3. Remove disposable coveralls ("Tyveks") and discard into DOT-approved 55-gallon drum.

4. Remove respirator (if worn).

5. Remove inner gloves and discard.

6. At the end of the work day, shower entire body, including hair, either at the work site or at home.

7. Sanitize respirator if worn.

B. SAMPLING EQUIPMENT DECONTAMINATION—GROUNDWATER SAMPLING PUMPS

Sampling pumps are decontaminated after each use as follows.

1. Don phthalate-free gloves.

2. Spread plastic on the ground to keep equipment from touching the ground

3. Turn off pump after sampling. Remove pump from well and remove and dispose of tubing. Place pump in decontamination tube.

4. Turn pump back on and pump 1 gallon of Liquinox® solution through the sampling pump.

5. Rinse with 1 gallon of 10% methanol solution pumped through the pump. (DO NOT USE ACETONE).

6. Rinse with 1 gallon of tap water.

7. Rinse with 1 gallon of deionized water.

8. Keep decontaminated pump in decontamination tube or remove and wrap in aluminum foil or clean plastic sheeting.

9. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.

10. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved 55-gallon drums.

C. SAMPLING EQUIPMENT DECONTAMINATION—OTHER EQUIPMENT

Reusable sampling equipment is decontaminated after each use as follows.

1. Don phthalate-free gloves.
2. Before entering the potentially contaminated zone, wrap soil contact points in aluminum foil (shiny side out).
3. Rinse and scrub with potable water.
4. Wash all equipment surfaces that contacted the potentially contaminated soil/water with Liquinox® solution.
5. Rinse with potable water.
6. Rinse with distilled or potable water and methanol solution (DO NOT USE ACETONE).
7. Air dry.
8. Rinse with deionized water.
9. Completely air dry and wrap exposed areas with aluminum foil (shiny side out) for transport and handling if equipment will not be used immediately.
10. Collect all rinsate and dispose of in a DOT-approved 55-gallon drum.
11. Decontamination materials (e.g., plastic sheeting, tubing, etc.) that have come in contact with used decontamination fluids or sampling equipment will be disposed of in DOT-approved 55-gallon drums.

D. HEALTH AND SAFETY MONITORING EQUIPMENT DECONTAMINATION

1. Before use, wrap soil contact points in plastic to reduce need for subsequent cleaning.
2. Wipe all surfaces that had possible contact with contaminated materials with a paper towel wet with Liquinox® solution, then a towel wet with methanol solution, and finally three times with a towel wet with distilled water. Dispose of all used paper towels in a DOT-approved 55-gallon drum.

E. SAMPLE CONTAINER DECONTAMINATION

The outsides of sample bottles or containers filled in the field may need to be decontaminated before being packed for shipment or handled by personnel without hand protection. The procedure is:

1. Wipe container with a paper towel dampened with Liquinox® solution or immerse in the solution AFTER THE CONTAINERS HAVE BEEN SEALED. Repeat the above steps using potable water.

2. Dispose of all used paper towels in a DOT-approved 55-gallon drum.

F. HEAVY EQUIPMENT AND TOOLS

Heavy equipment such as drilling rigs, drilling rods/tools, and the backhoe will be decontaminated upon arrival at the site and between locations as follows:

1. Set up a decontamination pad in area designated by the Facility

2. Steam clean heavy equipment until no visible signs of dirt are observed. This may require wire or stiff brushes to dislodge dirt from some areas.

V. Attachments

None.

VI. Key Checks and Items

- Clean with solutions of Liquinox®, methanol, and distilled water.
- Do not use acetone for decontamination.
- Drum all contaminated rinsate and materials.
- Decontaminate filled sample bottles before relinquishing them to anyone.

CH2MHILL

Indoor Vapor Intrusion Assessment
Sub-slab Vapor Field Sampling Log - Summa Canister Method

Project Info

Project Name: ..... **Project # :** .....

By: ..... **Date:** .....

Structure

Identification: .....

Address: .....

Slab Information:

☐ Concrete slab on grade (directly on top of soil) ☐ Other (describe) .....

☐ Concrete slab on gravel underlayment .....

Condition of slab .....

Type of Sub Slab Soil .....

Is water present in the soil .....

Sub-slab Probe Installation, Leak Checking, Probe Purging, & Sampling Log

	Sample location (show in diagram)	1	2	3	4
	Sample Identification (field ID)				
Probe Installation	Depth of slab (inches)				
	Depth of hole drilled (inches below slab surface)				
	Depth of installed probe (inches below slab surface)				
Manifold Leak check	Leak check (sampling manifold) - Pass/No Pass				
Probe Purge	Purge rate, mL/min.				
	Purge Start (time of day)				
	Purge vacuum, " Hg				
	Purge completed (time of day)				
Helium Leak Check (optional)	Leak check (Helium) - % or ppmv				
Field Analysis (optional)	Gem 2000 (O_2 / CO_2 / CH_4) - %				
	PID - ppmv				
Canister Sampling	Canister & flow controller ID (if used)				
	Initial Canister Pressure (" Hg)				
	Sampling rate, mL/min				
	Sampling period started (time of day)				
	Sampling vacuum, " Hg				
	Sampling period ended (time of day)				
	Final Canister Pressure (" Hg)				

Observations and Comments: .....

CLICK HERE FOR ATTACHMENTS

Waste Management: Non-Hazardous Waste
Enterprise Standard Operating Procedure HSE-411

1.0 Purpose

This Enterprise Standard Operating Procedure (SOP) describes the management practices associated with non-hazardous waste. Waste management includes storage, transportation, and disposal of waste. It is designed to be used in conjunction with HSE-413, Waste Management Planning and HSE-408, Waste Management Analysis and Characterization and applies to field projects as well as office and warehouse wastes.

2.0 Scope and Application

2.1 Scope

Non-hazardous wastes are generally subject to solid waste management requirements. Other wastes that are not hazardous but are subject to regulation include asbestos waste (see HSE-502), PCB waste (see HSE-412), and lead-contaminated waste (see HSE-508). However, non-hazardous waste may be more stringently regulated by a state or local entity. Consult the Responsible Environmental Manger to determine state or local management standards.

2.2 Application

This SOP applies Enterprise Wide to all CH2M HILL Legal Entities and Business Groups, their employees, subcontractors and their lower-tier subcontractors that operate in the United States (US) and internationally.

Some state environmental or OSHA programs may have more stringent requirements. . State regulations may be found under Regtools. Contact the appropriate Responsible Environmental Manager (REM) to address these specific requirements. This SOP should be used as a starting point for international operations, but country-specific health, safety and environmental (HSE) regulations shall prevail, and a country-specific SOP should be developed to comply with these specific HSE regulations.

2.3 Applicable Enterprise SOPs

Applicable Enterprise Standards of Practice and Standard Operating Procedures that are applicable to this Waste Management-Non Hazardous Waste SOP are as follows:

- HSE-408, Waste Management Analysis and Characterization
- HSE-409, Waste Management
- HSE-412, PCB Waste
- HSE-413, Waste Management Planning
- HSE-415, Universal Waste
- HSE-502, Asbestos Waste
- HSE-508, Lead-contaminated Waste

3.0 Definitions

3.1 Asbestos-Containing Material (ACM)

Asbestos-containing materials are materials that contain asbestos that may be generated from construction, demolition or renovation of structures where asbestos is present; or removal of materials containing asbestos.

3.2 Characterization

Characterization is the process performed by a generator to determine the type of waste being managed and how the waste should be disposed. This process can involve identifying waste constituent concentrations and comparing the concentrations to legal requirements or threshold levels that affect how the waste is disposed. Waste characterization procedures are provided in the HSE-408, Waste Management Analysis and Characterization.

3.3 Construction and Demolition (C&D) Debris

Construction and demolition (C&D) debris is waste material that is produced in the process of construction, renovation or demolition of structures. Structures can include buildings, bridges, slabs, and pavements. Components of C&D debris typically include concrete, asphalt, wood, metals, gypsum wallboard, and roofing. Note that some states have separate regulatory requirements for C&D waste.

3.4 Lead-contaminated Waste

Lead-contaminated wastes are wastes that contain lead (e.g., old paint containing lead). Such wastes may be generated during construction, demolition, or renovation of structures. HSE-508, Lead-contaminated Waste, discusses managing lead-contaminated materials

3.5 Non-Hazardous Waste

In this SOP, non-hazardous wastes are considered to be wastes that are not classified as hazardous under RCRA Subtitle C and are not subject to other regulatory requirements (e.g., PCB, asbestos).

3.6 National Pollutant Discharge Elimination System (NPDES)

The National Pollutant Discharge Elimination System (NPDES) permit program regulates the point source discharge of industrial wastewater and storm water.

3.7 Publicly Owned Treatment Works (POTW)

Publicly-owned treatment works (POTW), owned by a state or municipality, are used to treat (including recycle and reclaim) either domestic sewage or a combination of domestic sewage and industrial waste of a liquid nature. If owned by a federal agency (e.g., Department of Defense), this is called a federally-owned treatment works (FOTW).

3.8 Purge Water

Purge water is removed from a well prior to the collection of a groundwater sample to make sure that the sample is representative of groundwater in the aquifer and not stagnant water within the well.

3.9 Petroleum-Contaminated Soil

Petroleum-contaminated soil refers to soil that may be contaminated with petroleum as a result of leaky underground storage tanks or some other source.

3.10 PCB Wastes

Most PCB wastes that are encountered are generated from management of PCB-containing equipment (e.g., light ballasts), clean up and remediation of PCB-contaminated soils. This also includes PCB articles—any PCB item, PCB container, PCB equipment, or anything that deliberately or unintentionally contains PCBs.

3.11 Solid Waste

For purposes of this SOP, solid wastes are generally non-hazardous wastes that do not contain any regulated constituents such as solvents, lead, and PCBs.

3.12 Stockpiles

A stockpile is an area where soil or debris is consolidated and stored or managed in a pile.

3.13 Underground Injection Control (UIC)

The Underground Injection Control (UIC) Program refers to the Environmental Protection Agency (EPA) program responsible for monitoring subsurface wastewater discharges.

3.14 Universal Waste

Universal waste is hazardous waste that is regulated by EPA or state jurisdictions having authority over hazardous waste regulation. If managed as universal waste, these hazardous wastes are subject to less stringent management procedures. These wastes currently include batteries, agricultural pesticides, mercury-containing thermostats, and lamps.

3.15 Well Development Water

Well development waster refers to water that is circulated through the well screen and well bore to remove settled and suspended materials within the well, which increases the permeability of the formation surrounding the well screen.

4.0 Roles and Responsibilities

4.1 Project Manager (PM)

The PM is responsible for ensuring that non-hazardous wastes are managed in accordance with this SOP. The PM should work with the Responsible Environmental Manager (REM) to identify good management practices and comply with any local requirements affecting non-hazardous or solid wastes.

4.2 Responsible Environmental Manger (REM)

The REM assists the project manager in ensuring that the project complies with the environmental laws and regulations by identifying issues and resources to meet project needs.

4.3 Safety Coordinator (SC)

The SC is familiar with project plans, including air emission controls and permit conditions, and implements the plans in the field.

5.0 Procedures

CH2M HILL requires managing non-hazardous wastes in accordance with good management practices.

5.1 Waste Characterization and Management

To assure proper management and disposal, it is necessary to determine the type of waste that needs to be managed. Refer to HSE-408, Waste Management Analysis and Characterization for waste characterization procedures. The following wastes are subject to other requirements that are discussed in the corresponding SOP:

- **Asbestos—**Refer to HSE-502. Asbestos-containing wastes must be double-bagged and placed in landfill cells permitted to accept asbestos-containing wastes.
- **PCBs—**Refer to HSE-412.
- **Universal Waste—**Refer to HSE-415. If universal waste is not managed according to the universal waste regulatory requirements, it is considered hazardous waste and would need to be managed as discussed in HSE-409.

Some states and local agencies require that petroleum-contaminated soil be managed in a more stringent manner, and may even require that it be managed as hazardous waste. Consult the REM for state and local requirements.

For all waste streams, CH2M HILL's order of preference for waste management is source reduction, recycling, and lastly disposal.

5.1.1 Source Reduction

Source reduction is defined as the design, manufacture, and use of products to reduce the quantity and toxicity of waste produced when the products reach the end of their useful lives. Source reduction activities fall into some basic categories:

- Product reuse (e.g., reusable shopping bags and coffee mugs)
- Reduced material volume (e.g., less unnecessary packaging for products)
- Reduced toxicity of products (e.g., use substitutes for lead, cadmium, mercury, and other toxins)
- Increased product lifetime (e.g., design products with longer useful life)
- Decreased consumption (e.g., changing consumer buying practices, bulk purchasing).

These source reduction practices reduce cost and amount of waste management practices.

5.1.2 Recycling

A variety of office and project wastes can be recycled. Check with your REM to see what markets are available in your area.

5.1.3 Office Recycling

The following materials are recycled at CH2M HILL offices:

- Aluminum cans
- Corrugated cardboard
- Laser printer cartridges
- Newspaper
- Office paper
- Magazines
- Telephone books
- Lead-acid batteries
- Selected plastics

5.1.4 Project Recycling

In addition to the office recyclables that are generated on project sites, the following project materials should also be recycled:

- Asphalt
- Concrete
- Insulation
- Scrap metal
- Petroleum-contaminated soil
- Carbon filters

5.2 Storage

The storage of solid waste (including items that may be recycled, e.g., petroleum-contaminated soil) may be subject to state or local requirements. Consult your REM for assistance.

5.2.1 Stockpiles

Solid waste stockpiles are typically regulated by state and local agencies. Technical standards may include storing the wastes on plastic sheeting and covering with plastic. Some states require permits for solid waste stockpiles. States may also have time limits for solid waste stockpiles and dust control requirements. Consult your REM for assistance.

5.2.2 Containers

Solid waste containers should meet DOT specifications. State and local agencies may also have specific requirements for solid waste containers. Consult your REM for assistance.

5.2.3 Labels

Use the following label for containers of non-hazardous waste. The non-hazardous waste label and other labels can be ordered by phone or online through Mesa Label Express (www.mesalabel.com; 858-693-4987) or Labelmaster (www.labelmaster.com; 800-621-5808).

5.3 Disposal

Non-hazardous wastes are subject to regulation as solid waste. Consult your REM for assistance. The following subsections discuss management of typical non-hazardous wastes generated at CH2M HILL project sites.

5.3.1 Construction and Demolition (C&D) Debris

Demolition debris can be hauled, and then dispensed at any construction and demolition (C&D) landfill or any municipal solid waste landfill that is permitted to accept C&D debris. C&D debris should be reduced whenever possible. Clean C&D debris can be reused, such as broken concrete without protruding metal bars, bricks, rock, stone, reclaimed asphalt pavement, dirt or sand. Additionally, there are a number of C&D debris recyclers that will accept wood, aluminum and other metals, asphalt, concrete, and corrugated cardboard. If debris is known to contain hazardous substances, review HSE-413, Waste Management Planning and HSE-408, Waste Management Analysis and Characterization to determine the appropriate procedures for disposal.

5.3.2 Lead-Contaminated Waste

If lead-based paint debris from abatement, deleading, renovation, remodeling, and demolition contains more than 5 mg/L of lead (determined by knowledge of the waste or TCLP tests), the debris may be subject to RCRA subtitle C hazardous waste requirements. For RCRA requirements and procedures, refer to HSE-413, Waste Management Planning and HSE-408, Waste Management Analysis and Characterization. EPA has proposed a rule to exclude lead-based paint from regulation as hazardous waste, although it is regulated under the Toxic Substances Control Act (TSCA).

5.3.3 Petroleum-Contaminated Soil

Petroleum-contaminated soil is generated from spilled petroleum compounds, often from leaky underground storage tanks. The soil can be treated, disposed of, recycled, and reused in many different manners. Typical strategies that have been used to manage petroleum-contaminated soil include: use of the petroleum-contaminated soil as a landfill cap, removal of the petroleum through soil treatment with Low-Temperature Thermal Desorption (LTTD), and soil land farming to break down the petroleum products with reuse onsite.

LTTD has proven very effective in reducing concentrations of petroleum products including gasoline, jet fuels, kerosene, diesel fuel, heating oils, and lubricating oils. Operation of LTTD units at a project site requires various permits and demonstration of compliance with permit requirements. Monitoring of LTTD system waste streams (*e.g.*, concentrations of particulates, volatiles, and carbon monoxide in stack gas) are required by the agency(ies) issuing the permits for operation of the facility. Each state has its own standards for soil cleanup levels. Contact your REM for assistance as soil and air monitoring may be required.

5.3.4 Well Purge and Development Water

There are four options for the disposal of well purge and development water generated at project sites:

1. Onsite treatment and discharge
2. Discharge to POTW/FOTW
3. Discharge to injection galleries/injection wells
4. Discharge to ground

Note that discharge to surface water is not an option. A discharge to surface water would require an NPDES permit.

Onsite Treatment and Discharge

Non-hazardous well purge/development water may be treated with an existing groundwater treatment system that has an NPDES permit or POTW approval. It can also be discharged to the sewer without treatment if the POTW grants approval and the POTW's influent criteria are met. Purge water can also be discharged to an onsite wastewater pretreatment system operated by the facility owner, providing it does not affect the discharge from the pretreatment system.

Hazardous purge/well development water can also be treated onsite in a treatment system without a hazardous waste treatment permit if the treatment system can be defined as a wastewater treatment unit under RCRA (40 CFR 264.1 (g)(10)). To do so, the following criteria must be met:

1. The treatment unit has an NPDES permit under the Clean Water Act (CWA), or discharges to a POTW via sewer or direct connection, under a permit or written approval;

2. The treatment unit receives and treats (or stores) influent wastewater, which might be hazardous; and

3. The treatment unit meets the definition of a *tank* or *tank system*.

If discharged to a POTW, the water is no longer defined as a "solid waste" under RCRA once it is in the sewer because it is regulated under the CWA.

In addition to the above, the water should originate from wells at the site and not from other sites; i.e., from the same aquifer. Do not treat water from offsite sources unless instructed by the client in writing, and only after receiving EPA or state approval.

Although treatment devices, such as carbon canisters, air strippers, and oil/water separators are often considered a tank or tank system, these definitions are subject to state and local

regulatory interpretation. Waste residues, e.g., filter bags, and tower packing, from water treatment are not exempt from the RCRA regulations and must be tested to determine if they are a hazardous waste.

Discharge at Offsite POTW/FOTW

Hazardous and non-hazardous well purge/development water may be discharged at an offsite POTW under the following conditions:

1. The discharged water is properly classified, using "client" knowledge and/or testing;
2. The water must *not* be ignitable and must not have a sheen or film of separate-phase oil or other organics;
3. A written notice, signed by the client, is submitted to the POTW, and the water meets the POTW acceptance limits (the client determines this);
4. Approval from the POTW is received *in writing*; and
5. For hazardous waste shipments to POTWs, federal regulations in 40 CFR 270.1(c)(2)(v) also require the POTW to:
    - Have an EPA ID number;
    - Request use of a Hazardous Waste Manifest for the shipment;
    - Report manifest discrepancies;
    - Submit Biennial and unmanifested waste reports; and
    - The waste must meet pre-treatment requirements.

This is not a preferred option. It is also impractical because it is difficult to find a POTW that will accept RCRA or state hazardous wastes. If a POTW is used, document the shipment with a shipping paper or manifest, and make arrangements for transportation with a transporter approved for use by CH2M HILL and the client.

Discharge to Injection Galleries/Injection Wells

Discharge of well purge/development water to an injection gallery or injection well is allowed by permit or approval. The purge water must originate from wells at the site, i.e., from the same aquifer, and have the same chemical properties as that approved for re-injection. The criteria below must be met:

1. The water is non-hazardous or is exempt from hazardous waste regulations under 40 CFR 261.4(a) &(b); and
2. The injection gallery at the client site is operating under a state permit, or approval from the EPA Regional Underground Injection Control (UIC) Coordinator; or
3. For CERCLA Sites, if the water is hazardous and is discharged to an injection gallery or injection well constructed within a designated area of contamination, the agency will likely establish discharge limits, and monitoring/reporting requirements through the state UIC or wastewater discharge program.

Discharge to Ground Surface

Discharge of purge water to ground surface is allowable under the following conditions:

1. The discharged water is properly classified, using client knowledge and/or testing;
2. The water is *not* a RCRA or state hazardous waste;
3. Written approval is received from the client; and
4. Discharge is performed under state permit or approval, or state guidelines.

States often require that purge water be filtered with carbon prior to discharge to ground surface. Portable handcart-mounted adsorption units are available from a number of vendors such as Continental Environmental Systems (800-342-1103). Remember that a container of granular activated carbon (GAC) that shows signs of "breakthrough" is considered "spent" and must be managed as a waste and must be characterized under procedures discussed in the Waste Management Analysis and Characterization SOP (HSE-408).

6.0 Training Requirements

Employees on projects that generate waste must complete the following training:

- Dangerous Goods Training
- Environmental Awareness Training
- Waste Management Training

7.0 Checklists

The HSE Self Assessment Checklist: Non Hazardous Waste Management in Attachment 1 is provided as a method for verifying compliance with this SOP. The REM specifies the frequency in which this checklist shall be completed by the SC and provides this information in the project's written safety plan. The REM shall assist the SC in resolving any deficiencies identified during the self assessment. The REM may also use this checklist when performing HS audits at CH2M HILL projects, including subcontractor's activities.

8.0 References

The following regulations were referenced to prepare this Enterprise Standard Operating Procedure:

- US Environmental Protection Agency (EPA): 40 CFR Parts 260 through 279, Resource Recovery and Conservation Act (RCRA)

9.0 Attachments

Attachment 1: **HS&E Self Assessment Checklist: Non-Hazardous Waste**

10.0 Approval

Revision	Date	Prepared By	Approved By:
1.0	10-08-2007	Jim Kelly	R Keith Christopher

CH2MHILL

Attachment 1: HSE Self-Assessment Checklist

CH2MHILL

HS&E Self-Assessment Checklist –Non-Hazardous Waste

This checklist shall be used by CH2M HILL personnel **only** and shall be completed at the frequency specified in the project's HSP/FSI. This checklist is to be used at locations where CH2M HILL generate or manage non-hazardous waste.

CH2M HILL staff shall not direct the means and methods of subcontractor activities nor direct the details of appropriate corrective actions. The subcontractor must determine how to correct deficiencies and CH2M HILL staff must carefully rely on their expertise. Conditions considered to be imminently dangerous (possibility of serious injury or death) must be corrected immediately or all exposed personnel must be removed from the hazard until corrected.

Project Name: _____ Project No.: _____

Location: _____ PM:

Auditor: _____ Title: _____ Date: _____

This specific checklist has been completed to:

☐ Evaluate CH2M HILL compliance with its Non-Hazardous Waste SOP (HSE-411)

☐ Evaluate a CH2M HILL subcontractor's compliance with non-hazardous waste procedures.

Subcontractors Name: _____

- Check "Yes" if an assessment item is complete/correct
- Check "No" if an item is incomplete/deficient. Deficiencies shall be brought to the immediate attention of the subcontractor. Section 3 must be completed for all items checked "No."
- Check "N/A" if an item is not applicable
- Check "N/O" if an item is applicable but was not observed during the assessment

SECTION 1

	Yes	No	N/A	N/O
PROCEDURES				
SOURCE REDUCTION AND RECYLCING (5.1.1)				
1. Products have been re-used to reduce waste quantity and toxicity	☐	☐	☐	☐
2. Material volumes have been reduced by less packaging.	☐	☐	☐	☐
3. Less toxic products have been used to reduce waste toxicity.	☐	☐	☐	☐
4. Materials at CH2M HILL offices are recycled.	☐	☐	☐	☐
5. Recyclables generated at project sites are recycled.	☐	☐	☐	☐
STORAGE (5.2)				
6. Local or state solid waste storage requirements have been identified.	☐	☐	☐	☐
7. Local and state solid waste stockpile requirements have been identified.	☐	☐	☐	☐
8. Solid waste containers meet DOT specifications.	☐	☐	☐	☐
9. Non-hazardous waste label used for containers of non-hazardous waste.	☐	☐	☐	☐
DISPOSAL (5.3)				
Construction and Demolition Debris (5.3.1)				
10. Construction debris is disposed of at a landfill permitted to take C&D debris.	☐	☐	☐	☐
11. Clean C&D debris is reused.	☐	☐	☐	☐
12. C&D debris considered for recycling.	☐	☐	☐	☐
13. C&D debris containing hazardous waste is managed under HSE-408.	☐	☐	☐	☐

	Yes	No	N/A	N/O
Lead-Contaminated Waste (5.3.2)				
14. Lead-based paint debris managed under HSE-408 and HSE-413.	☐	☐	☐	☐
Petroleum-Contaminated Soil (5.3.3)				
15. REM consulted for treatment, disposal and recycling options for petroleum-contaminated soils.	☐	☐	☐	☐
Well Water Onsite Treatment and Discharge				
16. Non-hazardous well purge/development water treated in existing NPDES-permitted system.	☐	☐	☐	☐
17. Non-hazardous water is discharged to sewer untreated with POTW approval.	☐	☐	☐	☐
18. Non-hazardous waste is discharged to onsite wastewater pretreatment system.	☐	☐	☐	☐
19. Treatment of hazardous wastewater meets requirements of RCRA wastewater treatment unit.	☐	☐	☐	☐
Discharge at Offsite POTW/FOTW (5.3.4)				
20. Discharged water is classified using “client” knowledge and/or testing.	☐	☐	☐	☐
21. The water is not ignitable, does not contain organics or have an oily sheen.	☐	☐	☐	☐
22. Client provided written notice to POTW that water meets acceptance limits.	☐	☐	☐	☐
23. POTW discharge approval received in writing.	☐	☐	☐	☐
24. POTW EPA ID number obtained for hazardous wastewater.	☐	☐	☐	☐
25. Hazardous waste manifest used for transport of hazardous waste to POTW.	☐	☐	☐	☐
26. Waste meets pre-treatment requirements	☐	☐	☐	☐
Discharge to Injection Galleries/Injection Wells (5.3.4)				
27. Permit or approval obtained for discharge to injection gallery or well.	☐	☐	☐	☐
28. Purge water originated from wells at the site (same aquifer with same chemical properties).	☐	☐	☐	☐
29. The purge water is non-hazardous or exempt from hazardous waste regulations.	☐	☐	☐	☐
30. Injection gallery at site is operating under state permit or approval from EPA.	☐	☐	☐	☐
Discharge to Ground Surface (5.3.4)				
31. Discharged water is classified using “client” knowledge and/or testing.	☐	☐	☐	☐
32. Purge water is not a RCRA or state hazardous waste.	☐	☐	☐	☐
33. Written approval received from the client.	☐	☐	☐	☐
34. State permit or approval received for discharge.	☐	☐	☐	☐
35. Carbon filtration used prior to discharge to the ground surface.	☐	☐	☐	☐

<u>SECTION 3</u>

Complete this section for all items checked “No’ in Sections 1 or 2. Deficient items must be corrected in a timely manner.

Item #	Corrective Action Planned/Taken	Date Corrected

Auditor: ___________________________________ Project Manager: ____________________________

STANDARD OPERATING PROCEDURE

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

Conducting Building Surveys for Vapor Intrusion Evaluation

Quality Management

SOP NO. : BLDGSURVEY-1
REVISION: 2.0
DATE: 11/17/2009
PAGES: 5

File Name: SOP_VI_Building_Survey_020809.Doc

Location: Vapor Intrusion VOC Share Point site/Key Documents/Best Practices/SOPs

Primary Contact(s): Jennifer Simms/PHL and Ben Thompson/CVO

QA/QC Review: Dave MacPhaul/GNV, Mike Bedan/DEN, Julie Keating/DEN, Loren Lund/DEN

Associated Internal Resources:

Excel survey forms for commercial/industrial buildings and residential buildings are available at Vapor Intrusion VOC Share Point site/Key Documents/Best Practices/SOPs.

Example project reports using this SOP can be found at Vapor Intrusion VOC Share Point Site/Limited Access Site/VI Project Repository/

For vapor intrusion evaluations in residential areas, a community outreach plan should be developed and the field team should be trained on how to interact with residents. Internal *Public Involvement Specialists* who can be consulted for this include Amy Brand/VBO and Ginny Farris/WDC.

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STANDARD OPERATING PROCEDURE

Conducting Building Surveys for Vapor Intrusion Evaluation

1. Background

This standard operating procedure (SOP) describes the procedures for conducting building surveys for vapor intrusion evaluations. A building survey is performed as part of a vapor intrusion evaluation to obtain information for development of a conceptual site model (CSM) and to prepare for vapor intrusion sampling.

2. Purpose and Objectives

The three purposes of performing a building survey are to 1) gather building characteristics data for the vapor intrusion CSM, 2) select optimal vapor intrusion sampling locations within the building, and 3) determine if there are any potential indoor sources.

This SOP can be used to perform building surveys in residential, commercial, or industrial buildings. At project sites with multiple buildings, a building survey should be performed for each building that is included in the vapor intrusion evaluation.

A CSM for vapor intrusion pathway evaluation describes potential constituent sources, migration pathways, and potential human receptors under current and/or future land uses at the site.

The important building characteristics for vapor intrusion pathway evaluation include construction materials; room dimensions; building/room use; presence of a basement or crawl space; condition of the slab; presence/condition of doors and windows; type, age, and typical operational settings of the air handling unit; identification of potential vapor intrusion pathways into the building (e.g., cracks, sumps, drains, utilities, etc.); and the presence of potential indoor sources of volatile organic compounds (VOCs).

The building survey will likely be the first interaction with the occupants at the building and is an appropriate time to provide occupants with information on the vapor intrusion evaluation being performed and any sampling procedures that will be used.

3. Project-Specific Considerations

Some states include building survey procedures and forms in their regulations or guidance documents. 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.

Varying levels of detail can be attained for building surveys. The project should develop data quality objectives (DQOs) to determine what specific information should be collected for their project.

For vapor intrusion evaluations in residential areas, a community outreach plan should be developed and the field team should be trained on how to communicate with residents.

Ideally, the building survey should be conducted at least one week before the actual indoor air or subslab soil gas sampling event. This advance timeframe allows the vapor intrusion investigator to identify and eliminate (to the extent practical) potential background sources of indoor air contamination. It also permits the investigator to confirm the sample locations with the occupants and regulatory agency(s) (if applicable) ahead of the scheduled sampling event.

4. Health and Safety

There are several health and safety topics to consider when performing building surveys:

- Field teams should perform building surveys in pairs. A field team member should never enter a residence alone. The mental stability of a home owner should not be taken for granted. Building surveys at abandoned buildings should also be performed in pairs; if one team member is injured, the other will be able to seek help.
- Walk slowly and with caution to avoid slips, trips, and falls.
- Beware of animals and insects. This applies to abandoned buildings and residences.
- Be careful of overhead hazards in basements. Do not attempt to enter crawl spaces.

5. Materials

- *Building Survey Form* – to record survey information. Example forms are provided in Attachment A of this SOP; there is one for residential buildings, and one for industrial/commercial buildings.
- Flashlight
- Walking wheel or measuring tape – to measure building and room dimensions
- Camera – to photograph the building, heating, ventilation, and air conditioning (HVAC) system, etc.
- Photoionization detector – to monitor total VOCs for health and safety at sites where high VOC concentrations may be expected (*OPTIONAL*)

6. Field Procedures

6.1. Gain access to the building. Schedule the site visit with the site contact. At a client-owned and -operated site this step may just require a phone call to the client. At an off-site residence this may require significant coordination, including obtaining an access agreement and providing vapor intrusion fact sheets to inform residents of the vapor intrusion pathway and the reason for the investigation.

6.2. Obtain occupant information. The building occupants are the potential receptors in the vapor intrusion CSM. Is the building use residential, commercial, or industrial?

How many people typically occupy the building? Are there sensitive receptors (children, elderly, or immune-impaired) in the building? How much time do occupants spend in the building?

6.3. Obtain building information. How old is the building? What was its original use? Have there been any additions or other significant modifications? How many floors does the building have? Does the building have a basement? If so, how far does it extend below grade? Is the slab on grade? Is the slab elevated above the ground surface?

6.4. Observe the slab condition. The building slab is the barrier between subslab soil gas and the indoor air. How thick is the slab? What is the general condition of the slab? What is the floor covering in each room of the lowest floor (carpet, tile, etc.)?

6.5. Identify potential vapor intrusion pathways. The entry of organic vapors into a structure is caused by the infiltration of contaminants through the floor and walls that are in contact with the soil. Any openings, cracks, or penetrations in the foundation may be entryways for subslab soil gas. Are there any utilities that penetrate the foundation? Are they sealed properly? Are there cracks in the slab? If so, note where these cracks are and their approximate size. Are there sumps? If so, note the dimensions of each and their typical operating conditions. Is the wall/floor juncture sealed well? Is there a French drain? Has the basement been waterproofed? Are there expansion joints in the slab? If so, note their condition. Are there any utilities that penetrate the foundation? If so, are they sealed well?

6.6. Other vapor intrusion pathways may be cracks in the walls and floors, sumps, spaces around the wall/floor juncture of floating floor construction, or other breaches in the walls or slab. The *Building Survey Form* asks a series of questions that are designed to assist in the identification of potential points of vapor intrusion. Identify the type of building foundation, construction of the basement floor, and the presence of sumps or drains. Any obvious breaches in the walls or slab in the basement (or lowest floor) should be noted. The investigator should also examine the points at which all utility lines enter the structure.

6.7. Survey the building envelope. The condition of the building envelope will determine the rate of outdoor to indoor air exchange. A high rate of outdoor air exchange can dilute soil gas that may be migrating into the building. Walk around the inside and outside of the building and record information on the building construction and condition. How many doors/windows/loading docks are there, what condition are they in, and are they typically left open or closed? What are the building construction materials?

6.8. Determine the indoor air volume. If a building has a very large indoor air volume, soil gas migrating into the building may become quickly diluted. Indoor air sampling may be necessary in multiple rooms if the indoor air volume is not connected. Measure the building dimensions (length, width, and height). Measure

the dimensions of rooms within the building. How are the rooms connected? Are doors typically kept open or shut?

6.9. Evaluate the HVAC system. The HVAC system's operation can determine if the building is negatively or positively pressurized. If a building is negatively pressurized, then subslab gas will be pulled into the building and if the building is positively pressurized, subslab gas will not enter the building. Record the type/model of the systems and the typical operating conditions. Is there one air conditioning zone or multiple zones (look for multiple thermostats)? Does the HVAC system use radiant heat or forced air? Are there ventilation fans? If so, note where and their typical operating conditions.

6.10. Identify any existing vapor mitigation systems. Is there a radon mitigation system or other subslab depressurization system? Is there sealant on any cracks or crevices? Is there a sealant coat on the floor for vapor or water mitigation?

6.11. Sketch the building floor plan. Record all pertinent building characteristics for the vapor intrusion evaluation. Include building dimensions, locations of windows/doors/loading docks, outdoor surface cover (grass, asphalt, etc.), and locations of any potential indoor VOC sources.

6.12. Identify potential indoor contaminant sources within the building. Record the location of the potential sources and determine if they can be removed before indoor air sampling is performed. Potential indoor sources of VOCs may include cleaning products, paint, dry-cleaned clothes, gasoline, cosmetics, or cigarette smoke. Recent remodeling activities, including painting, new carpeting or flooring, and new furniture should be identified because they could be potential sources of VOCs. It may be necessary to include additional sheets to inventory all the potential VOC sources within the structure. When potential indoor VOC sources are identified and removed from a building, it may be necessary to ventilate the rooms affected in advance of the air sampling event. This ventilation should be completed at least 24 hours before the commencement of the indoor air sampling event. A hand-held field screening instrument can also be used to pinpoint potential indoor VOC sources.

6.13. Identify potential outdoor contaminant sources. These may include gas stations, major roadways, dry cleaners, repair shops, industries, or landfills.

6.14. *OPTIONAL.* Identify possible indoor air and subslab sample locations that meet the project-specific DQOs.

Typically, indoor air samples should be collected on the lowest floor of the building at breathing zone height (approximately 3 to 5 feet) toward the center of the building away from windows. Consideration should be given on a case-specific basis to those situations (such as a day care facility) where a different sampling height may also be appropriate to evaluate a unique setting or population. Indoor air samples can be collected from more than one floor within a structure to address

varying risk exposures and as part of the process to distinguish contaminants related to vapor intrusion from background sources. Thus, the location and position of the sample container will vary depending on which floor the sampling event takes place. In residential structures, ground floor (living space) samples should be located to approximate human risk exposure. The basement sample(s) are primarily designed to investigate "worst case" situations within a structure. Therefore, basement samples are positioned as close as possible to the source area (e.g., sumps or major cracks in the foundation).

Subslab sample locations should also be toward the center of the building and ideally in an area of exposed concrete away from any penetrations in the slab. Positions near the perimeter of the slab are subject to dilution and should be avoided. To minimize potential damage to flooring, it may be necessary to select a location in a closet or utility room (where carpeting or tiles are less visible or not present at all). The selected location(s) should be chosen in consultation with the property owner during the building survey.

Procedures for collecting indoor air and subslab soil gas samples inside a building are described in the *Ambient Air Sampling Standard Operating Procedure* and the *Subslab Soil Gas Sampling Standard Operating Procedure*.

7. Data Reduction and Evaluation

The information collected during the building survey can be used to develop a preliminary vapor intrusion CSM for the work plan, refine an existing CSM, select locations for indoor air and subslab samples, or to provide information to support the evaluation of the vapor intrusion pathway in a vapor intrusion evaluation or human health risk assessment.

8. Quality Control

Adequate time should be reserved for performing building surveys and detailed notes should be recorded at the time of the building survey.

Standard Operating Procedure for Installing Subslab Probes and Collecting Subslab Soil Gas Samples Using SUMMA Canisters

1.0 Scope and Application

This standard operating procedure (SOP) describes the approach for installing subslab probes and collecting subslab soil gas samples in SUMMA™ canisters. It includes instructions on probe installation, leak checking, soil gas sampling, and probe abandonment. This SOP should be used in conjunction with project data quality objectives. The project team is responsible for making 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 subslab samples should attempt this procedure.

2.0 Project-Specific Considerations

2.1 A utility clearance should be performed before mobilization, as with all intrusive site work. The sampling team should look around the building to locate where utilities come into the building and make sure they are not underground. Utility shut-off valves should be located in case an underground utility is encountered. It is highly recommended that ground penetrating radar (GPR), specifically a concrete scanner, be used to identify utilities, wire mesh, and/or rebar in the slab prior to drilling.

2.2 There are three types of probe installation techniques. The type chosen depends on site access, probe seal integrity considerations, and the number of sampling events planned. It is critical that the sealing compound used is low in volatile organic compounds (VOCs). The suggested sealing compounds below have been tested and approved for use. Consult a subject matter expert if another compound is preferred or available. See Table 1 for more specific details.

2.2.1 Temporary – Beeswax – Use if time is short, access is an issue, and a higher risk of leaks (requiring repeated resealing of the probe) is acceptable. It MUST be 100% pure, natural beeswax.

2.2.2 Semi-permanent – Fix-It-All –Use if setting the probe and sampling on one day is preferred, access limitations are minimal, only one sampling event is intended, and minimal moisture is present.

2.2.3 Permanent – Portland cement – Use if there is unlimited access and multiple sampling events are desired.

3.0 Materials

3.1 Subslab Probe Installation

- Hammer drill and drill bits (7/8-inch or 1-inch and 5/16-inch or 1/2-inch)
- Vacuum cleaner ('shop vac' type or handheld) for removing concrete dust from the drilled hole
- Subslab probe (for permanent or semi-permanent installations) See Figure 8 for an expanded view of the probe parts.
    - 1/4-inch stainless steel tube (Swagelok® part #SS-T4-S-035-20)
    - Swagelok® nut and ferrule (part #SS-400-NFSET)
    - Probe union (1/4-inch male Swagelok® to 1/8-inch female NPT – part #SS-400-7-2)
    - Probe seal (flush mounted hex socket plug 1/8-inch PTFE coated, 3/16 inch) NPT slotted brass plug) – McMaster-Carr part #4534K11
- Metal tubing cutter for adjusting the length of the probe so that it does not extend below the slab

- Probe seal consisting of beeswax, Fix-it-All, or portland cement
- Wax melter (for beeswax only) – can be obtained from a beauty supply store (paraffin wax melter or body hair wax melter). Also need a metal measuring cup with handle for placing the wax into the melter; this way the wax can be melted in the cup and then easily poured into the probe hole. The beeswax CANNOT be melted with a direct flame because this generates VOCs.
- Large Q-tips or paper towels and water for cleaning the concrete dust out of the hole
- Tongue depressor, putty knife, or similar tool for putting the probe seal material into the hole
- Teflon pipe tape to wrap the end of the probe tubing so that the probe fits tightly into the hole to prevent the seal material from clogging the probe.
- Tape measure to measure the thickness of the slab, measured off of a long screwdriver or drill bit
- Optional: Sonicare® toothbrush with bristles removed. (This can be useful in removing air bubbles from the cement mixture while installing the probe thus making a more competent seal). Toothpicks or Q-tips without cotton tip can also be used for this purpose.

3.2 The helium leak check equipment, including the helium enclosure, helium canister containing high grade helium (NOT balloon grade), regulator for the helium canister, and helium detector. The enclosure may be constructed from a small bowl or container. The helium detector (e.g. Dielectric MGD-2002) can be rented from an equipment rental company.

3.3 Sampling

- Sampling union (1/4-inch male Swagelok® or equivalent to ¼-inch male NPT- part# SS-400-1-2)
- Vacuum pump for purging with rotometer to control flow to 200 mL/min
- 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. See Figure 10. This manifold must be clean, free of oils, and flushed free of VOCs before use.
- Teflon tubing, 1/4-inch outer diameter
- Tedlar bag (1-L or 3-L) to collect the purged soil gas so it is not discharged into the building
- Gem2000 Landfill Gas Meter – this is optional if field measurements of CO2, O2, CH4 are necessary
- MiniRae PID Meter – this is optional if field measurements of total VOCs are necessary
- Flow controller or critical orifice, certified clean, and set at desired sampling rate. These are typically provided and set by the laboratory.
- Canister, SUMMA™ polished, certified clean, and evacuated. (Canisters are typically provided by the laboratory.)
    - Miscellaneous fitting (Swagelok® nut and ferrule (part #SS-400-NFSET) to connect tubing to sampling union and SUMMA™ canister
- 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.

3.4 Probe Abandonment

- Probe removal fitting
- Crowbar

- Concrete patch (either pre-mixed cement patch or portland cement)

3.5 Miscellaneous

- Teflon tape
- Wrenches and screwdriver (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.
- Extension cord
- Timer/watch
- Tools required to cut carpet, and/or tools needed for removal of other floor coverings
- Shipping container, suitable for protection of canister during shipping. Typically, strong cardboard boxes are used for canister shipment. The canisters should be shipped to the laboratory in the same shipping container in which they were received.

4.0 Probe Installation

4.1 Locate the sampling locations in accordance with the work plan. Note the location of the probe, locations of significant features (walls, cracks, sumps, drains, etc), and conditions of the slab and soil.

4.2 If needed, expose the concrete by cutting the carpet or other loose floor coverings (Note: Carpet need not be removed, but rather an 'L' shape should be cut to expose the concrete for drilling and the leak check enclosure).

4.3 Drill a 7/8-inch or 1-inch diameter hole to a depth of 1-3/4 inches (measured to the center of the hole) to allow room for installing the probe nut and probe union (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 airtight for sampling and that cracks are noted.

4.4 Drill a 5/16-inch or 1/2-inch diameter hole through the remainder of the slab and approximately 3 inches down into the subslab material (See Figure 3). Drilling into the subslab 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 subslab material on the attached Sampling Log.

4.5 Clean out the drilled hole with the vacuum (equipped with a micro tip), Q-tips and paper towel. This removes any remaining dust, allowing the seal material to adhere to the hole wall better.

4.6 Some agencies may require that glass beads be poured into the subslab hole before installing the probe. If so, pour glass "seed beads" (available at a craft store) into the hole until enough beads have been added so that the top of the beads are even with the bottom of the slab. A thin piece of wire marked with the slab thickness and inserted into the hole can be used to determine this.

4.7 Install the subslab probe into the hole. First, trim the probe to the appropriate length so that when inserted into the hole it will not extend below the slab. Then wrap the end of the probe tubing with Teflon tape so that the probe fits tightly into the hole to prevent the seal material from clogging the probe. For permanent or semi-permanent probes, the probe is constructed of stainless steel tubing and Swagelok® parts. Temporary probes consist of 1/4 -inch OD Teflon tubing.

4.7.1 Temporary Seal (beeswax)

4.7.1.1 Melt the beeswax in the wax melter and pour the melted wax into the hole around the tubing. 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 hole is completely full.

4.7.1.2 Let the wax cool for 10 minutes.

4.7.1.3 Be sure to never leave the probe hole open to atmosphere for extended periods to minimize the effects of surface infiltration.

4.7.1.4 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.

4.7.2 Semi-permanent (Fix-It-All) or Permanent (portland cement) Seal

4.7.2.1 Wet the walls of the hole using the Q-tip or moistened paper towel. This helps the mortar bond to the drilled concrete. Prepare the mortar in accordance with manufacturer's directions to a stiff consistency. Make sure that the consistency is such that the mixture will not run down the sides of the hole and potentially clog the probe or hole but is still easy enough to work with (so it can be easily scooped into the hole.) Only mix an amount that can be used in 15 minutes. Place sample probe and sample union part way into the hole, as shown in Figure 4. Using the tongue depressor or similar tool, apply mortar around the base of the sampling probe and sampling union such that it will be sealed once it is in place.

4.7.2.2 Fill the hole with mortar, and press the probe further into the hole until its top is flush with the floor. In doing so, slightly wiggle the probe to create good 'wetting' contact between the probe and the mortar as well as the mortar and the drilled concrete. It may be helpful to work the concrete with a Sonicare® toothbrush (with the bristles removed) or a toothpick or similar object during this step to remove the air bubbles from the mortar and make a more competent seal. Scrape off excess and make sure there is clear access to the probe. See Figure 5.

4.7.2.3 For Fix-It-All, let dry for 30 minutes. For cement, let dry for 24 hours.

4.7.2.4 Be sure to never leave the probe hole open to atmosphere for extended periods to minimize the effects of surface infiltration.

4.7.2.4.1 For permanent or semi-permanent probes, a probe seal should be inserted into the probe union to minimize the effects of surface infiltration while the sealant is drying/curing.

5.0 System Set-up

5.1 For semi-permanent and permanent subslab probes, remove the probe seal and attach the sampling union to the subslab probe. Then attach 1/4-inch Teflon tubing to the sampling union with a Swagelok® nut and ferrule set. See Figure 6.

5.2 Place the helium leak check enclosure over the subslab probe by threading the Teflon tubing through the hole of the enclosure. Slide the enclosure down so it seals on the concrete slab. If there is an uneven surface (e.g. carpet and concrete), modeling clay can be utilized to seal the bottom of the helium enclosure to the ground surface. Attach the other end of the sample tube to the sampling manifold with the use of a nut and ferrule set. See Figures 7 and 9.

5.3 Attach the subslab sample tubing to the sampling manifold. See Figure 10. ***Do not connect the canister at this time***.

5.4 Adjust the vacuum pump to achieve the desired flow rate of 200 milliliters/minute (ml/min). This should be performed at the outlet of the vacuum pump before purging, either by using a suitable flow meter or calculating the amount of time required to fill a 1-liter Tedlar bag.

5.5 Attach the air pump to the sampling manifold and the Tedlar bag to the air pump exhaust.

6.0 System Leak Checking and Purging

6.1 Physical Leak Check - Perform a leak check of the sample manifold system by doing the following:

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 vacuum pump. Verify that the flow is set to 200 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 vacuum 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 subslab 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 probe seal. This is accomplished by doing the following:

6.2.1 Place the helium leak check enclosure around the subslab probe to achieve a buildup of helium in the leak check enclosure. The enclosure should not be tightly sealed and there should be an exhaust for the helium so pressure doesn't build up in the enclosure.

6.2.2 Start the flow of helium to the leak check enclosure at 200 ml/min. Let the helium fill the enclosure for 1 minute.

6.2.3 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.

6.2.4 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. It is important to switch these 2 valves simultaneously. Otherwise, a vacuum can be built up in the sampling system, and its sudden release can draw concrete powder (left at the bottom of the probe hole after drilling) into the sampling system which will damage the valves and vacuum pump.

6.2.5 If there is shallow groundwater in the area, carefully watch the tubing as the pump is turned on. If water is observed in the sample tubing, shut the pump off immediately. Subslab soil gas collection may not be feasible.

6.2.6 Purge the first 30 seconds (approx. 100 mls) into a 1 liter Tedlar bag. Remove the bag and replace with a fresh 1 liter Tedlar bag. Continue the purge for at least another 2.5 minutes. This will result in a total of about 500 mls of purge gas in the second bag and 600 mls of purge volume total. At the end of the purge time, remove the Tedlar bag from the pump and connect it to the helium detector. If a reading of >1 percent or 10,000 ppm_v (verify that this limit is consistent with appropriate project-specific agency guidance) is observed, then the probe leak check has failed and corrective action is required. There are three options:

6.2.6.1 Make sure that all the fittings are tight.

6.2.6.2 Try fortifying the probe seal by adding more sealing material or modeling clay and repeating the purge and leak check procedure.

6.2.6.3 If that fails, abandon the hole, drill a new one, and repeat the whole procedure.

Note: Helium leak detectors may be sensitive to high concentrations of methane (or other atmospheric gasses.) If these are expected to be present in the subslab vapor, then caution should be used with this technique as false positive readings may be encountered during leak testing.

6.2.7 At the end of the purge 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.

6.2.7.1 In the event that multiple sampling locations are proposed or a 24 hour subslab soil gas sample needs to be collected, a flow diversion valve (Swagelok® part# SS-4P4T) should be placed in line with the sampling union and sample tubing when setting up the location for purging. Once purging has been completed, the flow diversion valve can be turned to the off position, allowing disconnection of the vacuum pump for use at another location without the loss of purge integrity at the purged location.

6.2.8 The purged subslab soil gas in the Tedlar bag can be screened with a Gem2000 landfill gas meter to get field measurements of CO2, O2 and CH4 and/or a miniRae PID to get field measurements of total VOCs.

6.2.9 Record the purge date, time, purge rate, leak check result, and purge volume on the attached Sampling Log.

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

7.0 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. The cleanliness of personnel who come in contact with the sampling equipment is also important, so smoking, eating, drinking, perfumes, deodorants, and dry-cleaned clothing are prohibited. 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 and 30 inches Hg. Do not use a canister that has an initial vacuum pressure of 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 is (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 2 to 10 inches Hg for 6L canisters and 2 to 5 inches Hg for 1L canisters. 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 final vacuum pressure in the canister is between 2 and 10 inches Hg (6L) or 2 and 5 inches HG (1L). More than 10(5) inches Hg can greatly increase reporting limits; however, a small amount of vacuum pressure should be left in the canister so the laboratory can confirm that the canister was not opened during shipment. Consult with the project team if a final vacuum pressure greater than 10 (5) or less than 2 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 attached 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.

7.12 Using the vacuum pump, evacuate the Tedlar bags. Be sure this is done outside.

8.0 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 if corporate card policy does not cover this.

8.7 Ship canisters for overnight delivery.

9.0 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 quality assurance prescribed in EPA Method TO-14/15 for flow controller cleaning and adjustment. SOPs are required.

10.0 Probe Abandonment and Removal

10.1 After sampling, it is critical that the probe either be removed or plugged to prevent the creation of a new pathway for vapor intrusion.

10.2 If the probe is to be used again in the future, wrap the probe seal insert with Teflon tape and tighten it into the probe opening, using a hex key, until it is tight and flush with the concrete floor.

10.3 If the probe is to be removed, insert the removal fitting into the probe. Using a crow bar, remove the entire probe assembly. If the probe cannot be removed in this manner, then over drill the probe with a rotary hammer drill and 1-inch drill bit.

10.4 Fill the hole with Portland cement mix.

Table 1 – Probe Seal Types

Probe Type	Suggested Probe Seal	Benefits	Drawbacks
Temporary	Beeswax	Quick. Can Set probe and take sample in one visit	Wax is brittle when cool and is very susceptible to leakage.
		Easy to remove	
Semi-permanent	Fix-It-All	Sets up fairly quickly (>30 min.), but may require 2 visits on the same day	Not good for wet environments. Material breaks down
		Solid seal	
		Easy to remove	
Permanent	Portland cement	Solid permanent seal	Takes at least 24 hours to set.
		Good for multiple sampling events	Will require at least 2 visits on consecutive days
			Difficult to remove

Table 2 - Common Sampling Rates for Subslab 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 – Subslab Sampling

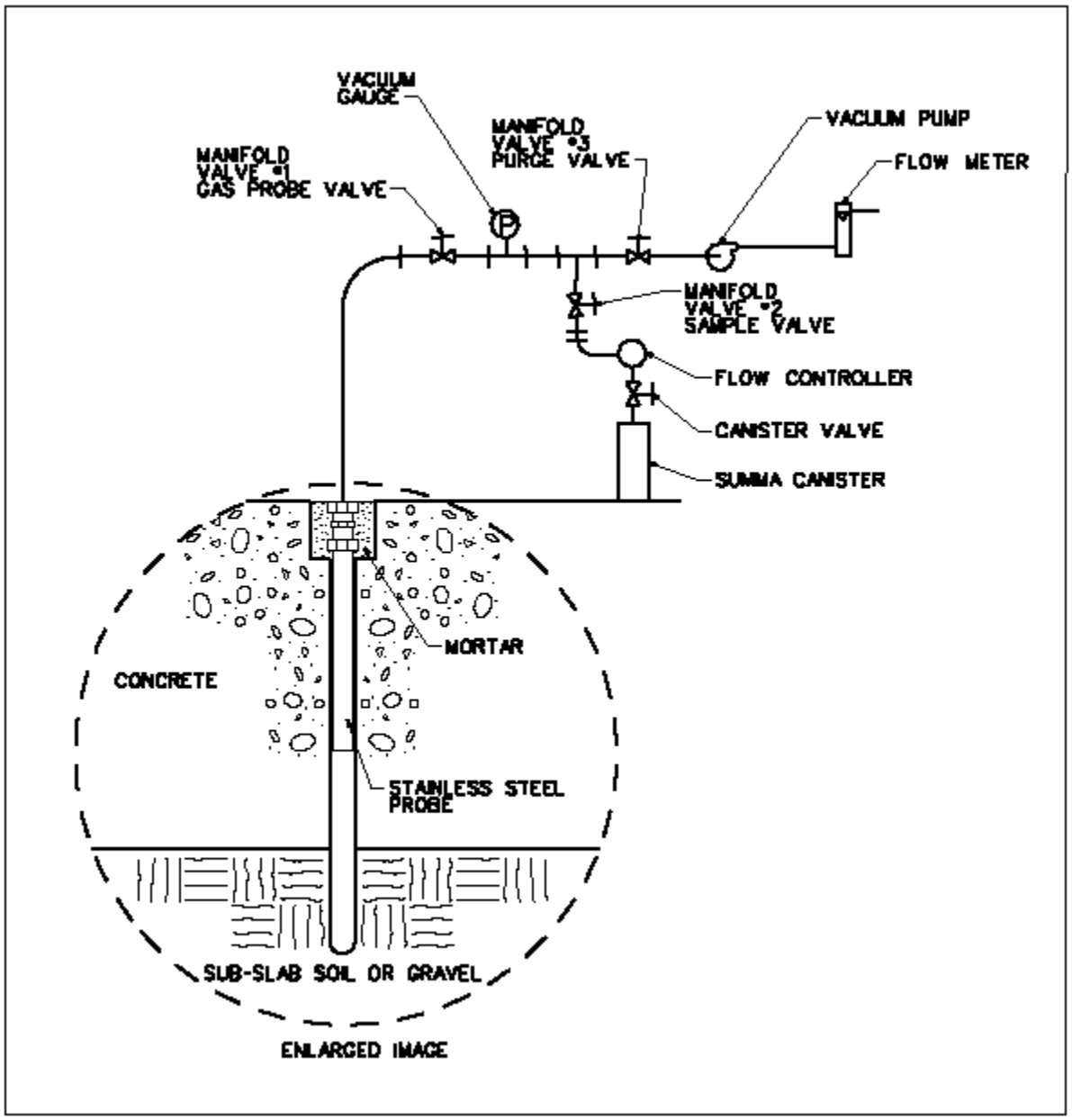


Figure 2 – Drilling 1-inch mortar hole to a depth of 1 and 3/4-inch

Figure 3 – Drilling 1/2” probe hole

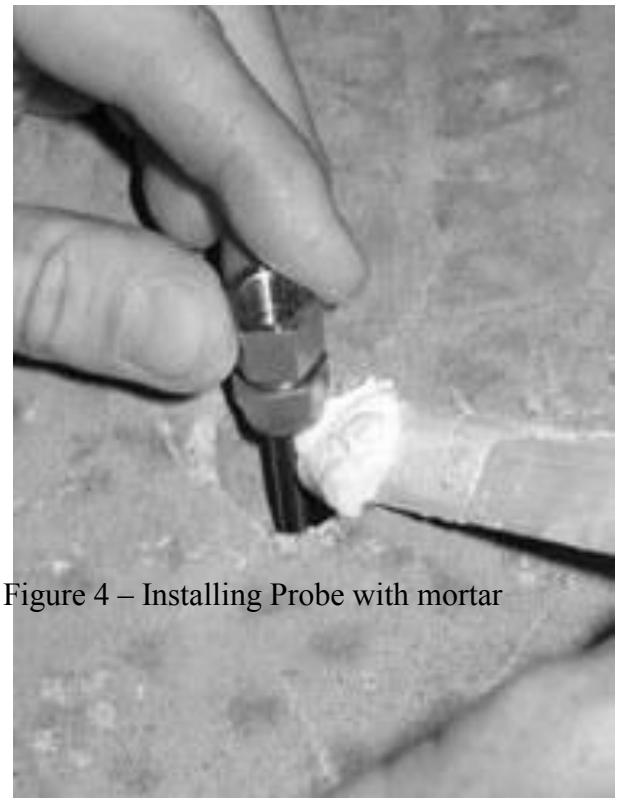


Figure 4 – Installing Probe with mortar

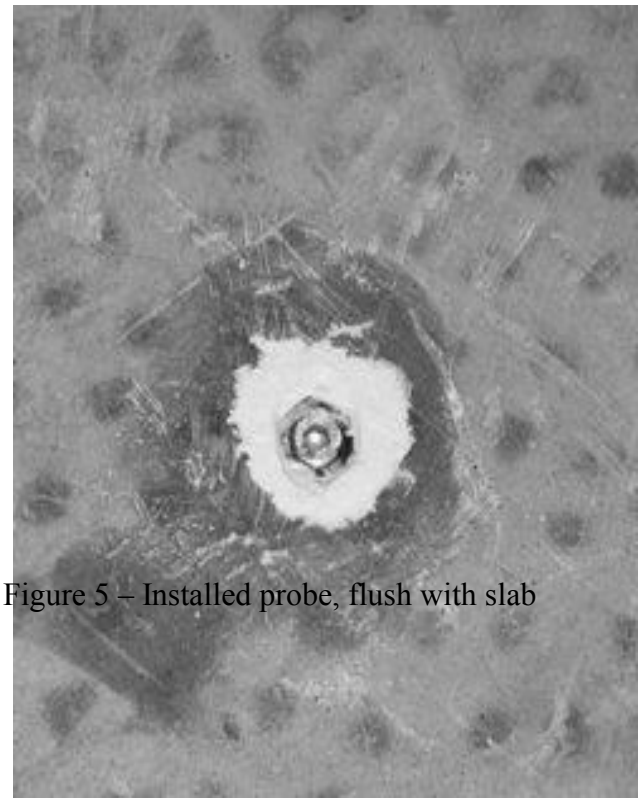


Figure 5 – Installed probe, flush with slab

Figure 6 – Installed probe with sample tube

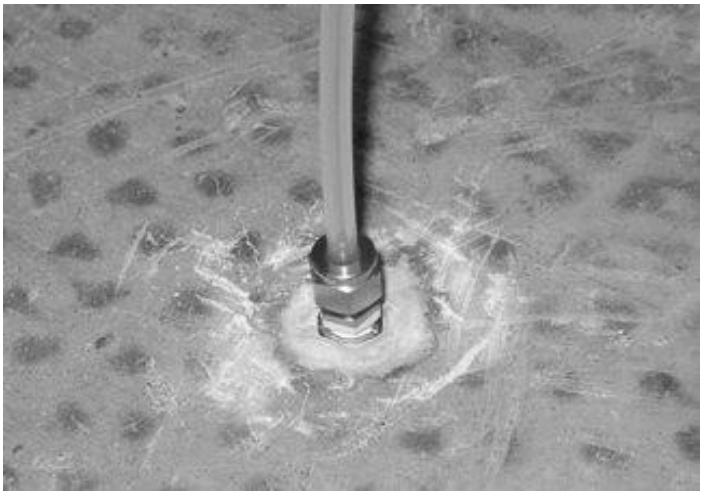
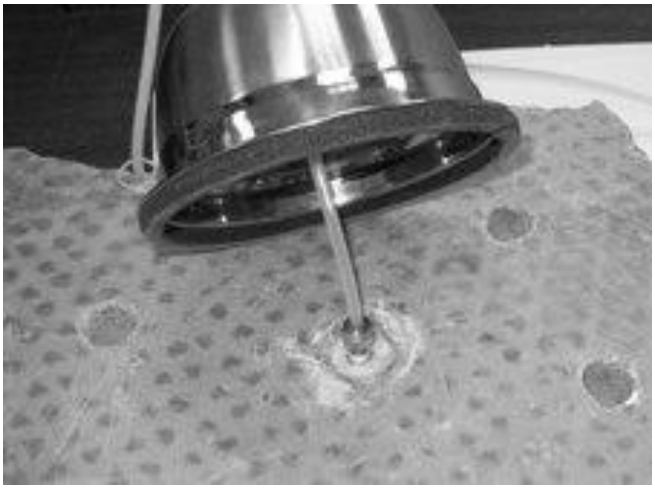


Figure 7 - Installing the helium leak check assembly



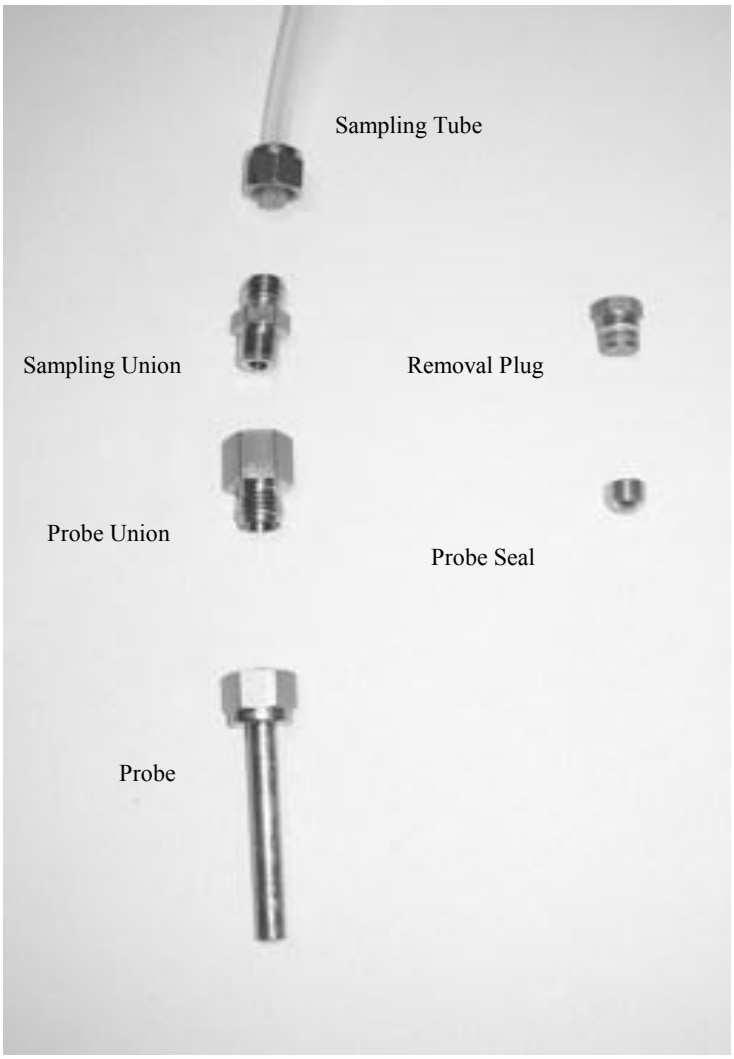


Figure 8 – Probe Parts

Figure 9 –Helium Leak Check Assembly

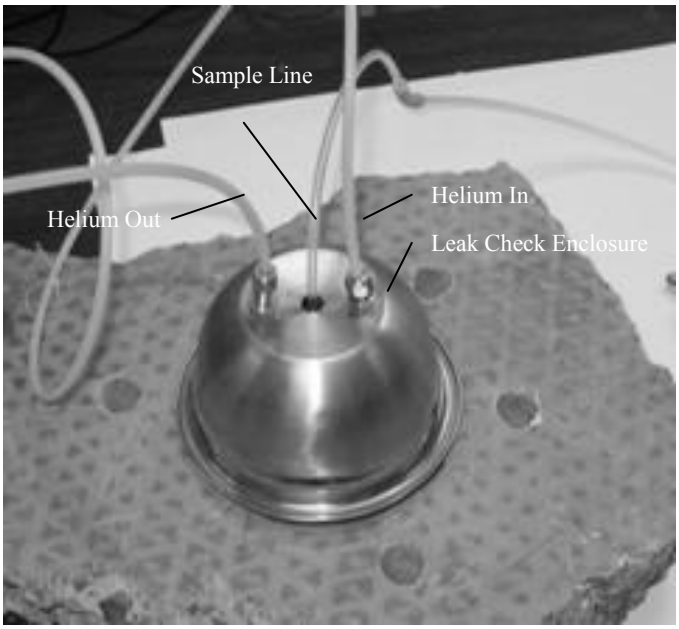
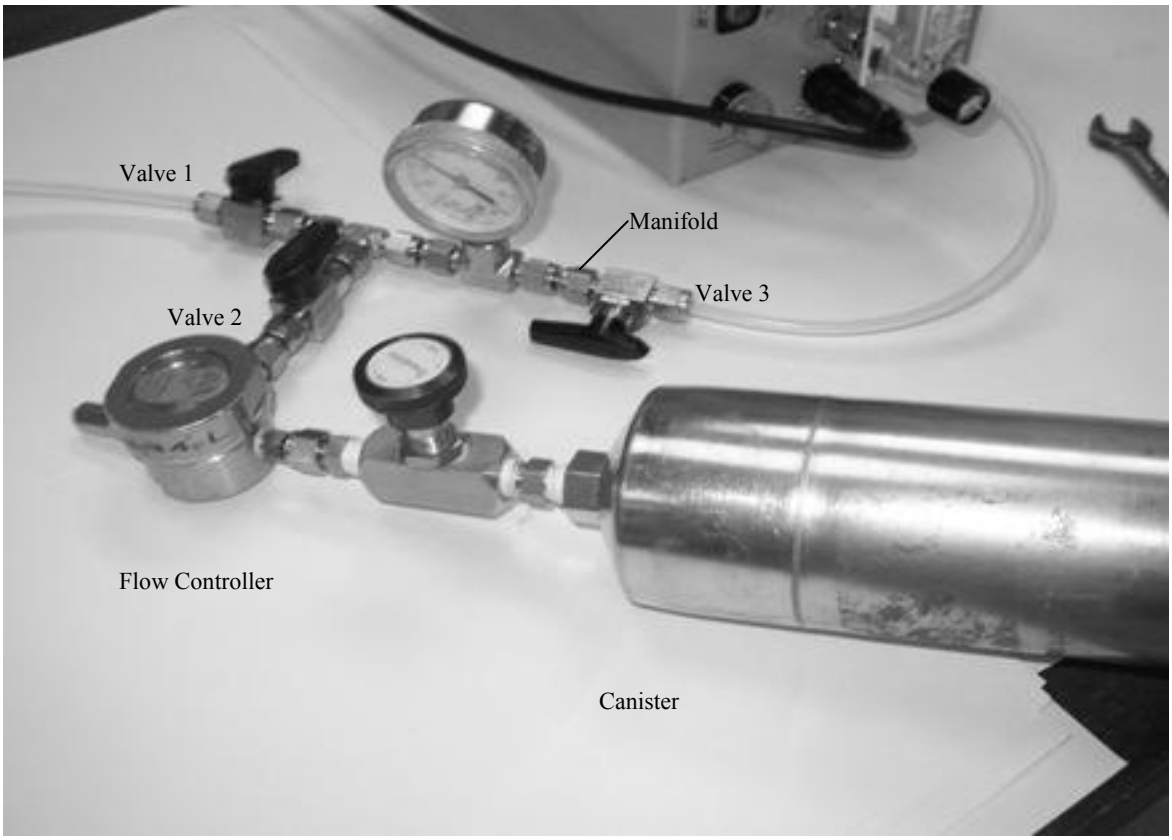


Figure 10 – Sampling Manifold



CH2MHILL

Indoor Vapor Intrusion Assessment
Sub-slab Vapor Field Sampling Log - Summa Canister Method

Project Info

Project Name: ..... **Project # :** .....

By: ..... **Date:** .....

Structure

Identification: .....

Address: .....

Slab Information:

☐ Concrete slab on grade (directly on top of soil) ☐ Other (describe) .....

☐ Concrete slab on gravel underlayment .....

Condition of slab .....

Type of Sub Slab Soil .....

Is water present in the soil .....

Sub-slab Probe Installation, Leak Checking, Probe Purging, & Sampling Log

	Sample location (show in diagram)	1	2	3	4
	Sample Identification (field ID)				
Probe Installation	Depth of slab (inches)				
	Depth of hole drilled (inches below slab surface)				
	Depth of installed probe (inches below slab surface)				
Manifold Leak check	Leak check (sampling manifold) - Pass/No Pass				
Probe Purge	Purge rate, mL/min.				
	Purge Start (time of day)				
	Purge vacuum, " Hg				
	Purge completed (time of day)				
Helium Leak Check (optional)	Leak check (Helium) - % or ppmv				
Field Analysis (optional)	Gem 2000 (O_2 / CO_2 / CH_4) - %				
	PID - ppmv				
Canister Sampling	Canister & flow controller ID (if used)				
	Initial Canister Pressure (" Hg)				
	Sampling rate, mL/min				
	Sampling period started (time of day)				
	Sampling vacuum, " Hg				
	Sampling period ended (time of day)				
	Final Canister Pressure (" Hg)				

Observations and Comments: .....

Standard Operating Procedure

Locating and Clearing Underground Utilities

I. Purpose

The purpose of this SOP is to provide general guidelines and specific procedures that must be followed on Navy CLEAN projects for locating underground utilities and clearing dig locations in order to maximize our ability to avoid hitting underground utilities and to minimize liabilities to CH2M HILL and its subcontractors and health and safety risks to our project staff.

This SOP shall be used by Activity Managers and Project Managers to, in-turn, develop Activity-specific and project-specific utility location procedures. The activity and project-specific procedures will become part of work plans and project instructions and will be used to prepare scopes of work (SOWs) for the procurement of utility location subcontractors to meet the needs of individual projects.

This SOP also identifies the types of utility locating services that are available from subcontractors and the various tools that are used to locate utilities, and discusses when each type of service and tool may or may not be applicable.

II. Scope

Depending on the Navy/Marine Activity we typically find ourselves in one of two scenarios:

Scenario 1

The Activity provides utility locating (or dig clearance) services through the public works department or similar organization, or has a contract with an outside utility clearance service. Some of these services are provided in the form of dig permits which are required before you can dig or drill. In other cases no official permit is required and the process is somewhat vague.

Scenario 2

The Activity does not get involved in any utility locating processes aside from possibly providing the most recent utility maps, and relies on CH2M HILL to clear the dig locations.

Table 1 provides an up to date summary of which scenarios apply to the various primary Activities served under the Navy CLEAN program.

Scenario 1 is preferred because under this scenario the Navy tends to assume the responsibility if the location is improperly cleared, a utility is struck, and property damage results. However, our experience has been that the clearance services provided

by the Navy do not meet the standards that we consider to be adequate, in that they often simply rely on available base maps to mark utilities and do not verify locations using field geophysics. And if they do use locating tools, they do not provide adequate documentation or marking to confirm that a location has been cleared. So while the Navy's process may protect us from liability for property damage, it does not adequately protect our staff and subcontractors from health risks nor does it compensate us for down time, should a utility be hit.

Therefore, regardless of what services the Navy provides, in most cases we still need to supplement this effort with clearance services from our own third party utility location subcontractor following the procedures and guideline outlined in Section IV of this SOP. The cost implications of providing this service will range from $500 to several $1,000 depending on the size of the project.

The scope of services that we ask our subcontractors to provide can involve utility marking/mapping or the clearing of individual dig locations. In the former we ask our subs to mark all utilities within a "site" and often ask them to prepare a map based on their work. In the later, we ask them to clear (identify if there are any utilities within) a certain radius of a proposed dig/drill location.

The appropriate requested scope of services for a project will depend on the project. Clearing individual boreholes is often less expensive and allows the sub to concentrate their efforts on a limited area. However if the scope of the investigation is fluid (all borehole locations are not predetermined) it may be best to mark and map an entire site or keep the subcontractor on call.

Clearance of individual dig locations should be done to a minimum 20 foot radius around the location.

An example SOW for a utility subcontractor procurement is provided in Attachment A.

III. Services and Equipment

This section provides a general description of the services available to help us locate subsurface utilities and describes the types of equipment that these services may (or may not) use to perform their work. It identifies the capabilities of each type of equipment to help the PM specify what they should require from our utility location subs.

Services

The services that are available to us for identifying and marking underground utilities are:

- The local public/private utility-run service such as Miss Utility
- Utility location subcontractors (hired by us)

Attachment B provides a detailed description of each type of organization. It also provides contact numbers and web sites for the various Miss-Utility-type organizations in the areas where we do work for the Navy and contacts and services provided by several subcontractors that we have used or spoken to in the past.

Equipment

Attachment C provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the PM determine if the equipment being used by a subcontractor is adequate.

It is important to make the potential subcontractors aware of the possible types of utilities (and utility materials) that are at the site, and to have them explain in their bid what types of equipment they will use to locate utilities /clear dig locations, and what the limitations of these equipment are.

A list of in-house experts that can be used to help you evaluate bids or answer questions you may have is provided in Appendix C.

IV. Procedures and Guidelines

This section presents specific procedures to be followed for the utility location work to be conducted by CH2M HILL and our subcontractors. In addition, a PM will have to follow the procedures required by the Activity to obtain their approvals, clearances and dig permits where necessary. These "dig permit" requirements vary by Activity and must be added to the project-specific SOP, or project instructions. It is preferable that the Activity perform their clearance processes before we follow up with our clearance work.

Activity Notification and Dig Permit Procedures

Identify Activity-specific permit and/or procedural requirements for excavation and drilling activities. Contact the Base Civil Engineer and obtain the appropriate form to begin the clearance process.

Activity Specific: To be provided by Activity or Project Manager

CH2M HILL Utility Clearance Procedures

Do not begin subsurface construction activities (e.g., trenching, excavation, drilling, etc.) until a check for underground utilities and similar obstructions has been conducted by CH2M HILL as a follow-up to the services provided by the Navy. The use of as-built drawings and utility company searches must be supplemented with a geophysical or other survey by a qualified, independent survey contractor (subcontracted to CH2M HILL) to identify additional and undiscovered buried utilities.

Examples of the type of geophysical technologies include (these are further described in Attachment C):

- **Ground Penetrating Radar (GPR),** which can detect pipes, including gas pipes, tanks, conduits, cables etc, both metallic and non-metallic at depths up to 30 feet depending on equipment. Sensitivity for both minimum object size and maximum depth detectable depends on equipment selected, soil conditions, etc.
- **Radio Frequency (RF),** involves inducing an RF signal in the pipe or cable and using a receiver to trace it. Some electric and telephone lines emit RF naturally and can be

detected without an induced signal. This method requires knowing where the conductive utility can be accessed to induce RF field if necessary.

- **Dual RF**, a modified version of RF detection using multiple frequencies to enhance sensitivity but with similar limitations to RF
- **Ferromagnetic Detectors**, are metal detectors that will detect ferrous and non-ferrous utilities. Sensitivity is limited, e.g. a 100 mm iron disk to a depth of about one meter or a 25 mm steel paper clip to a depth of about 20 cm.
- **Electronic markers,** are emerging technologies that impart a unique electronic signature to materials such as polyethylene pipe to facilitate location and tracing after installation. Promising for future installations but not of help for most existing utilities already in place.

The following procedures shall be used to identify and mark underground utilities during subsurface construction activities on the project:

- Contact utility companies or the state/regional utility protection service (such as Miss Utility) at least two (2) working days prior to intrusive activities to advise of the proposed work, and ask them to establish the location of the utility underground installations prior to the start of actual excavation: this is a law. These services will only mark the location of public-utility-owned lines and not Navy-owned utilities. In many cases there will not be any public-utility-owned lines on the Activity. There may also be Base-access issues to overcome.
- Procure and schedule the independent survey.
- The survey contractor shall determine the most appropriate geophysical technique or combinations of techniques to identify the buried utilities on the project site, based on the survey contractor's experience and expertise, types of utilities anticipated to be present and specific site conditions. ***The types of utilities must be provided to the bidding subcontractors in the SOW and procedures to be used must be specified by the bidder in their bid. It is extremely helpful to provide the sub with utility maps, with the caveat that all utilities are not necessarily depicted.***
- The survey subcontractor shall employ the same geophysical techniques used to identify the buried utilities, to survey the proposed path of subsurface investigation/construction work to confirm no buried utilities are present.
- Obtain utility clearances for subsurface work on both public and private property.
- Clearances provided by both the "Miss Utility" service and the CH2M HILL-subcontracted service are to be in writing, signed by the party conducting the clearance. The Miss Utility service will have standard notification forms/letters which typically simply state that they have been to the site and have done their work. The CH2M HILL subcontractor shall be required to fill out the form provided in Attachment D (this can be modified for a particular project) indicating that each dig/drill location has been addressed. ***This documentation requirement (with a copy of the form) needs to be provided in the subcontractor SOW.***

- Marking shall be done using the color coding presented in Attachment E. The type of material used for marking must be approved by the Activity prior to marking. Some base commanders have particular issues with persistent spray paint on their sidewalks and streets. ***Any particular marking requirements need to be provided in the subcontractor SOW.***
- Protect and preserve the markings of approximate locations of facilities until the markings are no longer required for safe and proper excavations. If the markings of utility locations are destroyed or removed before excavation commences or is completed, the Project Manager must notify the utility company or utility protection service to inform them that the markings have been destroyed.
- Perform a field check prior to drilling/digging (preferably while the utility location sub is still at the site) to see if field utility markings coincide with locations on utility maps. Look for fire hydrants, valves, manholes, light poles, lighted signs, etc to see if they coincide with utilities identified by the subcontractor.
- Underground utility locations must be physically verified (or dig locations must be physically cleared) by hand digging using wood or fiberglass-handled tools, air knifing, or by some other acceptable means approved by CH2M HILL, when the dig location (e.g. mechanical drilling, excavating) is expected to be within 5 feet of a marked underground system. Hand clearance shall be done to a depth of four feet unless a utility cross-section is available that indicates the utility is at a greater depth. In that event, the hand clearance shall proceed until the documented depth of the utility is reached.
- Conduct a site briefing for employees at the start of the intrusive work regarding the hazards associated with working near the utilities and the means by which the operation will maintain a safe working environment. Detail the method used to isolate the utility and the hazards presented by breaching the isolation.
- Monitor for signs of utilities during advancement of intrusive work (e.g., sudden change in advancement of auger or split spoon during drilling or change in color, texture or density during excavation that could indicate the ground has been previously disturbed).

IV. Attachments

A- Example SOW for Utility Location Subcontractor Procurement
B - Services Available for Identifying and Marking Underground Utilities
C – Equipment Used for Identifying Underground Utilities
D – Utility Clearance Documentation Form
E – Utility Marking Color Codes

Attachment A – Example SOW for Subcontracting Underground Utilities Locating Services

CTO-XXX

Scope of Work

Subsurface Utility Locating

Site XX

Navy Activity

City, State

A licensed and insured utility locator will be subcontracted to identify and mark out subsurface utilities for an environmental investigation/remediation project at Site XX of <<insert name of base, city, and state>>. The subcontractor will need to be available beginning at <<insert time>> on <<insert date>>. It is estimated that the work can be completed within XX days.

Proposed Scope of Work

The subcontractor will identify and mark all subsurface utilities (CHOOSE 1) that lie within a radius of 20 feet of each of XX sampling locations at Site XX shown on the attached Figure 1; (OR) that lie within the bounds of Site XX as delineated on the attached Figure 1. (If multiple sites are to be cleared, provide maps of each site with sample locations or clearance boundaries clearly delineated and a scale provided.)

Utilities will be identified using all reasonably available as-built drawings, electronic locating devices, and any other means necessary to maintain the safety of drilling and sampling personnel and the protection of the base infrastructure. The location of utilities identified from as-built drawings or other maps must be verified in the field prior to marking.

Base utility drawings for the Site(s) (CHOOSE 1) can be found at <<insert specific department and address or phone number on the base>> and should be reviewed by the subcontractor and referenced as part of the utility locating. (OR), will be provided to the subcontractor by CH2M HILL upon the award of the subcontract. (OR), are not available. Utility drawings shall not be considered definitive and must be field verified.

Field verification will include detection using nonintrusive subsurface detection equipment (magnetometers, GPR, etc) as well as opening manhole covers to verify pipe directions. As part of the bid, the Subcontractor shall provide a list of the various subsurface investigation tools they propose to have available and use at the site and what the limitations are of each tool.

A CH2M HILL representative shall be present to coordinate utility clearance activities and identify points and features to be cleared.

Field Marking and Documentation

All utilities located within **(CHOOSE 1)** ***a 20-ft radius of the XX proposed soil boring locations*** **(OR)** ***within the boundary of the site(s)*** as identified on the attached figure(s) will be marked using **paint** ***(some Bases such as the WNY may have restrictions on the use of permanent paint)*** and/or pin flags color coded to indicate electricity, gas, water, steam, telephone, TV cable, fiber optic, sewer, etc. The color coding shall match the industry standard as described on the attached form. In addition, the ***Buried Utility Location Tracking Form*** (attached) will be completed by the Subcontractor based upon what is identified in the field during the utility locating and submitted back to CH2M HILL (field staff or project manager) within 24 hours of completing the utility locating activities.

(OPTIONAL) ***The subcontractor shall also provide a map (or hand sketch) of the identified utilities to the Engineer within XX days of field demobilization. The map shall include coordinates or ties from fixed surface features to each identified subsurface utility.***

Bid Sheet/Payment Units

The subcontractor will bid on a time and materials basis for time spent on site and researching utility maps. Mobilization (including daily travel to the site) should be bid as a lump sum, as well as the preparation of the AHA and any required mapping. The per diem line item should be used if the field crew will require overnight accommodations at the project site.

Health and Safety Requirements

The utility locating subcontractor is to provide and assume responsibility for an adequate corporate Health and Safety Plan for onsite personnel. Standard personal safety equipment including: hard hat, safety glasses, steel-toed boots, gloves are recommended for all project activities. Specific health and safety requirements will be established by the Subcontractor for each project. The health and safety requirements will be subject to the review of CH2M HILL.

The subcontractor shall also prepare and provide to the Engineer, at least 48 hours prior to mobilization, an acceptable Activity Hazard Analysis (AHA) using the attached AHA form or similar.

It is also required that all subcontractor personnel who will be on site attend the daily 15-minute health and safety tailgate meeting at the start of each day in the field.

Subcontractor personnel showing indications of being under the influence of alcohol or illegal drugs will be sent off the job site and their employers will be notified. Subcontractor personnel under the influence of prescription or over-the-counter medication that may impair their ability to operate equipment will not be permitted to do so. It is expected that the subcontractor will assign them other work and provide a capable replacement (if necessary) to operate the equipment to continue work.

Security

The work will be performed on US Navy property. CH2M HILL will identify the Subcontractor personnel who will perform the work to the appropriate Navy facility point-of-contact, and will identify the Navy point-of-contact to the Subcontractor crew. The Subcontractor bears final responsibility for coordinating access of his personnel onto Navy property to perform required work. This responsibility includes arranging logistics and providing to CH2M HILL, in advance or at time of entry as specified, any required identification information for the Subcontractor personnel. Specifically, the following information should be submitted with the bid package for all personnel that will perform the work in question (this information is required to obtain a base pass):

- Name
- Birth Place
- Birth Date
- Social Security Number
- Drivers License State and Number
- Citizenship

Please be advised that no weapons, alcohol, or drugs will be permitted on the Navy facility at any time. If any such items are found, they will be confiscated, and the Subcontractor will be dismissed.

Quality Assurance

The Subcontractor will be licensed and insured to operate in the State of <<state>> and will comply with all applicable federal, state, county and local laws and regulations. The subcontractor will maintain, calibrate, and operate all electronic locating instruments in accordance with the manufacturer's recommendations. Additionally, the Subcontractor shall make all reasonable efforts to review as-built engineering drawings maintained by Base personnel, and shall notify the CH2M HILL Project Manager in writing (email is acceptable) whenever such documentation was not available or could not be reviewed.

Subcontractor Standby Time

At certain periods during the utility locating activities, the Subcontractor's personnel may be asked to stop work and standby when work may normally occur. During such times, the Subcontractor will cease activities until directed by the CH2M HILL representative to resume operations. Subcontractor standby time also will include potential delays caused by the CH2M HILL representative not arriving at the site by the agreed-upon meeting time for start of the work day. Standby will be paid to the

Subcontractor at the hourly rate specified in the Subcontractor's Bid Form attached to these specifications.

Cumulative Subcontractor standby will be accrued in increments no shorter than 15 minutes (i.e., an individual standby episode of less than 15 minutes is not chargeable).

During periods for which standby time is paid, the surveying equipment will not be demobilized and the team will remain at the site. At the conclusion of each day, the daily logs for the Subcontractor and CH2M HILL representative will indicate the amount of standby time incurred by the Subcontractor, if any. Payment will be made only for standby time recorded on CH2M HILL's daily logs.

Down Time

Should equipment furnished by the Subcontractor malfunction, preventing the effective and efficient prosecution of the work, or inclement weather conditions prevent safe and effective work from occurring, down time will be indicated in the Subcontractor's and CH2M Hill representative's daily logs. No payment will be made for down time.

Schedule

It is anticipated that the subsurface utility locating activities will occur on <<insert date>>. It is estimated that the above scope will be completed within XXX days.

Attachment B - Services Available for Identifying and Marking Underground Utilities

The services that are available to us for identifying and marking underground utilities are:

- The Activity's PWC (or similar organization)
- The local public/private utility -run service such as Miss Utility
- Utility location subcontractors (hired by CH2M HILL)

Each are discussed below.

Navy Public Works Department

A Public Works Department (PWD) is usually present at each Activity. The PWD is responsible for maintaining the public works at the base including management of utilities. In many cases, the PWD has a written permit process in place to identify and mark-out the locations of Navy-owned utilities [Note: The PWD is usually NOT responsible for the locations/mark-outs of non-Navy owned, public utilities (e.g., Washington Gas, Virginia Power, municipal water and sewer, etc.). Therefore, it is likely that we will have to contact other organizations besides the PWD in order to identify non-Navy owned, public utilities].

At some Activities, there may not be a PWD, the PWD may not have a written permit process in place, or the PWD may not take responsibility for utility locating and mark-outs. In these cases, the PWD should still be contacted since it is likely that they will have the best understanding of the utility locations at the Activity (i.e., engineering drawings, institutional knowledge, etc.). Subsequently, the PWD should be brought into a cooperative arrangement (if possible) with the other services employed in utility locating and mark-out in order to have the most comprehensive assessment performed.

At all Activities we should have a contact (name and phone number), and preferably an established relationship, with PWD, either directly or through the NAVFAC Atlantic, Midlant, or Washington NTR or Activity Environmental Office that we can work with and contact in the event of problems.

Miss Utility or "One Call" Services for Public Utility Mark-outs

Miss Utility or "One Call" service centers are information exchange centers for excavators, contractors and property owners planning any kind of excavation or digging. The "One Call" center notifies participating public utilities of the upcoming excavation work so they can locate and mark their underground utilities in advance to prevent possible damage to underground utility lines, injury, property damage and service outages. In some instances, such with southeastern Virginia bases, the Navy has entered into agreement with Ms. Utilities and is part of the response process for Miss

Utilities. Generally, a minimum of 48 hours is required for the public utility mark-outs to be performed. The "One Call" services are free to the public. Note that the "One Call" centers only coordinate with participating public utilities. There may be some public utilities that do NOT participate in the "One Call" center which may need to be contacted separately. For example, in Washington, DC, the Miss Utility "One Call" center does not locate and mark public sewer and water lines. Therefore, the municipal water and sewer authority must be contacted separately to have the sewer and water lines marked out. The AM should contact the appropriate one-call center to determine their scope of services.

A national listing of the "One Call" service centers for each state is presented on the web at http://www.underspace.com/refs/ocdir.htm. For the Mid-Atlantic region, the following "One Call" service centers are available.

Name	Phone	Website	Comments
Miss Utility of DELMARVA	800-257-7777	www.missutility.net	Public utility mark-outs in Delaware, Maryland, Washington, DC, and Northern Virginia
Miss Utility of Southern Virginia (One Call)	800-552-7001	not available	Public utility mark-outs in Southern Virginia
Miss Utility of Virginia	800-257-7777 800-552-7007	www.missutilityofvirginia.com	General information on public utility mark-outs in Virginia, with links to Miss Utility of DELMARVA and Miss Utility of Southern Virginia (One Call)
Miss Utility of West Virginia, Inc	800-245-4848	none	Call to determine what utilities they work with in West Virginia
North Carolina One Call Center	800-632-4949	www.ncocc.org/ncocc/default.htm	Public Utility Markouts in North Carolina

Private Subcontractors

1. Utility-locating support is required at some level for most all CH2M HILL field projects in "clearing" proposed subsurface boring locations on the project site. Utility location and sample clearance can include a comprehensive effort of GIS map interpretation, professional land surveying, field locating, and geophysical surveying. Since we can usually provide our own GIS-related services for projects and our professional land surveying services are normally procured separately, utility-locating subcontractors will normally only be required for some level of geophysical surveying support in the field. This level of geophysical surveying support can range widely from a simple electromagnetic (EM) survey over a known utility line, to a blind geophysical effort, including a ground-penetrating radar (GPR) survey and/or a comprehensive EM survey to delineate and characterize all unknown subsurface anomalies.

   The level of service required from the subcontractor will vary depending on the nature of the site. At sites where utility locations are well defined on the maps and

recent construction is limited, CH2M HILL may be confident with a limited effort from a traditional utility-locating subcontractor providing a simple EM survey. At sites where utility locations are not well defined, where recent constructions may have altered utility locations, or the nature of the site makes utility location difficult, CH2M HILL will require the services of a comprehensive geophysical surveying subcontractor, with a wide range of GPR and EM services available for use on an "as-needed" basis. Typical costs for geophysical surveying subcontractors will range from approximately $200 per day for a simple EM effort (usually one crew member and one instrument) to approximately $1,500 per day for a comprehensive geophysical surveying effort (usually a two-person crew and multiple instruments). Comprehensive geophysical surveying efforts may also include field data interpretation (and subsequent report preparation) and non-destructive excavation to field-verify utility depths and locations.

The following table provides a list of recommended geophysical surveying support subcontractors that can be used for utility-locating services:

Company Name and Address	Contact Name and Phone Number	Equipment[1]					Other Services[2]		
		1	2	3	4	5	A	B	C
US Radar, Inc.* PO Box 319 Matawan, NJ 07747	Ron LaBarca 732-566-2035			4					
Utilities Search, Inc.*	Jim Davis 703-369-5758	4				4	4	4	4
So Deep, Inc.* 8397 Euclid Avenue Manassas Park, VA 20111	703-361-6005	4					4	4	4
Accurate Locating, Inc. 1327 Ashton Rd., Suite 101 Hanover, MD 21076	Ken Shipley 410-850-0280	4	4						
NAEVA Geophysics, Inc. P.O. Box 7325 Charlottesville, VA 22906	Alan Mazurowski 434-978-3187	4	4	4	4	4	4	4	4
Earth Resources Technology. Inc. 8106 Stayton Rd. Jessup, MD 20794	Peter Li 240-554-0161	4	4	4	4	4	4	4	
Geophex, Ltd 605 Mercury Street Raleigh, NC 27603	I. J. Won 919-839-8515	4	4	4	4	4	4	4	4

Notes:

*Companies denoted with an asterisk have demonstrated reluctance to assume responsibility for damage to underground utilities or an inability to accommodate the insurance requirements that CH2M HILL requests for this type of work at many Navy sites.

[1]Equipment types are:

1. Simple electromagnetic instruments, usually hand-held
2. Other, more innovative, electromagnetic instruments, including larger instruments for more area coverage
3. Ground-penetrating radar systems of all kinds
4. Audio-frequency detectors of all kinds
5. Radio-frequency detectors of all kinds

[2]Other services include:

A. Data interpretation and/or report preparation to provide a permanent record of the geophysical survey results and a professional interpretation of the findings, including expected accuracy and precision.

B. Non-destructive excavation to field-verify the depths, locations, and types of subsurface utilities.

C. Concrete/asphalt coring and pavement/surface restoration.

Attachment C – Equipment Used for Identifying Underground Utilities

This attachment provides a summary of the various types of equipment used for subsurface utility location. It describes the capabilities and limitations of each in order to help the AM and PM determine if the equipment being proposed by a subcontractor or Navy is adequate. A list of in-house experts that can be used to answer questions you may have is provided below.

CH2M HILL In-house Utility Location Experts

Tamir Klaff/WDC

Home Office Phone – 703-669-9611

Electromagnetic Induction (EMI) Methods

EMI instruments, in general, induce an electromagnetic field into the ground (the primary field) and then record the response (the secondary field), if any. Lateral changes in subsurface conductivity, such as caused by the presence of buried metal or by significant soil variations, cause changes in the secondary field recorded by the instrument and thus enable detection and mapping of the subsurface features. It should be noted that EMI only works for electrically conductive materials--plastic or PVC pipes are generally not detected with EMI. Water and gas lines are commonly plastic, although most new lines include a copper "locator" strip on the top of the PVC to allow for detection with EMI.

EMI technology encompasses a wide range of instruments, each with inherent strengths and weaknesses for particular applications. One major division of EMI is between "time-domain" and "frequency-domain" instruments that differ in the aspect of the secondary field they detect. Another difference in EMI instruments is the operating frequency they use to transmit the primary field. Audio- and radio-frequencies are often used for utility detection, although other frequencies are also used. Consideration of the type of utility expected, surface features that could interfere with detection, and the "congestion" of utilities in an area, should be made when choosing a particular EMI instrument for a particular site.

One common EMI tool used for utility location is a handheld unit that can be used to quickly scan an area for utilities and allows for marking locations in "real time". This method is most commonly used by "dig-safe" contractors marking out known utilities prior to excavation. It should be noted that this method works best when a signal (the primary field) can be placed directly onto the line (i.e., by clamping or otherwise connecting to the end of the line visible at the surface, or for larger utilities such as sewers, by running a transmitter through the utility). These types of tools also have a limited capability to scan an area for unknown utilities. Usually this requires having enough area to separate a hand held transmitter at least a hundred feet from the

receiver. Whether hunting for unknown, or confirming known, utilities, this method will only detect continuous lengths of metallic conductors.

In addition to the handheld EMI units, larger, more powerful EMI tools are available that provide more comprehensive detection and mapping of subsurface features. Generally, data with these methods are collected on a regular grid in the investigation area, and are then analyzed to locate linear anomalies that can be interpreted as utilities. These methods will usually detect *all* subsurface metal (above a minimum size), including pieces of abandoned utilities. In addition, in some situations, backfill can be detected against native soils giving information on trenching and possible utility location. Drawbacks to these methods are that the secondary signals from utilities are often swamped (i.e., undetectable) close to buildings and other cultural features, and that the subsurface at heavily built-up sites may be too complicated to confidently interpret completely.

Hand-held metal detectors (treasure-finders) are usually based on EMI technology. They can be used to locate shallow buried metal associated with utilities (e.g., junctions, manholes, metallic locators). Advantages of these tools is the ease of use and real-time marking of anomalies. Drawbacks include limited depths of investigations and no data storage capacity.

Ground Penetrating Radar (GPR)

GPR systems transmit radio and microwave frequency (e.g., 80 megaHertz to 1,000 megaHertz) waves into the ground and then record reflections of those waves coming back to the surface. Reflections of the radar waves typically occur at lithologic changes, subsurface discontinuities, and subsurface structures. Plastic and PVC pipes can sometimes be detected in GPR data, especially if they are shallow, large, and full of a contrasting material such as air in a wet soil, or water in a dry soil. GPR data are usually collected in regular patterns over an area and then analyzed for linear anomalies that can be interpreted as utilities. GPR is usually very accurate in x-y location of utilities, and can be calibrated at a site to give very accurate depth information as well. A significant drawback to GPR is that depth of investigation is highly dependant on background soil conductivity, and it will not work on all sites. It is not uncommon to get only 1-2 feet of penetration with the signal in damp, clayey environments. Another drawback to GPR is that sites containing significant fill material (e.g., concrete rubble, scrap metal, garbage) will result in complicated anomalies that are difficult or impossible to interpret.

Magnetic Field Methods

Magnetic field methods rely on detecting changes to the earth's magnetic field caused by ferrous metal objects. This method is usually more sensitive to magnetic metal (i.e., deeper detection) than EMI methods. A drawback to this method is it is more susceptible to being swamped by surface features such as fences and cars. In addition, procedures must usually be implemented that account for natural variations in the earth's background field as it changes throughout the day. One common use of the method is to measure and analyze the gradient of the magnetic field, which eliminates most of the drawbacks to the method. It should be noted this method only detects

ferrous metal, primarily iron and steel for utility location applications. Some utility detector combine magnetic and EMI methods into a single hand-held unit.

Optical Methods

Down the hole cameras may be useful in visually reviewing a pipe for empty conduits and/or vaults.

Attachment D – Utility Clearance Documentation Form

Attachment E – Utility Marking Color Codes

The following is the standard color code used by industry to mark various types of utilities and other features at a construction site.

White – Proposed excavations and borings

Pink – Temporary survey markings

Red – Electrical power lines, cables, conduits and lighting cables

Yellow – Gas, oil, steam, petroleum or gaseous materials

Orange – Communication, alarm or signal lines, cables, or conduits

Blue – Potable water

Purple – Reclaimed water, irrigation and slurry lines

Green – Sewer and storm drain lines

Appendix C
Data Management Plan

DRAFT

DATA MANAGEMENT PROCESS OVERVIEW FOR THE NAVY CLEAN PROGRAM

Prepared 5 May 2006

Prepared by

CH2MHILL

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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 discussses 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 Revison/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

Appendix D
Laboratory SOPs

Laboratory SOPs are proprietary and confidential.
They are provided upon request at the discretion of the Project Manager.

Appendix E
Generic Screening Levels

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
ALAR	1596-84-5	160.17	EPI Dermwin v2.0	1.70E-08	4.23E-10	EPI HenryWin v3.2
Acephate	30560-19-1	183.16	EPI Dermwin v2.0	2.00E-11	5.01E-13	EPI HenryWin v3.2
Acetaldehyde	75-07-0	44.05	EPI Dermwin v2.0	2.70E-03	0.0000667	EPI HenryWin v3.2
Acetochlor	34256-82-1	269.77	EPI Dermwin v2.0	9.10E-07	2.23E-08	EPI HenryWin v3.2
Acetone	67-64-1	58.08	EPI Dermwin v2.0	1.40E-03	0.000035	EPI HenryWin v3.2
Acetone Cyanohydrin	75-86-5	85.11	EPI Dermwin v2.0	5.30E-04	0.000013	EPI HenryWin v3.2
Acetonitrile	75-05-8	41.05	EPI Dermwin v2.0	1.40E-03	0.0000345	EPI HenryWin v3.2
Acetophenone	98-86-2	120.15	EPI Dermwin v2.0	4.30E-04	0.0000104	EPI HenryWin v3.2
Acetylaminofluorene, 2-	53-96-3	223.28	EPI Dermwin v2.0	7.80E-09	1.92E-10	EPI HenryWin v3.2
Acrolein	107-02-8	56.06	EPI Dermwin v2.0	5.00E-03	0.000122	EPI HenryWin v3.2
Acrylamide	79-06-1	71.08	EPI Dermwin v2.0	7.00E-08	1.70E-09	EPI HenryWin v3.2
Acrylic Acid	79-10-7	72.06	EPI Dermwin v2.0	1.50E-05	3.70E-07	EPI HenryWin v3.2
Acrylonitrile	107-13-1	53.06	EPI Dermwin v2.0	5.60E-03	0.000138	EPI HenryWin v3.2
Adiponitrile	111-69-3	108.14	EPI Dermwin v2.0	4.90E-08	1.21E-09	EPI HenryWin v3.2
Alachlor	15972-60-8	269.77	EPI Dermwin v2.0	3.40E-07	8.32E-09	EPI HenryWin v3.2
Aldicarb	116-06-3	190.26	EPI Dermwin v2.0	5.90E-08	1.44E-09	EPI HenryWin v3.2
Aldicarb Sulfone	1646-88-4	222.26	EPI Dermwin v2.0	1.40E-07	3.37E-09	EPI HenryWin v3.2
Aldrin	309-00-2	364.92	EPI Dermwin v2.0	1.80E-03	0.000044	EPI HenryWin v3.2
Ally	74223-64-6	381.37	EPI Dermwin v2.0	5.40E-15	1.32E-16	EPI HenryWin v3.2
Allyl Alcohol	107-18-6	58.08	EPI Dermwin v2.0	2.00E-04	4.99E-06	EPI HenryWin v3.2
Allyl Chloride	107-05-1	76.53	EPI Dermwin v2.0	4.50E-01	0.011	EPI HenryWin v3.2
Aluminum	7429-90-5	30.01	EPI Dermwin v2.0			
Aluminum Phosphide	20859-73-8	57.96	EPI Dermwin v2.0			
Amdro	67485-29-4	494.49	EPI Dermwin v2.0	9.00E-05	2.20E-06	EPI HenryWin v3.2
Ametryn	834-12-8	227.33	EPI Dermwin v2.0	9.90E-08	2.43E-09	EPI HenryWin v3.2
Aminobiphenyl, 4-	92-67-1	169.23	EPI Dermwin v2.0	7.10E-06	1.73E-07	EPI HenryWin v3.2
Aminophenol, m-	591-27-5	109.13	EPI Dermwin v2.0	1.10E-08	2.68E-10	EPI HenryWin v3.2
Aminophenol, p-	123-30-8	109.13	EPI Dermwin v2.0	1.50E-08	3.59E-10	EPI HenryWin v3.2
Amitraz	33089-61-1	293.42	EPI Dermwin v2.0	4.00E-04	9.87E-06	EPI HenryWin v3.2
Ammonia	7664-41-7	17.03	EPI Dermwin v2.0	6.60E-04		PHYPROP conversion
Ammonium Perchlorate	7790-98-9	117.49	EPI Dermwin v2.0			
Ammonium Sulfamate	7773-06-0	97.09	EPI Dermwin v2.0			
Aniline	62-53-3	93.13	EPI Dermwin v2.0	8.30E-05	2.02E-06	EPI HenryWin v3.2
Antimony (metallic)	7440-36-0	124.78	EPI Dermwin v2.0			
Antimony Pentoxide	1314-60-9	323.52	EPI			
Antimony Potassium Tartrate	11071-15-1	613.83	EPI Dermwin v2.0			

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Antimony Tetroxide	1332-81-6	307.52	EPI Dermwin v2.0			
Antimony Trioxide	1309-64-4	291.52	EPI Dermwin v2.0			
Apollo	74115-24-5	303.15	EPI Dermwin v2.0	1.60E-08	3.90E-10	EPI HenryWin v3.2
Aramite	140-57-8	334.86	EPI Dermwin v2.0	7.80E-06	1.90E-07	EPI HenryWin v3.2
Arsenic, Inorganic	7440-38-2	77.95	EPI Dermwin v2.0			
Arsine	7784-42-1	77.95	EPI Dermwin v2.0			
Assure	76578-14-8	372.81	EPI Dermwin v2.0	4.30E-07	1.06E-08	EPI HenryWin v3.2
Asulam	3337-71-1	230.24	EPI Dermwin v2.0	7.00E-11	1.71E-12	EPI HenryWin v3.2
Atrazine	1912-24-9	215.69	EPI Dermwin v2.0	9.60E-08	2.36E-09	EPI HenryWin v3.2
Auramine	492-80-8	267.38	EPI Dermwin v2.0	1.50E-07	3.64E-09	EPI HenryWin v3.2
Avermectin B1	65195-55-3	875.12	EPI Dermwin v2.0	5.40E-26	1.32E-27	EPI HenryWin v3.2
Azobenzene	103-33-3	182.23	EPI Dermwin v2.0	5.50E-04	0.0000135	EPI HenryWin v3.2
Barium	7440-39-3	137.33	EPI Dermwin v2.0			
Baygon	114-26-1	209.25	EPI Dermwin v2.0	5.80E-08	1.43E-09	EPI HenryWin v3.2
Bayleton	43121-43-3	293.76	EPI Dermwin v2.0	3.30E-09	8.11E-11	EPI HenryWin v3.2
Baythroid	68359-37-5	434.3	EPI Dermwin v2.0	1.20E-06	2.90E-08	EPI HenryWin v3.2
Benefin	1861-40-1	335.29	EPI Dermwin v2.0	1.20E-02	0.000291	EPI HenryWin v3.2
Benomyl	17804-35-2	290.32	EPI Dermwin v2.0	2.00E-10	4.93E-12	EPI HenryWin v3.2
Bentazon	25057-89-0	240.28	EPI Dermwin v2.0	8.90E-08	2.18E-09	EPI HenryWin v3.2
Benzaldehyde	100-52-7	106.13	EPI Dermwin v2.0	1.10E-03	0.0000267	EPI HenryWin v3.2
Benzene	71-43-2	78.11	EPI Dermwin v2.0	2.30E-01	0.00555	EPI HenryWin v3.2
Benzenethiol	108-98-5	110.17	EPI Dermwin v2.0	1.40E-02	0.000335	EPI HenryWin v3.2
Benzidine	92-87-5	184.24	EPI Dermwin v2.0	2.90E-09	7.05E-11	EPI HenryWin v3.2
Benzoic Acid	65-85-0	122.12	EPI Dermwin v2.0	1.60E-06	3.81E-08	EPI HenryWin v3.2
Benzotrichloride	98-07-7	195.48	EPI Dermwin v2.0	1.10E-02	0.00026	EPI HenryWin v3.2
Benzyl Alcohol	100-51-6	108.14	EPI Dermwin v2.0	1.40E-05	3.37E-07	EPI HenryWin v3.2
Benzyl Chloride	100-44-7	126.59	EPI Dermwin v2.0	1.70E-02	0.000412	EPI HenryWin v3.2
Beryllium and compounds	7440-41-7	9.01	EPI Dermwin v2.0			
Bidrin	141-66-2	237.19	EPI Dermwin v2.0	2.10E-09	5.03E-11	EPI HenryWin v3.2
Bifenox	42576-02-3	342.14	EPI Dermwin v2.0	4.40E-06	1.08E-07	EPI HenryWin v3.2
Biphenthrin	82657-04-3	422.88	EPI Dermwin v2.0	4.10E-05	1.00E-06	EPI HenryWin v3.2
Biphenyl, 1,1'-	92-52-4	154.21	EPI Dermwin v2.0	1.30E-02	0.000308	EPI HenryWin v3.2
Bis(2-chloro-1-methylethyl) ether	108-60-1	171.07	EPI Dermwin v2.0	3.00E-03	0.0000742	EPI HenryWin v3.2
Bis(2-chloroethoxy)methane	111-91-1	173.04	EPI Dermwin v2.0	1.60E-04	3.85E-06	EPI HenryWin v3.2
Bis(2-chloroethyl)ether	111-44-4	143.01	EPI Dermwin v2.0	7.00E-04	0.000017	EPI HenryWin v3.2
Bis(2-ethylhexyl)phthalate	117-81-7	390.57	EPI Dermwin v2.0	1.10E-05	2.70E-07	EPI HenryWin v3.2

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Bis(chloromethyl)ether	542-88-1	114.96	EPI Dermwin v2.0	1.80E-01	0.00436	EPI HenryWin v3.2
Bisphenol A	80-05-7	228.29	EPI Dermwin v2.0	3.70E-10	9.16E-12	EPI HenryWin v3.2
Boron And Borates Only	7440-42-8	13.84	EPI Dermwin v2.0			
Boron Trifluoride	7637-07-2	67.81	EPI Dermwin v2.0			
Bromate	15541-45-4	79.9	EPI Dermwin v2.0			
Bromo-2-chloroethane, 1-	107-04-0	143.41	EPI Dermwin v2.0	3.70E-02	0.000909	EPI HenryWin v3.2
Bromobenzene	108-86-1	157.01	EPI Dermwin v2.0	1.00E-01	0.00247	EPI HenryWin v3.2
Bromodichloromethane	75-27-4	163.83	EPI Dermwin v2.0	8.70E-02	0.00212	EPI HenryWin v3.2
Bromoform	75-25-2	252.73	EPI Dermwin v2.0	2.20E-02	0.000535	EPI HenryWin v3.2
Bromomethane	74-83-9	94.94	EPI Dermwin v2.0	3.00E-01	0.00734	EPI HenryWin v3.2
Bromophos	2104-96-3	365.99	EPI Dermwin v2.0	8.40E-03	0.000205	EPI HenryWin v3.2
Bromoxynil	1689-84-5	276.92	EPI Dermwin v2.0	5.40E-09	1.32E-10	EPI HenryWin v3.2
Bromoxynil Octanoate	1689-99-2	403.12	EPI Dermwin v2.0	1.30E-03	0.0000319	EPI HenryWin v3.2
Butadiene, 1,3-	106-99-0	54.09	EPI Dermwin v2.0	3.00E+00	0.0736	EPI HenryWin v3.2
Butanol, N-	71-36-3	74.12	EPI Dermwin v2.0	3.60E-04	8.81E-06	EPI HenryWin v3.2
Butyl Benzyl Phthlate	85-68-7	312.37	EPI Dermwin v2.0	5.20E-05	1.26E-06	EPI HenryWin v3.2
Butyl alcohol, sec-	78-92-2	74.12	EPI Dermwin v2.0	3.70E-04	9.06E-06	EPI HenryWin v3.2
Butylate	2008-41-5	217.37	EPI Dermwin v2.0	3.50E-03	0.0000845	EPI HenryWin v3.2
Butylated hydroxyanisole	25013-16-5	180.25	EPI Dermwin v2.0	4.80E-05	1.17E-06	EPI HenryWin v3.2
Butylphthalyl Butylglycolate	85-70-1	336.39	EPI Dermwin v2.0	1.30E-07	3.08E-09	EPI HenryWin v3.2
Cacodylic Acid	75-60-5	138	EPI Dermwin v2.0			
Cadmium (Diet)	7440-43-9	112.41	EPI Dermwin v2.0			
Cadmium (Water)	7440-43-9	112.41	EPI Dermwin v2.0			
Caprolactam	105-60-2	113.16	EPI Dermwin v2.0	1.00E-06	2.53E-08	EPI HenryWin v3.2
Captafol	2425-06-1	349.06	EPI Dermwin v2.0	2.00E-07	4.92E-09	EPI HenryWin v3.2
Captan	133-06-2	300.59	EPI Dermwin v2.0	2.90E-07	7.00E-09	EPI HenryWin v3.2
Carbaryl	63-25-2	201.23	EPI Dermwin v2.0	1.30E-07	3.27E-09	EPI HenryWin v3.2
Carbofuran	1563-66-2	221.26	EPI Dermwin v2.0	1.30E-07	3.09E-09	EPI HenryWin v3.2
Carbon Disulfide	75-15-0	76.13	EPI Dermwin v2.0	5.90E-01	0.0144	EPI HenryWin v3.2
Carbon Tetrachloride	56-23-5	153.82	EPI Dermwin v2.0	1.10E+00	0.0276	EPI HenryWin v3.2
Carbosulfan	55285-14-8	380.55	EPI Dermwin v2.0	2.10E-05	5.12E-07	EPI HenryWin v3.2
Carboxin	5234-68-4	235.3	EPI Dermwin v2.0	1.30E-08	3.20E-10	EPI HenryWin v3.2
Ceric oxide	1306-38-3	172.11	EPI Dermwin v2.0			
Chloral Hydrate	302-17-0	165.4	EPI Dermwin v2.0	4.50E-09	1.09E-10	EPI HenryWin v3.2
Chloramben	133-90-4	206.03	EPI Dermwin v2.0	1.60E-09	3.87E-11	EPI HenryWin v3.2
Chloranil	118-75-2	245.88	EPI Dermwin v2.0	1.30E-08	3.27E-10	EPI HenryWin v3.2

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Chlordane	12789-03-6	409.78	EPI Dermwin v2.0	2.00E-03	0.0000486	EPI HenryWin v3.2
Chlordecone (Kepone)	143-50-0	490.64	EPI Dermwin v2.0	2.20E-06	5.38E-08	EPI HenryWin v3.2
Chlorfenvinphos	470-90-6	359.58	EPI Dermwin v2.0	1.20E-06	2.89E-08	EPI HenryWin v3.2
Chlorimuron, Ethyl-	90982-32-4	414.82	EPI Dermwin v2.0	7.40E-14	1.82E-15	EPI HenryWin v3.2
Chlorine	7782-50-5	70.91	EPI Dermwin v2.0	4.80E-01		PHYPROP conversion
Chlorine Dioxide	10049-04-4	67.45	EPI Dermwin v2.0			
Chlorite (Sodium Salt)	7758-19-2	90.44	EPI Dermwin v2.0			
Chloro-1,1-difluoroethane, 1-	75-68-3	100.5	EPI Dermwin v2.0	2.40E+00	0.0588	EPI HenryWin v3.2
Chloro-1,3-butadiene, 2-	126-99-8	88.54	EPI Dermwin v2.0	2.30E+00	0.0561	EPI HenryWin v3.2
Chloro-2-methylaniline HCl, 4-	3165-93-3	141.6	EPI Dermwin v2.0	8.10E-05	1.99E-06	EPI HenryWin v3.2
Chloroacetaldehyde, 2-	107-20-0	78.5	EPI Dermwin v2.0	7.40E-04	0.0000181	EPI HenryWin v3.2
Chloroacetic Acid	79-11-8	94.5	EPI Dermwin v2.0	3.80E-07	9.26E-09	EPI HenryWin v3.2
Chloroacetophenone, 2-	532-27-4	154.6	EPI Dermwin v2.0	1.30E-04	3.30E-06	EPI HenryWin v3.2
Chloroaniline, p-	106-47-8	127.57	EPI Dermwin v2.0	4.70E-05	1.16E-06	EPI HenryWin v3.2
Chlorobenzene	108-90-7	112.56	EPI Dermwin v2.0	1.30E-01	0.00311	EPI HenryWin v3.2
Chlorobenzilate	510-15-6	325.19	EPI Dermwin v2.0	3.00E-06	7.24E-08	EPI HenryWin v3.2
Chlorobenzoic Acid, p-	74-11-3	156.57	EPI Dermwin v2.0	1.60E-06	3.88E-08	EPI HenryWin v3.2
Chlorobenzotrifluoride, 4-	98-56-6	180.56	EPI Dermwin v2.0	1.40E+00	0.0347	EPI HenryWin v3.2
Chlorobutane, 1-	109-69-3	92.57	EPI Dermwin v2.0	6.80E-01	0.0167	EPI HenryWin v3.2
Chlorodifluoromethane	75-45-6	86.47	EPI Dermwin v2.0	1.70E+00	0.0406	EPI HenryWin v3.2
Chloroform	67-66-3	119.38	EPI Dermwin v2.0	1.50E-01	0.00367	EPI HenryWin v3.2
Chloromethane	74-87-3	50.49	EPI Dermwin v2.0	3.60E-01	0.00882	EPI HenryWin v3.2
Chloromethyl Methyl Ether	107-30-2	80.51	EPI Dermwin v2.0	1.20E-02	0.000304	EPI HenryWin v3.2
Chloronaphthalene, Beta-	91-58-7	162.62	EPI Dermwin v2.0	1.30E-02	0.00032	EPI HenryWin v3.2
Chloronitrobenzene, o-	88-73-3	157.56	EPI Dermwin v2.0	3.80E-04	9.30E-06	EPI HenryWin v3.2
Chloronitrobenzene, p-	100-00-5	157.56	EPI Dermwin v2.0	2.00E-04	4.89E-06	EPI HenryWin v3.2
Chlorophenol, 2-	95-57-8	128.56	EPI Dermwin v2.0	4.60E-04	0.0000112	EPI HenryWin v3.2
Chloropicrin	76-06-2	164.38	EPI Dermwin v2.0	8.40E-02	0.00205	EPI HenryWin v3.2
Chlorothalonil	1897-45-6	265.91	EPI Dermwin v2.0	8.20E-05	2.00E-06	EPI HenryWin v3.2
Chlorotoluene, o-	95-49-8	126.59	EPI Dermwin v2.0	1.50E-01	0.00357	EPI HenryWin v3.2
Chlorotoluene, p-	106-43-4	126.59	EPI Dermwin v2.0	1.80E-01	0.00438	EPI HenryWin v3.2
Chlorozotocin	54749-90-5	313.7	EPI Dermwin v2.0	1.50E-20	3.67E-22	EPI HenryWin v3.2
Chlorpropham	101-21-3	213.67	EPI Dermwin v2.0	2.30E-05	5.69E-07	EPI HenryWin v3.2
Chlorpyrifos	2921-88-2	350.59	EPI Dermwin v2.0	1.20E-04	2.93E-06	EPI HenryWin v3.2
Chlorpyrifos Methyl	5598-13-0	322.53	EPI Dermwin v2.0	1.50E-04	3.75E-06	EPI HenryWin v3.2
Chlorsulfuron	64902-72-3	357.77	EPI Dermwin v2.0	1.40E-14	3.42E-16	EPI HenryWin v3.2

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Chlorthiophos	60238-56-4	361.24	EPI Dermwin v2.0	4.90E-05	1.20E-06	EPI HenryWin v3.2
Chromium(III), Insoluble Salts	16065-83-1		EPI			
Chromium(VI)	18540-29-9		EPI			
Chromium, Total	7440-47-3	52	EPI Dermwin v2.0			
Cobalt	7440-48-4	58.93	EPI Dermwin v2.0			
Coke Oven Emissions	8007-45-2	78.11	EPI Dermwin v2.0	2.30E-01	0.00555	EPI HenryWin v3.2
Copper	7440-50-8	63.55	EPI Dermwin v2.0			
Cresol, m-	108-39-4	108.14	EPI Dermwin v2.0	3.50E-05	8.56E-07	EPI HenryWin v3.2
Cresol, o-	95-48-7	108.14	EPI Dermwin v2.0	4.90E-05	1.20E-06	EPI HenryWin v3.2
Cresol, p-	106-44-5	108.14	EPI Dermwin v2.0	4.10E-05	1.00E-06	EPI HenryWin v3.2
Cresol, p-chloro-m-	59-50-7	142.59	EPI Dermwin v2.0	1.00E-04	2.45E-06	EPI HenryWin v3.2
Cresols	1319-77-3	108.14	EPI Dermwin v2.0	4.90E-05	1.20E-06	EPI HenryWin v3.2
Crotonaldehyde, trans-	123-73-9	70.09	EPI Dermwin v2.0	7.90E-04	0.0000194	EPI HenryWin v3.2
Cumene	98-82-8	120.2	EPI Dermwin v2.0	4.70E-01	0.0115	EPI HenryWin v3.2
Cupferron	135-20-6	155.16	EPI Dermwin v2.0	8.70E-16	2.12E-17	EPI HenryWin v3.2
Cyanazine	21725-46-2	240.7	EPI Dermwin v2.0	1.10E-10	2.57E-12	EPI HenryWin v3.2
Cyanides						
~Calcium Cyanide	592-01-8	92.11	EPI Dermwin v2.0			
~Copper Cyanide	544-92-3	89.56	EPI Dermwin v2.0			
~Cyanide (CN-)	57-12-5	27.03	EPI Dermwin v2.0	5.40E-03	0.000133	EPI HenryWin v3.2
~Cyanogen	460-19-5	52.04	EPI Dermwin v2.0	2.20E-01	0.0054	EPI HenryWin v3.2
~Cyanogen Bromide	506-68-3	105.92	EPI Dermwin v2.0	1.00E+00	0.0245	EPI HenryWin v3.2
~Cyanogen Chloride	506-77-4	61.47	EPI Dermwin v2.0	7.90E-02	0.0019412	Yaws 2001
~Hydrogen Cyanide	74-90-8	27.03	EPI Dermwin v2.0	5.40E-03	0.000133	EPI HenryWin v3.2
~Potassium Cyanide	151-50-8	65.12	EPI Dermwin v2.0			
~Potassium Silver Cyanide	506-61-6	199	EPI Dermwin v2.0			
~Silver Cyanide	506-64-9	133.89	EPI Dermwin v2.0			
~Sodium Cyanide	143-33-9	49.01	EPI Dermwin v2.0			
~Thiocyanate	463-56-9	59.09	EPI Dermwin v2.0	6.00E-03	0.000146	EPI HenryWin v3.2
~Zinc Cyanide	557-21-1	117.43	EPI Dermwin v2.0			
Cyclohexane	110-82-7	84.16	EPI Dermwin v2.0	6.10E+00	0.15	EPI HenryWin v3.2
Cyclohexane, 1,2,3,4,5-pentabromo-6-chloro-	87-84-3	513.09	EPI Dermwin v2.0	4.40E-10	1.07E-11	EPI HenryWin v3.2
Cyclohexanone	108-94-1	98.15	EPI Dermwin v2.0	3.70E-04	9.00E-06	EPI HenryWin v3.2
Cyclohexylamine	108-91-8	99.18	EPI Dermwin v2.0	1.70E-04	4.16E-06	EPI HenryWin v3.2
Cyhalothrin/karate	68085-85-8	449.86	EPI Dermwin v2.0	6.10E-05	1.48E-06	EPI HenryWin v3.2
Cypermethrin	52315-07-8	416.31	EPI Dermwin v2.0	1.70E-05	4.20E-07	EPI HenryWin v3.2

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Cyromazine	66215-27-8	166.19	EPI Dermwin v2.0	2.30E-12	5.65E-14	EPI HenryWin v3.2
DDD	72-54-8	320.05	EPI Dermwin v2.0	2.70E-04	6.60E-06	EPI HenryWin v3.2
DDE, p,p'-	72-55-9	318.03	EPI Dermwin v2.0	1.70E-03	0.0000416	EPI HenryWin v3.2
DDT	50-29-3	354.49	EPI Dermwin v2.0	3.40E-04	8.32E-06	EPI HenryWin v3.2
Dacthal	1861-32-1	331.97	EPI Dermwin v2.0	8.90E-05	2.18E-06	EPI HenryWin v3.2
Dalapon	75-99-0	142.97	EPI Dermwin v2.0	2.30E-06	5.66E-08	EPI HenryWin v3.2
Decabromodiphenyl ether, 2,2',3,3',4,4',5,5',6,6'- (BDE-209)	1163-19-5	959.17	EPI Dermwin v2.0	1.80E-06	4.45E-08	EPI HenryWin v3.2
Demeton	8065-48-3	258.34	EPI			EPI (HenryWin)
Di(2-ethylhexyl)adipate	103-23-1	370.58	EPI Dermwin v2.0	1.80E-05	4.34E-07	EPI HenryWin v3.2
Diallate	2303-16-4	270.22	EPI Dermwin v2.0	1.60E-04	3.80E-06	EPI HenryWin v3.2
Diazinon	333-41-5	304.35	EPI Dermwin v2.0	4.60E-06	1.13E-07	EPI HenryWin v3.2
Dibromo-3-chloropropane, 1,2-	96-12-8	236.33	EPI Dermwin v2.0	6.00E-03	0.000147	EPI HenryWin v3.2
Dibromobenzene, 1,4-	106-37-6	235.91	EPI Dermwin v2.0	3.70E-02	0.000893	EPI HenryWin v3.2
Dibromochloromethane	124-48-1	208.28	EPI Dermwin v2.0	3.20E-02	0.000783	EPI HenryWin v3.2
Dibromoethane, 1,2-	106-93-4	187.86	EPI Dermwin v2.0	2.70E-02	0.00065	EPI HenryWin v3.2
Dibromomethane (Methylene Bromide)	74-95-3	173.84	EPI Dermwin v2.0	3.40E-02	0.000822	EPI HenryWin v3.2
Dibutyl Phthalate	84-74-2	278.35	EPI Dermwin v2.0	7.40E-05	1.81E-06	EPI HenryWin v3.2
Dibutyltin Compounds	NA					
Dicamba	1918-00-9	221.04	EPI Dermwin v2.0	8.90E-08	2.18E-09	EPI HenryWin v3.2
Dichloro-2-butene, 1,4-	764-41-0	125	EPI Dermwin v2.0	2.70E-02	0.000664	EPI HenryWin v3.2
Dichloro-2-butene, cis-1,4-	1476-11-5	125	EPI Dermwin v2.0	2.70E-02	0.000664	EPI HenryWin v3.2
Dichloro-2-butene, trans-1,4-	110-57-6	125	EPI Dermwin v2.0	2.70E-02	0.000664	EPI HenryWin v3.2
Dichloroacetic Acid	79-43-6	128.94	EPI Dermwin v2.0	3.40E-07	8.38E-09	EPI HenryWin v3.2
Dichlorobenzene, 1,2-	95-50-1	147	EPI Dermwin v2.0	7.80E-02	0.00192	EPI HenryWin v3.2
Dichlorobenzene, 1,4-	106-46-7	147	EPI Dermwin v2.0	9.90E-02	0.00241	EPI HenryWin v3.2
Dichlorobenzidine, 3,3'-	91-94-1	253.13	EPI Dermwin v2.0	2.10E-09	5.11E-11	EPI HenryWin v3.2
Dichlorobenzophenone, 4,4'-	90-98-2	251.11	EPI Dermwin v2.0	4.40E-05	1.07E-06	EPI HenryWin v3.2
Dichlorodifluoromethane	75-71-8	120.91	EPI Dermwin v2.0	1.40E+01	0.343	EPI HenryWin v3.2
Dichloroethane, 1,1-	75-34-3	98.96	EPI Dermwin v2.0	2.30E-01	0.00562	EPI HenryWin v3.2
Dichloroethane, 1,2-	107-06-2	98.96	EPI Dermwin v2.0	4.80E-02	0.00118	EPI HenryWin v3.2
Dichloroethylene, 1,1-	75-35-4	96.94	EPI Dermwin v2.0	1.10E+00	0.0261	EPI HenryWin v3.2
Dichloroethylene, 1,2- (Mixed Isomers)	540-59-0	96.94	EPI Dermwin v2.0	1.70E-01	0.00408	EPI HenryWin v3.2
Dichloroethylene, 1,2-cis-	156-59-2	96.94	EPI Dermwin v2.0	1.70E-01	0.00408	EPI HenryWin v3.2
Dichloroethylene, 1,2-trans-	156-60-5	96.94	EPI Dermwin v2.0	1.70E-01	0.00408	EPI HenryWin v3.2
Dichlorophenol, 2,4-	120-83-2	163	EPI Dermwin v2.0	1.80E-04	4.29E-06	EPI HenryWin v3.2
Dichlorophenoxy Acetic Acid, 2,4	94-75-7	221.04	EPI Dermwin v2.0	1.40E-06	3.54E-08	EPI HenryWin v3.2

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Dichlorophenoxy)butyric Acid, 4-(2,4-	94-82-6	249.1	EPI Dermwin v2.0	2.40E-07	5.87E-09	EPI HenryWin v3.2
Dichloropropane, 1,2-	78-87-5	112.99	EPI Dermwin v2.0	1.20E-01	0.00282	EPI HenryWin v3.2
Dichloropropane, 1,3-	142-28-9	112.99	EPI Dermwin v2.0	4.00E-02	0.000976	EPI HenryWin v3.2
Dichloropropanol, 2,3-	616-23-9	128.99	EPI Dermwin v2.0	1.50E-07	3.62E-09	EPI HenryWin v3.2
Dichloropropene, 1,3-	542-75-6	110.97	EPI Dermwin v2.0	1.50E-01	0.00355	EPI HenryWin v3.2
Dichlorvos	62-73-7	220.98	EPI Dermwin v2.0	2.30E-05	5.74E-07	EPI HenryWin v3.2
Dicyclopentadiene	77-73-6	132.21	EPI Dermwin v2.0	2.60E+00	0.0625	EPI HenryWin v3.2
Dieldrin	60-57-1	380.91	EPI Dermwin v2.0	4.10E-04	1.00E-05	EPI HenryWin v3.2
Diesel Engine Exhaus	NA					
Diethanolamine	111-42-2	105.14	EPI Dermwin v2.0	1.60E-09	3.87E-11	EPI HenryWin v3.2
Diethyl Phthalate	84-66-2	222.24	EPI Dermwin v2.0	2.50E-05	6.10E-07	EPI HenryWin v3.2
Diethylene Glycol Monobutyl Ethe	112-34-5	162.23	EPI Dermwin v2.0	2.90E-07	7.20E-09	EPI HenryWin v3.2
Diethylene Glycol Monoethyl Ether	111-90-0	134.18	EPI Dermwin v2.0	9.10E-07	2.23E-08	EPI HenryWin v3.2
Diethylformamide	617-84-5	101.15	EPI Dermwin v2.0	5.30E-06	1.30E-07	EPI HenryWin v3.2
Diethylstilbestro	56-53-1	268.36	EPI Dermwin v2.0	2.40E-10	5.80E-12	EPI HenryWin v3.2
Difenzoquat	43222-48-6	360.43	EPI Dermwin v2.0			
Diflubenzuron	35367-38-5	310.69	EPI Dermwin v2.0	1.90E-07	4.60E-09	EPI HenryWin v3.2
Difluoroethane, 1,1-	75-37-6	66.05	EPI Dermwin v2.0	8.30E-01	0.0203	EPI HenryWin v3.2
Dihydrosafrole	94-58-6	164.21	EPI Dermwin v2.0	6.70E+00	0.165	EPI HenryWin v3.2
Diisopropyl Ether	108-20-3	102.18	EPI Dermwin v2.0	1.00E-01	0.00256	EPI HenryWin v3.2
Diisopropyl Methylphosphonate	1445-75-6	180.19	EPI Dermwin v2.0	1.80E-03	0.0000438	EPI HenryWin v3.2
Dimethipin	55290-64-7	210.26	EPI Dermwin v2.0	9.40E-10	2.30E-11	EPI HenryWin v3.2
Dimethoate	60-51-5	229.25	EPI Dermwin v2.0	9.90E-09	2.43E-10	EPI HenryWin v3.2
Dimethoxybenzidine, 3,3'-	119-90-4	244.3	EPI Dermwin v2.0	1.90E-09	4.66E-11	EPI HenryWin v3.2
Dimethyl methylphosphonate	756-79-6	124.08	EPI Dermwin v2.0	5.10E-05	1.25E-06	EPI HenryWin v3.2
Dimethylamino azobenzene [p-]	60-11-7	225.3	EPI Dermwin v2.0	9.60E-06	2.34E-07	EPI HenryWin v3.2
Dimethylaniline HCl, 2,4-	21436-96-4	121.18	EPI Dermwin v2.0	1.00E-04	2.50E-06	EPI HenryWin v3.2
Dimethylaniline, 2,4-	95-68-1	121.18	EPI Dermwin v2.0	1.00E-04	2.50E-06	EPI HenryWin v3.2
Dimethylaniline, N,N-	121-69-7	121.18	EPI Dermwin v2.0	2.30E-03	0.0000568	EPI HenryWin v3.2
Dimethylbenzidine, 3,3'-	119-93-7	212.3	EPI Dermwin v2.0	3.30E-09	8.10E-11	EPI HenryWin v3.2
Dimethylformamide	68-12-2	73.1	EPI Dermwin v2.0	3.00E-06	7.39E-08	EPI HenryWin v3.2
Dimethylhydrazine, 1,1-	57-14-7	60.1	EPI Dermwin v2.0	2.80E-06	6.95E-08	EPI HenryWin v3.2
Dimethylhydrazine, 1,2-	540-73-8	60.1	EPI Dermwin v2.0	2.80E-06	6.95E-08	EPI HenryWin v3.2
Dimethylphenol, 2,4-	105-67-9	122.17	EPI Dermwin v2.0	3.90E-05	9.51E-07	EPI HenryWin v3.2
Dimethylphenol, 2,6-	576-26-1	122.17	EPI Dermwin v2.0	2.70E-04	6.65E-06	EPI HenryWin v3.2
Dimethylphenol, 3,4-	95-65-8	122.17	EPI Dermwin v2.0	1.70E-05	4.15E-07	EPI HenryWin v3.2

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Dimethylterephthalate	120-61-6	194.19	EPI Dermwin v2.0	5.50E-03	0.000134	EPI HenryWin v3.2
Dimethylvinylchloride	513-37-1	90.55	EPI Dermwin v2.0	3.30E+00	0.081	EPI HenryWin v3.2
Dinitro-o-cresol, 4,6-	534-52-1	198.14	EPI Dermwin v2.0	5.70E-05	1.40E-06	EPI HenryWin v3.2
Dinitro-o-cyclohexyl Phenol, 4,6-	131-89-5	266.26	EPI Dermwin v2.0	1.40E-09	3.38E-11	EPI HenryWin v3.2
Dinitrobenzene, 1,2-	528-29-0	168.11	EPI Dermwin v2.0	2.20E-06	5.33E-08	EPI HenryWin v3.2
Dinitrobenzene, 1,3-	99-65-0	168.11	EPI Dermwin v2.0	2.00E-06	4.90E-08	EPI HenryWin v3.2
Dinitrobenzene, 1,4-	100-25-4	168.11	EPI Dermwin v2.0	1.50E-05	3.70E-07	EPI HenryWin v3.2
Dinitrophenol, 2,4-	51-28-5	184.11	EPI Dermwin v2.0	3.50E-06	8.60E-08	EPI HenryWin v3.2
Dinitrotoluene Mixture, 2,4/2,6	25321-14-6	182.14	EPI Dermwin v2.0	1.60E-05	3.97E-07	EPI HenryWin v3.2
Dinitrotoluene, 2,4-	121-14-2	182.14	EPI Dermwin v2.0	2.20E-06	5.40E-08	EPI HenryWin v3.2
Dinitrotoluene, 2,6-	606-20-2	182.14	EPI Dermwin v2.0	3.10E-05	7.47E-07	EPI HenryWin v3.2
Dinitrotoluene, 2-Amino-4,6-	35572-78-2	197.15	EPI Dermwin v2.0	6.60E-09	1.62E-10	EPI HenryWin v3.2
Dinitrotoluene, 4-Amino-2,6-	19406-51-0	197.15	EPI Dermwin v2.0	6.60E-09	1.62E-10	EPI HenryWin v3.2
Dinoseb	88-85-7	240.22	EPI Dermwin v2.0	1.90E-05	4.56E-07	EPI HenryWin v3.2
Dioxane, 1,4-	123-91-1	88.11	EPI Dermwin v2.0	2.00E-04	4.80E-06	EPI HenryWin v3.2
Dioxins						
~Hexachlorodibenzo-p-dioxin, Mixture	NA	390.87	EPI	1.00E-03	0.0000256	EPI (HenryWin)
~TCDD, 2,3,7,8-	1746-01-6	321.98	EPI Dermwin v2.0	2.00E-03	0.00005	EPI HenryWin v3.2
Diphenamid	957-51-7	239.32	EPI Dermwin v2.0	1.50E-09	3.63E-11	EPI HenryWin v3.2
Diphenyl Sulfone	127-63-9	218.27	EPI Dermwin v2.0	1.00E-05	2.49E-07	EPI HenryWin v3.2
Diphenylamine	122-39-4	169.23	EPI Dermwin v2.0	1.10E-04	2.69E-06	EPI HenryWin v3.2
Diphenylhydrazine, 1,2-	122-66-7	184.24	EPI Dermwin v2.0	2.00E-05	4.78E-07	EPI HenryWin v3.2
Diquat	85-00-7	344.05	EPI Dermwin v2.0	5.80E-12	1.42E-13	EPI HenryWin v3.2
Direct Black 38	1937-37-7	737.77	EPI Dermwin v2.0	3.40E-38	8.23E-40	EPI HenryWin v3.2
Direct Blue 6	2602-46-2	821.67	EPI Dermwin v2.0	6.70E-42	1.64E-43	EPI HenryWin v3.2
Direct Brown 95	16071-86-6	760.11	EPI Dermwin v2.0			
Disulfoton	298-04-4	274.39	EPI Dermwin v2.0	8.80E-05	2.16E-06	EPI HenryWin v3.2
Dithiane, 1,4-	505-29-3	120.23	EPI Dermwin v2.0	1.70E-03	0.000042	EPI HenryWin v3.2
Diuron	330-54-1	233.1	EPI Dermwin v2.0	2.10E-08	5.04E-10	EPI HenryWin v3.2
Dodine	2439-10-3	287.45	EPI Dermwin v2.0	3.70E-09	9.01E-11	EPI HenryWin v3.2
EPTC	759-94-4	189.32	EPI Dermwin v2.0	6.50E-04	0.0000159	EPI HenryWin v3.2
Endosulfan	115-29-7	406.92	EPI Dermwin v2.0	2.70E-03	0.000065	EPI HenryWin v3.2
Endothall	145-73-3	186.17	EPI Dermwin v2.0	1.60E-14	3.85E-16	EPI HenryWin v3.2
Endrin	72-20-8	380.91	EPI Dermwin v2.0	4.10E-04	1.00E-05	EPI HenryWin v3.2
Epichlorohydrin	106-89-8	92.53	EPI Dermwin v2.0	1.20E-03	0.0000304	EPI HenryWin v3.2
Epoxybutane, 1,2-	106-88-7	72.11	EPI Dermwin v2.0	7.40E-03	0.00018	EPI HenryWin v3.2

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Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Ethephon	16672-87-0	144.5	EPI Dermwin v2.0	2.30E-10	5.70E-12	EPI HenryWin v3.2
Ethion	563-12-2	384.46	EPI Dermwin v2.0	1.50E-05	3.79E-07	EPI HenryWin v3.2
Ethoxyethanol Acetate, 2-	111-15-9	132.16	EPI Dermwin v2.0	1.30E-04	3.20E-06	EPI HenryWin v3.2
Ethoxyethanol, 2-	110-80-5	90.12	EPI Dermwin v2.0	1.90E-05	4.70E-07	EPI HenryWin v3.2
Ethyl Acetate	141-78-6	88.11	EPI Dermwin v2.0	5.50E-03	0.000134	EPI HenryWin v3.2
Ethyl Acrylate	140-88-5	100.12	EPI Dermwin v2.0	1.40E-02	0.000339	EPI HenryWin v3.2
Ethyl Chloride	75-00-3	64.52	EPI Dermwin v2.0	4.50E-01	0.0111	EPI HenryWin v3.2
Ethyl Ether	60-29-7	74.12	EPI Dermwin v2.0	5.00E-02	0.00123	EPI HenryWin v3.2
Ethyl Methacrylate	97-63-2	114.15	EPI Dermwin v2.0	2.30E-02	0.000573	EPI HenryWin v3.2
Ethyl-p-nitrophenyl Phosphonate	2104-64-5	323.31	EPI Dermwin v2.0	1.80E-05	4.44E-07	EPI HenryWin v3.2
Ethylbenzene	100-41-4	106.17	EPI Dermwin v2.0	3.20E-01	0.00788	EPI HenryWin v3.2
Ethylene Cyanohydrin	109-78-4	71.08	EPI Dermwin v2.0	3.10E-07	7.50E-09	EPI HenryWin v3.2
Ethylene Diamine	107-15-3	60.1	EPI Dermwin v2.0	7.10E-08	1.73E-09	EPI HenryWin v3.2
Ethylene Glycol	107-21-1	62.07	EPI Dermwin v2.0	2.50E-06	6.00E-08	EPI HenryWin v3.2
Ethylene Glycol Monobutyl Ethe	111-76-2	118.18	EPI Dermwin v2.0	6.50E-05	1.60E-06	EPI HenryWin v3.2
Ethylene Oxide	75-21-8	44.05	EPI Dermwin v2.0	6.10E-03	0.000148	EPI HenryWin v3.2
Ethylene Thiourea	96-45-7	102.15	EPI Dermwin v2.0	1.40E-05	3.36E-07	EPI HenryWin v3.2
Ethyleneimine	151-56-4	43.07	EPI Dermwin v2.0	4.90E-04	0.0000121	EPI HenryWin v3.2
Ethylphthalyl Ethyl Glycolate	84-72-0	280.28	EPI Dermwin v2.0	3.20E-08	7.73E-10	EPI HenryWin v3.2
Express	101200-48-0	395.39	EPI Dermwin v2.0	4.20E-12	1.02E-13	EPI HenryWin v3.2
Fenamiphos	22224-92-6	303.36	EPI Dermwin v2.0	4.90E-08	1.21E-09	EPI HenryWin v3.2
Fenpropathrin	39515-41-8	349.43	EPI Dermwin v2.0	3.10E-04	7.64E-06	EPI HenryWin v3.2
Fluometuron	2164-17-2	232.21	EPI Dermwin v2.0	1.10E-07	2.61E-09	EPI HenryWin v3.2
Fluoride	16984-48-8	38	EPI Dermwin v2.0			
Fluorine (Soluble Fluoride)	7782-41-4	38	EPI Dermwin v2.0			
Fluridone	59756-60-4	329.32	EPI Dermwin v2.0	3.30E-07	8.10E-09	EPI HenryWin v3.2
Flurprimidol	56425-91-3	312.29	EPI Dermwin v2.0	5.40E-08	1.31E-09	EPI HenryWin v3.2
Flutolanil	66332-96-5	323.32	EPI Dermwin v2.0	1.30E-07	3.18E-09	EPI HenryWin v3.2
Fluvalinate	69409-94-5	502.92	EPI Dermwin v2.0	5.90E-07	1.45E-08	EPI HenryWin v3.2
Folpet	133-07-3	296.56	EPI Dermwin v2.0	3.10E-06	7.66E-08	EPI HenryWin v3.2
Fomesafen	72178-02-0	438.76	EPI Dermwin v2.0	3.10E-11	7.53E-13	EPI HenryWin v3.2
Fonofos	944-22-9	246.32	EPI Dermwin v2.0	2.90E-04	6.98E-06	EPI HenryWin v3.2
Formaldehyde	50-00-0	30.03	EPI Dermwin v2.0	1.40E-05	3.37E-07	EPI HenryWin v3.2
Formic Acid	64-18-6	46.03	EPI Dermwin v2.0	6.80E-06	1.67E-07	EPI HenryWin v3.2
Fosetyl-AL	39148-24-8	354.11	EPI Dermwin v2.0			
Furans						

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
~Dibenzofuran	132-64-9	168.2	EPI Dermwin v2.0	8.70E-03	0.000213	EPI HenryWin v3.2
~Furan	110-00-9	68.08	EPI Dermwin v2.0	2.20E-01	0.0054	EPI HenryWin v3.2
Furazolidone	67-45-8	225.16	EPI Dermwin v2.0	1.30E-09	3.26E-11	EPI HenryWin v3.2
Furfural	98-01-1	96.09	EPI Dermwin v2.0	1.50E-04	3.77E-06	EPI HenryWin v3.2
Furium	531-82-8	253.23	EPI Dermwin v2.0	5.40E-14	1.33E-15	EPI HenryWin v3.2
Furmecyclox	60568-05-0	251.33	EPI Dermwin v2.0	2.80E-07	6.89E-09	EPI HenryWin v3.2
Glufosinate, Ammonium	77182-82-2	198.16	EPI Dermwin v2.0	1.00E-22	2.53E-24	EPI HenryWin v3.2
Glutaraldehyde	111-30-8	100.12	EPI Dermwin v2.0	9.80E-07	2.39E-08	EPI HenryWin v3.2
Glycidyl	765-34-4	72.06	EPI Dermwin v2.0	3.20E-05	7.84E-07	EPI HenryWin v3.2
Glyphosate	1071-83-6	169.07	EPI Dermwin v2.0	8.60E-11	2.10E-12	EPI HenryWin v3.2
Goal	42874-03-3	361.71	EPI Dermwin v2.0	3.40E-05	8.20E-07	EPI HenryWin v3.2
Guthion	86-50-0	317.32	EPI Dermwin v2.0	9.80E-07	2.39E-08	EPI HenryWin v3.2
Haloxyfop, Methyl	69806-40-2	375.73	EPI Dermwin v2.0	1.30E-05	3.19E-07	EPI HenryWin v3.2
Harmony	79277-27-3	387.39	EPI Dermwin v2.0	1.70E-12	4.08E-14	EPI HenryWin v3.2
Heptachlor	76-44-8	373.32	EPI Dermwin v2.0	1.20E-02	0.000294	EPI HenryWin v3.2
Heptachlor Epoxide	1024-57-3	389.32	EPI Dermwin v2.0	8.60E-04	0.000021	EPI HenryWin v3.2
Hexabromobenzene	87-82-1	551.49	EPI Dermwin v2.0	1.10E-03	0.0000281	EPI HenryWin v3.2
Hexabromodiphenyl ether, 2,2',4,4',5,5'- (BDE-153)	68631-49-2					
Hexachlorobenzene	118-74-1	284.78	EPI Dermwin v2.0	7.00E-02	0.0017	EPI HenryWin v3.2
Hexachlorobutadiene	87-68-3	260.76	EPI Dermwin v2.0	4.20E-01	0.0103	EPI HenryWin v3.2
Hexachlorocyclohexane, Alpha	319-84-6	290.83	EPI Dermwin v2.0	2.10E-04	5.14E-06	EPI HenryWin v3.2
Hexachlorocyclohexane, Beta-	319-85-7	290.83	EPI Dermwin v2.0	2.10E-04	5.14E-06	EPI HenryWin v3.2
Hexachlorocyclohexane, Gamma- (Lindane)	58-89-9	290.83	EPI Dermwin v2.0	2.10E-04	5.14E-06	EPI HenryWin v3.2
Hexachlorocyclohexane, Technica	608-73-1	290.83	EPI Dermwin v2.0	2.10E-04	5.14E-06	EPI HenryWin v3.2
Hexachlorocyclopentadiene	77-47-4	272.77	EPI Dermwin v2.0	1.10E+00	0.027	EPI HenryWin v3.2
Hexachloroethane	67-72-1	236.74	EPI Dermwin v2.0	1.60E-01	0.00389	EPI HenryWin v3.2
Hexachlorophene	70-30-4	406.91	EPI Dermwin v2.0	2.20E-11	5.48E-13	EPI HenryWin v3.2
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	222.12	EPI Dermwin v2.0	8.20E-10	2.01E-11	EPI HenryWin v3.2
Hexamethylene Diisocyanate, 1,6-	822-06-0	168.2	EPI Dermwin v2.0	2.00E-03	0.000048	EPI HenryWin v3.2
Hexane, N-	110-54-3	86.18	EPI Dermwin v2.0	7.40E+01	1.8	EPI HenryWin v3.2
Hexanedioic Acid	124-04-9	146.14	EPI Dermwin v2.0	1.90E-10	4.71E-12	EPI HenryWin v3.2
Hexanone, 2-	591-78-6	100.16	EPI Dermwin v2.0	3.80E-03	0.0000932	EPI HenryWin v3.2
Hexazinone	51235-04-2	252.32	EPI Dermwin v2.0	9.20E-11	2.26E-12	EPI HenryWin v3.2
Hydrazine	302-01-2	32.05	EPI Dermwin v2.0			
Hydrazine Sulfate	10034-93-2	128.1	EPI Dermwin v2.0			
Hydrogen Chloride	7647-01-0	35.45	EPI Dermwin v2.0			

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Hydrogen Fluoride	7664-39-3	20.01	EPI Dermwin v2.0			
Hydrogen Sulfide	7783-06-4	34.08	EPI Dermwin v2.0			
Hydroquinone	123-31-9	110.11	EPI Dermwin v2.0	1.90E-09	4.73E-11	EPI HenryWin v3.2
Imazalil	35554-44-0	297.19	EPI Dermwin v2.0	1.10E-07	2.59E-09	EPI HenryWin v3.2
Imazaquin	81335-37-7	311.34	EPI Dermwin v2.0	2.80E-16	6.91E-18	EPI HenryWin v3.2
Iodine	7553-56-2	253.81	EPI Dermwin v2.0			
Iprodione	36734-19-7	330.17	EPI Dermwin v2.0	1.30E-07	3.12E-09	EPI HenryWin v3.2
Iron	7439-89-6	55.85	EPI Dermwin v2.0			
Isobutyl Alcoho	78-83-1	74.12	EPI Dermwin v2.0	4.00E-04	9.78E-06	EPI HenryWin v3.2
Isophorone	78-59-1	138.21	EPI Dermwin v2.0	2.70E-04	6.64E-06	EPI HenryWin v3.2
Isopropalin	33820-53-0	309.37	EPI Dermwin v2.0	4.50E-03	0.000111	EPI HenryWin v3.2
Isopropanol	67-63-0	60.1	EPI Dermwin v2.0	3.30E-04	8.10E-06	EPI HenryWin v3.2
Isopropyl Methyl Phosphonic Acid	1832-54-8	138.1	EPI Dermwin v2.0	2.80E-07	6.88E-09	EPI HenryWin v3.2
Isoxaben	82558-50-7	332.4	EPI Dermwin v2.0	5.20E-08	1.27E-09	EPI HenryWin v3.2
JP-7	NA					
Kerb	23950-58-5	256.13	EPI Dermwin v2.0	4.00E-07	9.77E-09	EPI HenryWin v3.2
Lactofen	77501-63-4	461.78	EPI Dermwin v2.0	1.90E-05	4.72E-07	EPI HenryWin v3.2
Lead Compounds						
~Lead acetate	301-04-2	325.29	EPI Dermwin v2.0			
~Lead and Compounds	7439-92-1	207.2	EPI Dermwin v2.0			
~Lead subacetate	1335-32-6	805.7	EPI Dermwin v2.0			
~Tetraethyl Lead	78-00-2	323.45	EPI Dermwin v2.0	2.30E+01	0.568	EPI HenryWin v3.2
Linuron	330-55-2	249.1	EPI Dermwin v2.0	2.60E-07	6.25E-09	EPI HenryWin v3.2
Lithium	7439-93-2	6.94	EPI Dermwin v2.0			
Lithium Perchlorate	7791-03-9	106.39	EPI			
Londax	83055-99-6	410.4	EPI Dermwin v2.0	1.50E-13	3.78E-15	EPI HenryWin v3.2
MCPA	94-74-6	200.62	EPI Dermwin v2.0	5.40E-08	1.33E-09	EPI HenryWin v3.2
MCPB	94-81-5	228.68	EPI Dermwin v2.0	1.10E-07	2.71E-09	EPI HenryWin v3.2
MCPP	93-65-2	214.65	EPI Dermwin v2.0	3.70E-08	8.96E-10	EPI HenryWin v3.2
Malathion	121-75-5	330.35	EPI Dermwin v2.0	2.00E-07	4.89E-09	EPI HenryWin v3.2
Maleic Anhydride	108-31-6	98.06	EPI Dermwin v2.0	1.60E-04	3.93E-06	EPI HenryWin v3.2
Maleic Hydrazide	123-33-1	112.09	EPI Dermwin v2.0	1.10E-09	2.65E-11	EPI HenryWin v3.2
Malononitrile	109-77-3	66.06	EPI Dermwin v2.0	5.40E-06	1.31E-07	EPI HenryWin v3.2
Mancozeb	8018-01-7	212.36	EPI Dermwin v2.0	2.30E-05	5.64E-07	EPI HenryWin v3.2
Maneb	12427-38-2	212.36	EPI Dermwin v2.0	2.30E-05	5.64E-07	EPI HenryWin v3.2
Manganese (Diet)	7439-96-5	54.94	EPI Dermwin v2.0			

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Manganese (Water)	7439-96-5	54.94	EPI Dermwin v2.0			
Mephosfolan	950-10-7	269.32	EPI Dermwin v2.0	4.90E-09	1.19E-10	EPI HenryWin v3.2
Mepiquat Chloride	24307-26-4	149.67	EPI Dermwin v2.0	1.80E-10	4.31E-12	EPI HenryWin v3.2
Mercury Compounds						
~Mercuric Chloride	7487-94-7	271.5	EPI Dermwin v2.0			
~Mercuric Sulfide	1344-48-5	232.65	EPI Dermwin v2.0			
~Mercury (elemental)	7439-97-6	200.59	EPI Dermwin v2.0	4.70E-01	0.0114	SSL
~Mercury, Inorganic Salts	NA	200.59	MW Other			
~Methyl Mercury	22967-92-6	215.63	EPI Dermwin v2.0			
~Phenylmercuric Acetate	62-38-4	336.74	EPI Dermwin v2.0	2.30E-08	5.66E-10	EPI HenryWin v3.2
Merphos	150-50-5	298.5	EPI Dermwin v2.0	9.30E-04	0.0000227	EPI HenryWin v3.2
Merphos Oxide	78-48-8	314.5	EPI Dermwin v2.0	1.20E-05	2.94E-07	EPI HenryWin v3.2
Metalaxyl	57837-19-1	279.34	EPI Dermwin v2.0	1.20E-07	2.95E-09	EPI HenryWin v3.2
Methacrylonitrile	126-98-7	67.09	EPI Dermwin v2.0	1.00E-02	0.000247	EPI HenryWin v3.2
Methamidophos	10265-92-6	141.13	EPI Dermwin v2.0	3.50E-08	8.68E-10	EPI HenryWin v3.2
Methanol	67-56-1	32.04	EPI Dermwin v2.0	1.90E-04	4.55E-06	EPI HenryWin v3.2
Methidathion	950-37-8	302.32	EPI Dermwin v2.0	2.90E-07	7.17E-09	EPI HenryWin v3.2
Methomyl	16752-77-5	162.21	EPI Dermwin v2.0	8.10E-10	1.97E-11	EPI HenryWin v3.2
Methoxy-5-nitroaniline, 2-	99-59-2	168.15	EPI Dermwin v2.0	6.00E-07	1.47E-08	EPI HenryWin v3.2
Methoxychlor	72-43-5	345.66	EPI Dermwin v2.0	8.30E-06	2.03E-07	EPI HenryWin v3.2
Methoxyethanol Acetate, 2-	110-49-6	118.13	EPI Dermwin v2.0	1.30E-05	3.11E-07	EPI HenryWin v3.2
Methoxyethanol, 2-	109-86-4	76.1	EPI Dermwin v2.0	1.30E-05	3.30E-07	EPI HenryWin v3.2
Methyl Acetate	79-20-9	74.08	EPI Dermwin v2.0	4.70E-03	0.000115	EPI HenryWin v3.2
Methyl Acrylate	96-33-3	86.09	EPI Dermwin v2.0	8.10E-03	0.000199	EPI HenryWin v3.2
Methyl Ethyl Ketone (2-Butanone)	78-93-3	72.11	EPI Dermwin v2.0	2.30E-03	0.0000569	EPI HenryWin v3.2
Methyl Isobutyl Ketone (4-methyl-2-pentanone)	108-10-1	100.16	EPI Dermwin v2.0	5.60E-03	0.000138	EPI HenryWin v3.2
Methyl Isocyanate	624-83-9	57.05	EPI Dermwin v2.0	3.80E-02	0.000926	EPI HenryWin v3.2
Methyl Methacrylate	80-62-6	100.12	EPI Dermwin v2.0	1.30E-02	0.000319	EPI HenryWin v3.2
Methyl Parathion	298-00-0	263.21	EPI Dermwin v2.0	4.10E-06	1.00E-07	EPI HenryWin v3.2
Methyl Phosphonic Acid	993-13-5	96.02	EPI Dermwin v2.0	5.00E-10	1.22E-11	EPI HenryWin v3.2
Methyl Styrene (Mixed Isomers)	25013-15-4	118.18	EPI Dermwin v2.0	1.00E-01	0.00255	EPI HenryWin v3.2
Methyl methanesulfonate	66-27-3	110.13	EPI Dermwin v2.0	1.60E-04	4.03E-06	EPI HenryWin v3.2
Methyl tert-Butyl Ether (MTBE	1634-04-4	88.15	EPI Dermwin v2.0	2.40E-02	0.000587	EPI HenryWin v3.2
Methyl-5-Nitroaniline, 2-	99-55-8	152.15	EPI Dermwin v2.0	7.90E-07	1.94E-08	EPI HenryWin v3.2
Methyl-N-nitro-N-nitrosoguanidine, N-	70-25-7	147.09	EPI Dermwin v2.0	5.00E-11	1.22E-12	EPI HenryWin v3.2
Methylaniline Hydrochloride, 2	636-21-5	107.16	EPI Dermwin v2.0	8.10E-05	1.98E-06	EPI HenryWin v3.2

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Methylarsonic acid	124-58-3	139.97	EPI Dermwin v2.0			
Methylcholanthrene, 3-	56-49-5	268.36	EPI Dermwin v2.0	2.10E-04	5.24E-06	EPI HenryWin v3.2
Methylene Chloride	75-09-2	84.93	EPI Dermwin v2.0	1.30E-01	0.00325	EPI HenryWin v3.2
Methylene-bis(2-chloroaniline), 4,4'-	101-14-4	267.16	EPI Dermwin v2.0	4.70E-10	1.14E-11	EPI HenryWin v3.2
Methylene-bis(N,N-dimethyl) Aniline, 4,4'-	101-61-1	254.38	EPI Dermwin v2.0	4.90E-06	1.21E-07	EPI HenryWin v3.2
Methylenebisbenzenamine, 4,4'-	101-77-9	198.27	EPI Dermwin v2.0	6.50E-10	1.58E-11	EPI HenryWin v3.2
Methylenediphenyl Diisocyanate	101-68-8	250.26	EPI Dermwin v2.0	3.70E-05	8.95E-07	EPI HenryWin v3.2
Methylstyrene, Alpha-	98-83-9	118.18	EPI Dermwin v2.0	1.00E-01	0.00255	EPI HenryWin v3.2
Metolachlor	51218-45-2	283.8	EPI Dermwin v2.0	3.70E-07	9.00E-09	EPI HenryWin v3.2
Metribuzin	21087-64-9	214.29	EPI Dermwin v2.0	4.80E-09	1.17E-10	EPI HenryWin v3.2
Mineral oils	8012-95-1	170.34	EPI Dermwin v2.0	3.30E+02	8.18	EPI HenryWin v3.2
Mirex	2385-85-5	545.55	EPI Dermwin v2.0	3.30E-02	0.000811	EPI HenryWin v3.2
Molinate	2212-67-1	187.3	EPI Dermwin v2.0	1.70E-04	4.10E-06	EPI HenryWin v3.2
Molybdenum	7439-98-7	95.94	EPI Dermwin v2.0			
Monochloramine	10599-90-3	51.48	EPI Dermwin v2.0			
Monomethylaniline	100-61-8	107.16	EPI Dermwin v2.0	3.60E-04	8.88E-06	EPI HenryWin v3.2
N,N'-Diphenyl-1,4-benzenediamine	74-31-7	260.34	EPI Dermwin v2.0	8.40E-09	2.05E-10	EPI HenryWin v3.2
Naled	300-76-5	380.79	EPI Dermwin v2.0	2.70E-03	0.0000651	EPI HenryWin v3.2
Naphtha, High Flash Aromatic (HFAN)	64724-95-6					
Naphthylamine, 2-	91-59-8	143.19	EPI Dermwin v2.0	3.30E-06	8.10E-08	EPI HenryWin v3.2
Napropamide	15299-99-7	271.36	EPI Dermwin v2.0	3.40E-08	8.41E-10	EPI HenryWin v3.2
Nickel Carbonyl	13463-39-3	170.73	EPI			
Nickel Oxide	1313-99-1	74.69	EPI Dermwin v2.0			
Nickel Refinery Dust	NA					
Nickel Soluble Salts	7440-02-0	58.69	EPI Dermwin v2.0			
Nickel Subsulfide	12035-72-2	240.21	EPI			
Nitrate	14797-55-8	62	EPI Dermwin v2.0			
Nitrite	14797-65-0	47.01	EPI Dermwin v2.0			
Nitroaniline, 2-	88-74-4	138.13	EPI Dermwin v2.0	2.40E-06	5.90E-08	EPI HenryWin v3.2
Nitroaniline, 4-	100-01-6	138.13	EPI Dermwin v2.0	5.20E-08	1.26E-09	EPI HenryWin v3.2
Nitrobenzene	98-95-3	123.11	EPI Dermwin v2.0	9.80E-04	0.000024	EPI HenryWin v3.2
Nitrocellulose	9004-70-0	387.3	EPI Dermwin v2.0	1.30E-21	3.29E-23	EPI HenryWin v3.2
Nitrofurantoin	67-20-9	238.16	EPI Dermwin v2.0	5.40E-11	1.33E-12	EPI HenryWin v3.2
Nitrofurazone	59-87-0	198.14	EPI Dermwin v2.0	1.30E-11	3.10E-13	EPI HenryWin v3.2
Nitroglycerin	55-63-0	227.09	EPI Dermwin v2.0	3.50E-06	8.66E-08	EPI HenryWin v3.2
Nitroguanidine	556-88-7	104.07	EPI Dermwin v2.0	1.80E-10	4.49E-12	EPI HenryWin v3.2

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Nitromethane	75-52-5	61.04	EPI Dermwin v2.0	1.20E-03	0.0000286	EPI HenryWin v3.2
Nitropropane, 2-	79-46-9	89.09	EPI Dermwin v2.0	4.90E-03	0.000119	EPI HenryWin v3.2
Nitroso-N-ethylurea, N-	759-73-9	117.11	EPI Dermwin v2.0	5.40E-09	1.32E-10	EPI HenryWin v3.2
Nitroso-N-methylurea, N-	684-93-5	103.08	EPI Dermwin v2.0	4.10E-09	9.91E-11	EPI HenryWin v3.2
Nitroso-di-N-butylamine, N-	924-16-3	158.25	EPI Dermwin v2.0	5.40E-04	0.0000132	EPI HenryWin v3.2
Nitroso-di-N-propylamine, N-	621-64-7	130.19	EPI Dermwin v2.0	2.20E-04	5.38E-06	EPI HenryWin v3.2
Nitrosodiethanolamine, N-	1116-54-7	134.14	EPI Dermwin v2.0	9.30E-15	2.28E-16	EPI HenryWin v3.2
Nitrosodiethylamine, N-	55-18-5	102.14	EPI Dermwin v2.0	1.50E-04	3.63E-06	EPI HenryWin v3.2
Nitrosodimethylamine, N-	62-75-9	74.08	EPI Dermwin v2.0	7.40E-05	1.82E-06	EPI HenryWin v3.2
Nitrosodiphenylamine, N-	86-30-6	198.23	EPI Dermwin v2.0	4.90E-05	1.21E-06	EPI HenryWin v3.2
Nitrosomethylethylamine, N-	10595-95-6	88.11	EPI Dermwin v2.0	5.90E-05	1.44E-06	EPI HenryWin v3.2
Nitrosomorpholine [N-]	59-89-2	116.12	EPI Dermwin v2.0	1.00E-06	2.45E-08	EPI HenryWin v3.2
Nitrosopiperidine [N-]	100-75-4	114.15	EPI Dermwin v2.0	3.50E-05	8.44E-07	EPI HenryWin v3.2
Nitrosopyrrolidine, N-	930-55-2	100.12	EPI Dermwin v2.0	2.00E-06	4.89E-08	EPI HenryWin v3.2
Nitrotoluene, m-	99-08-1	137.14	EPI Dermwin v2.0	3.80E-04	9.30E-06	EPI HenryWin v3.2
Nitrotoluene, o-	88-72-2	137.14	EPI Dermwin v2.0	5.10E-04	0.0000125	EPI HenryWin v3.2
Nitrotoluene, p-	99-99-0	137.14	EPI Dermwin v2.0	2.30E-04	5.63E-06	EPI HenryWin v3.2
Nonane, n-	111-84-2	128.26	EPI Dermwin v2.0	1.40E+02	3.4	EPI HenryWin v3.2
Norflurazon	27314-13-2	303.67	EPI Dermwin v2.0	1.40E-08	3.43E-10	EPI HenryWin v3.2
Nustar	85509-19-9	315.4	EPI Dermwin v2.0	2.10E-05	5.06E-07	EPI HenryWin v3.2
Octabromodiphenyl Ether	32536-52-0	801.38	EPI Dermwin v2.0	1.00E-05	2.56E-07	EPI HenryWin v3.2
Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetra (HMX)	2691-41-0	296.16	EPI Dermwin v2.0	3.50E-08	8.67E-10	EPI HenryWin v3.2
Octamethylpyrophosphoramide	152-16-9	286.25	EPI Dermwin v2.0	2.60E-15	6.31E-17	EPI HenryWin v3.2
Oryzalin	19044-88-3	346.36	EPI Dermwin v2.0	7.80E-08	1.91E-09	EPI HenryWin v3.2
Oxadiazon	19666-30-9	345.23	EPI Dermwin v2.0	3.00E-06	7.27E-08	EPI HenryWin v3.2
Oxamyl	23135-22-0	219.26	EPI Dermwin v2.0	9.70E-09	2.37E-10	EPI HenryWin v3.2
Paclobutrazol	76738-62-0	293.8	EPI Dermwin v2.0	3.40E-09	8.28E-11	EPI HenryWin v3.2
Paraquat Dichloride	1910-42-5	257.16	EPI Dermwin v2.0	1.30E-11	3.22E-13	EPI HenryWin v3.2
Parathion	56-38-2	291.26	EPI Dermwin v2.0	1.20E-05	2.98E-07	EPI HenryWin v3.2
Pebulate	1114-71-2	203.35	EPI Dermwin v2.0	9.70E-03	0.000237	EPI HenryWin v3.2
Pendimethalin	40487-42-1	281.31	EPI Dermwin v2.0	3.50E-05	8.56E-07	EPI HenryWin v3.2
Pentabromodiphenyl Ether	32534-81-9	564.69	EPI Dermwin v2.0	1.40E-04	3.54E-06	EPI HenryWin v3.2
Pentabromodiphenyl ether, 2,2',4,4',5- (BDE-99)	60348-60-9	564.69	EPI Dermwin v2.0	1.40E-04	3.54E-06	EPI HenryWin v3.2
Pentachlorobenzene	608-93-5	250.34	EPI Dermwin v2.0	2.90E-02	0.000703	EPI HenryWin v3.2
Pentachloroethane	76-01-7	202.3	EPI Dermwin v2.0	7.90E-02	0.00194	EPI HenryWin v3.2
Pentachloronitrobenzene	82-68-8	295.34	EPI Dermwin v2.0	1.80E-03	0.0000442	EPI HenryWin v3.2

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Pentachlorophenol	87-86-5	266.34	EPI Dermwin v2.0	1.00E-06	2.45E-08	EPI HenryWin v3.2
Pentane, n-	109-66-0	72.15	EPI Dermwin v2.0	5.10E+01	1.25	EPI HenryWin v3.2
Perchlorate and Perchlorate Salts	14797-73-0	117.49	EPI			
Permethrin	52645-53-1	391.3	EPI Dermwin v2.0	7.60E-05	1.87E-06	EPI HenryWin v3.2
Phenacetin	62-44-2	179.22	EPI Dermwin v2.0	8.70E-09	2.13E-10	EPI HenryWin v3.2
Phenmedipham	13684-63-4	300.32	EPI Dermwin v2.0	3.40E-11	8.41E-13	EPI HenryWin v3.2
Phenol	108-95-2	94.11	EPI Dermwin v2.0	1.40E-05	3.33E-07	EPI HenryWin v3.2
Phenylenediamine, m-	108-45-2	108.14	EPI Dermwin v2.0	5.10E-08	1.25E-09	EPI HenryWin v3.2
Phenylenediamine, o-	95-54-5	108.14	EPI Dermwin v2.0	2.90E-07	7.20E-09	EPI HenryWin v3.2
Phenylenediamine, p-	106-50-3	108.14	EPI Dermwin v2.0	3.60E-08	8.88E-10	EPI HenryWin v3.2
Phenylphenol, 2-	90-43-7	170.21	EPI Dermwin v2.0	4.30E-05	1.05E-06	EPI HenryWin v3.2
Phorate	298-02-2	260.37	EPI Dermwin v2.0	1.80E-04	4.37E-06	EPI HenryWin v3.2
Phosgene	75-44-5	98.92	EPI Dermwin v2.0	6.80E-01	0.0167	EPI HenryWin v3.2
Phosmet	732-11-6	317.32	EPI Dermwin v2.0	3.40E-07	8.38E-09	EPI HenryWin v3.2
Phosphine	7803-51-2	34	EPI Dermwin v2.0			
Phosphoric Acid	7664-38-2	98	EPI Dermwin v2.0			
Phosphorus, White	7723-14-0	34	EPI Dermwin v2.0			
Phthalic Acid, P-	100-21-0	166.13	EPI Dermwin v2.0	1.60E-11	3.88E-13	EPI HenryWin v3.2
Phthalic Anhydride	85-44-9	148.12	EPI Dermwin v2.0	6.70E-07	1.63E-08	EPI HenryWin v3.2
Picloram	1918-02-1	241.46	EPI Dermwin v2.0	2.20E-12	5.33E-14	EPI HenryWin v3.2
Picramic Acid (2-Amino-4,6-dinitrophenol	96-91-3	199.12	EPI Dermwin v2.0	7.60E-13	1.86E-14	EPI HenryWin v3.2
Pirimiphos, Methyl	29232-93-7	305.33	EPI Dermwin v2.0	2.90E-05	7.01E-07	EPI HenryWin v3.2
Polybrominated Biphenyls	59536-65-1		EPI			EPI (HenryWin)
Polychlorinated Biphenyls (PCBs						
~Aroclor 1016	12674-11-2	257.55	EPI Dermwin v2.0	8.20E-03	0.0002	EPI HenryWin v3.2
~Aroclor 1221	11104-28-2	188.66	EPI Dermwin v2.0	3.00E-02	0.000736	EPI HenryWin v3.2
~Aroclor 1232	11141-16-5	188.66	EPI Dermwin v2.0	3.00E-02	0.000736	EPI HenryWin v3.2
~Aroclor 1242	53469-21-9	291.99	EPI Dermwin v2.0	7.80E-03	0.00019	EPI HenryWin v3.2
~Aroclor 1248	12672-29-6	291.99	EPI Dermwin v2.0	1.80E-02	0.00044	EPI HenryWin v3.2
~Aroclor 1254	11097-69-1	326.44	EPI Dermwin v2.0	1.20E-02	0.000283	EPI HenryWin v3.2
~Aroclor 1260	11096-82-5	395.33	EPI Dermwin v2.0	1.40E-02	0.000336	EPI HenryWin v3.2
~Heptachlorobiphenyl, 2,3,3',4,4',5,5'- (PCB 189)	39635-31-9	395.33	EPI Dermwin v2.0	5.60E-03	0.000138	EPI HenryWin v3.2
~Hexachlorobiphenyl, 2,3',4,4',5,5'- (PCB 167)	52663-72-6	360.88	EPI Dermwin v2.0	6.60E-03	0.000162	EPI HenryWin v3.2
~Hexachlorobiphenyl, 2,3,3',4,4',5'- (PCB 157)	69782-90-7	360.88	EPI Dermwin v2.0	6.60E-03	0.000162	EPI HenryWin v3.2
~Hexachlorobiphenyl, 2,3,3',4,4',5- (PCB 156)	38380-08-4	360.88	EPI Dermwin v2.0	5.80E-03	0.000143	EPI HenryWin v3.2
~Hexachlorobiphenyl, 3,3',4,4',5,5'- (PCB 169)	32774-16-6	360.88	EPI Dermwin v2.0	6.60E-03	0.000162	EPI HenryWin v3.2

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
~Pentachlorobiphenyl, 2',3,4,4',5- (PCB 123)	65510-44-3	326.44	EPI Dermwin v2.0	7.80E-03	0.00019	EPI HenryWin v3.2
~Pentachlorobiphenyl, 2,3',4,4',5- (PCB 118)	31508-00-6	326.44	EPI Dermwin v2.0	1.20E-02	0.000288	EPI HenryWin v3.2
~Pentachlorobiphenyl, 2,3,3',4,4'- (PCB 105)	32598-14-4	326.44	EPI Dermwin v2.0	1.20E-02	0.000283	EPI HenryWin v3.2
~Pentachlorobiphenyl, 2,3,4,4',5- (PCB 114)	74472-37-0	326.44	EPI Dermwin v2.0	7.80E-03	0.00019	EPI HenryWin v3.2
~Pentachlorobiphenyl, 3,3',4,4',5- (PCB 126)	57465-28-8	326.44	EPI Dermwin v2.0	7.80E-03	0.00019	EPI HenryWin v3.2
~Polychlorinated Biphenyls (high risk	1336-36-3	291.99	EPI Dermwin v2.0	7.80E-03	0.00019	EPI HenryWin v3.2
~Polychlorinated Biphenyls (low risk)	1336-36-3	291.99	EPI Dermwin v2.0	7.80E-03	0.00019	EPI HenryWin v3.2
~Polychlorinated Biphenyls (lowest risk)	1336-36-3	291.99	EPI Dermwin v2.0	7.80E-03	0.00019	EPI HenryWin v3.2
~Tetrachlorobiphenyl, 3,3',4,4'- (PCB 77)	32598-13-3	291.99	EPI Dermwin v2.0	3.80E-04	9.40E-06	EPI HenryWin v3.2
~Tetrachlorobiphenyl, 3,4,4',5- (PCB 81)	70362-50-4	291.99	EPI Dermwin v2.0	9.10E-03	0.000223	EPI HenryWin v3.2
Polymeric Methylene Diphenyl Diisocyanate (PMDI)	9016-87-9	512.53	EPI Dermwin v2.0	5.40E-10	1.32E-11	EPI HenryWin v3.2
Polynuclear Aromatic Hydrocarbons (PAHs)						
~Acenaphthene	83-32-9	154.21	EPI Dermwin v2.0	7.50E-03	0.000184	EPI HenryWin v3.2
~Anthracene	120-12-7	178.24	EPI Dermwin v2.0	2.30E-03	0.0000556	EPI HenryWin v3.2
~Benz[a]anthracene	56-55-3	228.3	EPI Dermwin v2.0	4.90E-04	0.000012	EPI HenryWin v3.2
~Benzo(j)fluoranthene	205-82-3	252.32	EPI Dermwin v2.0	8.30E-06	2.03E-07	EPI HenryWin v3.2
~Benzo[a]pyrene	50-32-8	252.32	EPI Dermwin v2.0	1.90E-05	4.57E-07	EPI HenryWin v3.2
~Benzo[b]fluoranthene	205-99-2	252.32	EPI Dermwin v2.0	2.70E-05	6.57E-07	EPI HenryWin v3.2
~Benzo[k]fluoranthene	207-08-9	252.32	EPI Dermwin v2.0	2.40E-05	5.84E-07	EPI HenryWin v3.2
~Chrysene	218-01-9	228.3	EPI Dermwin v2.0	2.10E-04	5.23E-06	EPI HenryWin v3.2
~Dibenz[a,h]anthracene	53-70-3	278.36	EPI Dermwin v2.0	5.80E-06	1.41E-07	EPI HenryWin v3.2
~Dibenzo(a,e)pyrene	192-65-4	302.38	EPI Dermwin v2.0	5.80E-07	1.41E-08	EPI HenryWin v3.2
~Dimethylbenz(a)anthracene, 7,12-	57-97-6	256.35	EPI Dermwin v2.0	1.50E-04	3.76E-06	EPI HenryWin v3.2
~Fluoranthene	206-44-0	202.26	EPI Dermwin v2.0	3.60E-04	8.86E-06	EPI HenryWin v3.2
~Fluorene	86-73-7	166.22	EPI Dermwin v2.0	3.90E-03	0.0000962	EPI HenryWin v3.2
~Indeno[1,2,3-cd]pyrene	193-39-5	276.34	EPI Dermwin v2.0	1.40E-05	3.48E-07	EPI HenryWin v3.2
~Methylnaphthalene, 1-	90-12-0	142.2	EPI Dermwin v2.0	2.10E-02	0.000514	EPI HenryWin v3.2
~Methylnaphthalene, 2-	91-57-6	142.2	EPI Dermwin v2.0	2.10E-02	0.000518	EPI HenryWin v3.2
~Naphthalene	91-20-3	128.18	EPI Dermwin v2.0	1.80E-02	0.00044	EPI HenryWin v3.2
~Nitropyrene, 4-	57835-92-4	247.26	EPI Dermwin v2.0	1.00E-06	2.45E-08	EPI HenryWin v3.2
~Pyrene	129-00-0	202.26	EPI Dermwin v2.0	4.90E-04	0.0000119	EPI HenryWin v3.2
Potassium Perchlorate	7778-74-7	138.55	EPI Dermwin v2.0			
Prochloraz	67747-09-5	376.67	EPI Dermwin v2.0	6.70E-07	1.64E-08	EPI HenryWin v3.2
Profluralin	26399-36-0	347.3	EPI Dermwin v2.0	1.20E-02	0.00029	EPI HenryWin v3.2
Prometon	1610-18-0	225.3	EPI Dermwin v2.0	3.70E-08	9.09E-10	EPI HenryWin v3.2
Prometryn	7287-19-6	241.36	EPI Dermwin v2.0	4.90E-07	1.19E-08	EPI HenryWin v3.2

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Propachlor	1918-16-7	211.69	EPI Dermwin v2.0	1.50E-05	3.60E-07	EPI HenryWin v3.2
Propanil	709-98-8	218.08	EPI Dermwin v2.0	7.00E-08	1.71E-09	EPI HenryWin v3.2
Propargite	2312-35-8	350.48	EPI Dermwin v2.0	2.60E-05	6.40E-07	EPI HenryWin v3.2
Propargyl Alcohol	107-19-7	56.06	EPI Dermwin v2.0	4.70E-05	1.15E-06	EPI HenryWin v3.2
Propazine	139-40-2	229.71	EPI Dermwin v2.0	1.90E-07	4.60E-09	EPI HenryWin v3.2
Propham	122-42-9	179.22	EPI Dermwin v2.0	7.50E-06	1.84E-07	EPI HenryWin v3.2
Propiconazole	60207-90-1	342.23	EPI Dermwin v2.0	7.00E-08	1.72E-09	EPI HenryWin v3.2
Propionaldehyde	123-38-6	58.08	EPI Dermwin v2.0	3.00E-03	0.0000734	EPI HenryWin v3.2
Propyl benzene	103-65-1	120.2	EPI Dermwin v2.0	4.30E-01	0.0105	EPI HenryWin v3.2
Propylene	115-07-1	42.08	EPI Dermwin v2.0	8.00E+00	0.196	EPI HenryWin v3.2
Propylene Glycol	57-55-6	76.1	EPI Dermwin v2.0	5.30E-07	1.29E-08	EPI HenryWin v3.2
Propylene Glycol Dinitrate	6423-43-4	166.09	EPI Dermwin v2.0	3.90E-05	9.42E-07	EPI HenryWin v3.2
Propylene Glycol Monoethyl Ether	1569-02-4	104.15	EPI Dermwin v2.0	1.00E-06	2.45E-08	EPI HenryWin v3.2
Propylene Glycol Monomethyl Ether	107-98-2	90.12	EPI Dermwin v2.0	3.80E-05	9.20E-07	EPI HenryWin v3.2
Propylene Oxide	75-56-9	58.08	EPI Dermwin v2.0	2.80E-03	0.0000696	EPI HenryWin v3.2
Pursuit	81335-77-5	289.34	EPI Dermwin v2.0	4.30E-15	1.04E-16	EPI HenryWin v3.2
Pydrin	51630-58-1	419.91	EPI Dermwin v2.0	1.40E-06	3.45E-08	EPI HenryWin v3.2
Pyridine	110-86-1	79.1	EPI Dermwin v2.0	4.50E-04	0.000011	EPI HenryWin v3.2
Quinalphos	13593-03-8	298.3	EPI Dermwin v2.0	1.90E-06	4.64E-08	EPI HenryWin v3.2
Quinoline	91-22-5	129.16	EPI Dermwin v2.0	6.80E-05	1.67E-06	EPI HenryWin v3.2
Refractory Ceramic Fibers	NA					
Resmethrin	10453-86-8	338.45	EPI Dermwin v2.0	5.40E-06	1.33E-07	EPI HenryWin v3.2
Ronnel	299-84-3	321.54	EPI Dermwin v2.0	1.30E-03	0.000032	EPI HenryWin v3.2
Rotenone	83-79-4	394.43	EPI Dermwin v2.0	4.60E-12	1.12E-13	EPI HenryWin v3.2
Safrole	94-59-7	162.19	EPI Dermwin v2.0	3.70E-04	9.07E-06	EPI HenryWin v3.2
Savey	78587-05-0	352.88	EPI Dermwin v2.0	9.70E-07	2.37E-08	EPI HenryWin v3.2
Selenious Acid	7783-00-8	128.97	EPI Dermwin v2.0			
Selenium	7782-49-2	80.98	EPI Dermwin v2.0			
Selenium Sulfide	7446-34-6	111.02	EPI Dermwin v2.0			
Sethoxydim	74051-80-2	327.49	EPI Dermwin v2.0	8.80E-10	2.16E-11	EPI HenryWin v3.2
Silica (crystalline, respirable)	7631-86-9	60.08	EPI Dermwin v2.0			
Silver	7440-22-4	107.87	EPI Dermwin v2.0			
Simazine	122-34-9	201.66	EPI Dermwin v2.0	3.90E-08	9.42E-10	EPI HenryWin v3.2
Sodium Acifluorfen	62476-59-9	383.65	EPI Dermwin v2.0	2.50E-09	6.05E-11	EPI HenryWin v3.2
Sodium Azide	26628-22-8	65.01	EPI Dermwin v2.0			
Sodium Diethyldithiocarbamate	148-18-5	171.25	EPI Dermwin v2.0			

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Sodium Fluoride	7681-49-4	41.99	EPI Dermwin v2.0			
Sodium Fluoroacetate	62-74-8	100.03	EPI Dermwin v2.0	4.50E-05	1.09E-06	EPI HenryWin v3.2
Sodium Metavanadate	13718-26-8	121.93	CRC 89th Ed			
Sodium Perchlorate	7601-89-0	122.44	EPI Dermwin v2.0			
Stirofos (Tetrachlorovinphos)	961-11-5	365.97	EPI Dermwin v2.0	7.50E-08	1.84E-09	EPI HenryWin v3.2
Strontium, Stable	7440-24-6	87.62	EPI Dermwin v2.0			
Strychnine	57-24-9	334.42	EPI Dermwin v2.0	2.40E-12	5.96E-14	EPI HenryWin v3.2
Styrene	100-42-5	104.15	EPI Dermwin v2.0	1.10E-01	0.00275	EPI HenryWin v3.2
Sulfonylbis(4-chlorobenzene), 1,1'	80-07-9	287.16	EPI Dermwin v2.0	5.60E-06	1.37E-07	EPI HenryWin v3.2
Sulfuric Acid	7664-93-9	98.07	EPI Dermwin v2.0			
Systhane	88671-89-0	288.78	EPI Dermwin v2.0	1.70E-07	4.28E-09	EPI HenryWin v3.2
TCMTB	21564-17-0	238.34	EPI Dermwin v2.0	2.70E-10	6.49E-12	EPI HenryWin v3.2
Tebuthiuron	34014-18-1	228.31	EPI Dermwin v2.0	4.90E-09	1.20E-10	EPI HenryWin v3.2
Temephos	3383-96-8	466.46	EPI Dermwin v2.0	8.00E-08	1.96E-09	EPI HenryWin v3.2
Terbacil	5902-51-2	216.67	EPI Dermwin v2.0	4.90E-09	1.20E-10	EPI HenryWin v3.2
Terbufos	13071-79-9	288.42	EPI Dermwin v2.0	9.80E-04	0.000024	EPI HenryWin v3.2
Terbutryn	886-50-0	241.36	EPI Dermwin v2.0	8.80E-07	2.15E-08	EPI HenryWin v3.2
Tetrabromodiphenyl ether, 2,2',4,4'- (BDE-47)	5436-43-1	485.8	EPI Dermwin v2.0	3.50E-04	8.48E-06	EPI HenryWin v3.2
Tetrachlorobenzene, 1,2,4,5-	95-94-3	215.89	EPI Dermwin v2.0	4.10E-02	0.001	EPI HenryWin v3.2
Tetrachloroethane, 1,1,1,2-	630-20-6	167.85	EPI Dermwin v2.0	1.00E-01	0.0025	EPI HenryWin v3.2
Tetrachloroethane, 1,1,2,2-	79-34-5	167.85	EPI Dermwin v2.0	1.50E-02	0.000367	EPI HenryWin v3.2
Tetrachloroethylene	127-18-4	165.83	EPI Dermwin v2.0	7.20E-01	0.0177	EPI HenryWin v3.2
Tetrachlorophenol, 2,3,4,6-	58-90-2	231.89	EPI Dermwin v2.0	3.60E-04	8.84E-06	EPI HenryWin v3.2
Tetrachlorotoluene, p- alpha, alpha, alpha	5216-25-1	229.92	EPI Dermwin v2.0	7.90E-03	0.000193	EPI HenryWin v3.2
Tetraethyl Dithiopyrophosphate	3689-24-5	322.31	EPI Dermwin v2.0	1.80E-04	4.45E-06	EPI HenryWin v3.2
Tetrafluoroethane, 1,1,1,2-	811-97-2	102.03	EPI Dermwin v2.0	2.00E+00	0.05	EPI HenryWin v3.2
Tetryl (Trinitrophenylmethylnitramine	479-45-8	287.15	EPI Dermwin v2.0	1.10E-07	2.71E-09	EPI HenryWin v3.2
Thallium (Soluble Salts)	7440-28-0	204.38	EPI Dermwin v2.0			
Thiobencarb	28249-77-6	257.78	EPI Dermwin v2.0	1.10E-05	2.67E-07	EPI HenryWin v3.2
Thiodiglyco	111-48-8	122.18	EPI Dermwin v2.0	1.10E-11	2.74E-13	EPI HenryWin v3.2
Thiofanox	39196-18-4	218.32	EPI Dermwin v2.0	3.80E-07	9.39E-09	EPI HenryWin v3.2
Thiophanate, Methyl	23564-05-8	342.39	EPI Dermwin v2.0	4.90E-08	1.21E-09	EPI HenryWin v3.2
Thiram	137-26-8	240.42	EPI Dermwin v2.0	7.40E-06	1.82E-07	EPI HenryWin v3.2
Tin	7440-31-5	120.73	EPI Dermwin v2.0			
Titanium Tetrachloride	7550-45-0	189.68	EPI Dermwin v2.0			
Toluene	108-88-3	92.14	EPI Dermwin v2.0	2.70E-01	0.00664	EPI HenryWin v3.2

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Toluidine, p-	106-49-0	107.16	EPI Dermwin v2.0	8.30E-05	2.02E-06	EPI HenryWin v3.2
Toxaphene	8001-35-2	413.82	EPI Dermwin v2.0	2.50E-04	6.00E-06	EPI HenryWin v3.2
Tralomethrin	66841-25-6	665.02	EPI Dermwin v2.0	1.60E-08	3.94E-10	EPI HenryWin v3.2
Tri-n-butyltin	688-73-3	291.07	EPI Dermwin v2.0	6.20E+01	1.52	EPI HenryWin v3.2
Triallate	2303-17-5	304.66	EPI Dermwin v2.0	4.90E-04	0.000012	EPI HenryWin v3.2
Triasulfuron	82097-50-5	401.83	EPI Dermwin v2.0	1.30E-11	3.23E-13	EPI HenryWin v3.2
Tribromobenzene, 1,2,4-	615-54-3	314.8	EPI Dermwin v2.0	1.60E-02	0.000388	EPI HenryWin v3.2
Tributyl Phosphate	126-73-8	266.32	EPI Dermwin v2.0	5.80E-05	1.41E-06	EPI HenryWin v3.2
Tributyltin Compounds	NA					
Tributyltin Oxide	56-35-9	596.12	EPI Dermwin v2.0	1.20E-05	3.02E-07	EPI HenryWin v3.2
Trichloro-1,2,2-trifluoroethane, 1,1,2-	76-13-1	187.38	EPI Dermwin v2.0	2.20E+01	0.526	EPI HenryWin v3.2
Trichloroacetic Acid	76-03-9	163.39	EPI Dermwin v2.0	5.50E-07	1.35E-08	EPI HenryWin v3.2
Trichloroaniline HCl, 2,4,6-	33663-50-2	232.93	EPI Dermwin v2.0	2.90E-12	7.18E-14	EPI HenryWin v3.2
Trichloroaniline, 2,4,6-	634-93-5	196.46	EPI Dermwin v2.0	5.50E-05	1.34E-06	EPI HenryWin v3.2
Trichlorobenzene, 1,2,3-	87-61-6	181.45	EPI Dermwin v2.0	5.10E-02	0.00125	EPI HenryWin v3.2
Trichlorobenzene, 1,2,4-	120-82-1	181.45	EPI Dermwin v2.0	5.80E-02	0.00142	EPI HenryWin v3.2
Trichloroethane, 1,1,1-	71-55-6	133.41	EPI Dermwin v2.0	7.00E-01	0.0172	EPI HenryWin v3.2
Trichloroethane, 1,1,2-	79-00-5	133.41	EPI Dermwin v2.0	3.40E-02	0.000824	EPI HenryWin v3.2
Trichloroethylene	79-01-6	131.39	EPI Dermwin v2.0	4.00E-01	0.00985	EPI HenryWin v3.2
Trichlorofluoromethane	75-69-4	137.37	EPI Dermwin v2.0	4.00E+00	0.097	EPI HenryWin v3.2
Trichlorophenol, 2,4,5-	95-95-4	197.45	EPI Dermwin v2.0	6.60E-05	1.62E-06	EPI HenryWin v3.2
Trichlorophenol, 2,4,6-	88-06-2	197.45	EPI Dermwin v2.0	1.10E-04	2.60E-06	EPI HenryWin v3.2
Trichlorophenoxyacetic Acid, 2,4,5-	93-76-5	255.49	EPI Dermwin v2.0	1.90E-06	4.66E-08	EPI HenryWin v3.2
Trichlorophenoxypropionic acid, -2,4,5	93-72-1	269.51	EPI Dermwin v2.0	3.70E-07	9.06E-09	EPI HenryWin v3.2
Trichloropropane, 1,1,2-	598-77-6	147.43	EPI Dermwin v2.0	1.30E-02	0.000317	EPI HenryWin v3.2
Trichloropropane, 1,2,3-	96-18-4	147.43	EPI Dermwin v2.0	1.40E-02	0.000343	EPI HenryWin v3.2
Trichloropropene, 1,2,3-	96-19-5	145.42	EPI Dermwin v2.0	7.20E-01	0.0176	EPI HenryWin v3.2
Tridiphane	58138-08-2	320.43	EPI Dermwin v2.0	1.70E-05	4.10E-07	EPI HenryWin v3.2
Triethylamine	121-44-8	101.19	EPI Dermwin v2.0	6.10E-03	0.000149	EPI HenryWin v3.2
Trifluralin	1582-09-8	335.29	EPI Dermwin v2.0	4.20E-03	0.000103	EPI HenryWin v3.2
Trimethyl Phosphate	512-56-1	140.08	EPI Dermwin v2.0	2.90E-07	7.20E-09	EPI HenryWin v3.2
Trimethylbenzene, 1,2,4-	95-63-6	120.2	EPI Dermwin v2.0	2.50E-01	0.00616	EPI HenryWin v3.2
Trimethylbenzene, 1,3,5-	108-67-8	120.2	EPI Dermwin v2.0	3.60E-01	0.00877	EPI HenryWin v3.2
Trinitrobenzene, 1,3,5-	99-35-4	213.11	EPI Dermwin v2.0	2.70E-07	6.50E-09	EPI HenryWin v3.2
Trinitrotoluene, 2,4,6-	118-96-7	227.13	EPI Dermwin v2.0	8.50E-07	2.08E-08	EPI HenryWin v3.2
Triphenylphosphine Oxide	791-28-6	278.29	EPI Dermwin v2.0	2.20E-08	5.26E-10	EPI HenryWin v3.2

Contaminant		Molecular Weight		Henry's Law Constants		
Analyte	CAS No.	MW	MW Ref	H` (unitless)	HLC (atm-m^2/mole)	H` and HLC Ref
Tris(1,3-Dichloro-2-propyl) Phosphate	13674-87-8	430.91	EPI Dermwin v2.0	1.10E-07	2.61E-09	EPI HenryWin v3.2
Tris(2-chloroethyl)phosphate	115-96-8	285.49	EPI Dermwin v2.0	1.30E-04	3.29E-06	EPI HenryWin v3.2
Tris(2-ethylhexyl)phosphate	78-42-2	434.65	EPI Dermwin v2.0	3.20E-06	7.86E-08	EPI HenryWin v3.2
Uranium (Soluble Salts)	NA					
Urethane	51-79-6	89.09	EPI Dermwin v2.0	2.60E-06	6.43E-08	EPI HenryWin v3.2
Vanadium Pentoxide	1314-62-1	181.88	EPI Dermwin v2.0			
Vanadium Sulfate	36907-42-3	273.11	CRC 89th Ed			
Vanadium and Compounds	NA	50.94	CRC 89th Ed			
Vanadium, Metallic	7440-62-2	50.94	EPI Dermwin v2.0			
Vernolate	1929-77-7	203.35	EPI Dermwin v2.0	1.30E-03	0.0000309	EPI HenryWin v3.2
Vinclozolin	50471-44-8	286.12	EPI Dermwin v2.0	7.10E-07	1.74E-08	EPI HenryWin v3.2
Vinyl Acetate	108-05-4	86.09	EPI Dermwin v2.0	2.10E-02	0.000511	EPI HenryWin v3.2
Vinyl Bromide	593-60-2	106.95	EPI Dermwin v2.0	5.00E-01	0.0123	EPI HenryWin v3.2
Vinyl Chloride	75-01-4	62.5	EPI Dermwin v2.0	1.10E+00	0.0278	EPI HenryWin v3.2
Warfarin	81-81-2	308.34	EPI Dermwin v2.0	1.10E-07	2.77E-09	EPI HenryWin v3.2
Xylene, Mixture	1330-20-7	106.17	EPI Dermwin v2.0	2.10E-01	0.00518	EPI HenryWin v3.2
Xylene, P-	106-42-3	106.17	EPI Dermwin v2.0	2.80E-01	0.0069	EPI HenryWin v3.2
Xylene, m-	108-38-3	106.17	EPI Dermwin v2.0	2.90E-01	0.00718	EPI HenryWin v3.2
Xylene, o-	95-47-6	106.17	EPI Dermwin v2.0	2.10E-01	0.00518	EPI HenryWin v3.2
Zinc (Metallic)	7440-66-6	67.41	EPI Dermwin v2.0			
Zinc Phosphide	1314-84-7	258.18	CRC 89th Ed			
Zineb	12122-67-7	275.74	EPI Dermwin v2.0	6.50E-09	1.59E-10	EPI HenryWin v3.2

EPA 2002 = U.S. Environmental Protection Agency. Industrial Waste Air Model (IWAIR) User's Guide. Office of Solid Waste. February 2002.

EPA 1987 = Processes, Coefficients, and Models for Simulation Toxic Organics and Heavy Metals in Surface Waters. EPA/600/3- 87/015. Office of Research and Development, Athens, GA.

CRC = Handbook of Chemistry and Physics

MW Other = Chemfinder, Dermwin version 1.42, or Physprop Datab

CRC Chrom III note = CRC 85th edition, (Values reported here are for chromium (III) oxide (CAS 1308-38-9) which is one of the water insoluble salts.)

CRC Chrom VI note = CRC 85th edition, (decomposes at this temp) Values reported here are for chromium (VI) oxide (CAS 1333-82-0)

EPI (Henry Win) 1 = EPI (HenryWin) Experimental value; citation not listed

Appendix F
Laboratory DoD ELAP Accreditation

PERRY JOHNSON LABORATORY ACCREDITATION, INC.

Certificate of Accreditation

Perry Johnson Laboratory Accreditation, Inc., has assessed the Laboratory of:

Columbia Analytical Services, Inc.
2655 Park Center Drive, Suite A
Simi Valley, CA 93065

(Hereinafter called the Organization) and hereby declares that Organization has met the requirements of the DoD Quality Systems Manual for Environmental Laboratories Version 4.1 (4/22/2009) and is accredited in accordance with the**:**

United States Department of Defense Environmental Laboratory Accreditation Program (DoD-ELAP)

This accreditation demonstrates technical competence for the defined scope:

Environmental Testing
(As detailed in the supplement)

Such testing shall only be offered at or from the address given above. This Accreditation is granted subject to the system rules governing the Accreditation referred to above, and the Organization hereby covenants with the Accreditation Body's duty to observe and comply with the said rules.

For PJLA:

The validity of this certificate is mandated through ongoing surveillance.

Tracy Szerszen
President/Operations Manager
Perry Johnson Laboratory
Accreditation, Inc. (PJLA)
26555 Evergreen, Suite 1325
Southfield, Michigan 48076

Initial Accreditation	Issue Date:	Expiration Date:
January 11, 2010	January 11, 2010	January 10, 2012
Accreditation No:	Certificate	Page No:
65818	L10-3	Page 1 of 5

Certificate of Accreditation: Supplement

Columbia Analytical Services, Inc.
2655 Park Center Drive, Suite A
Simi Valley, CA 93065

Accreditation is granted to this facility to perform the following testing:

Matrix	Standard / Method	Technology	Analyte
Water	RSK 175	GC/FID	Methane
Water	RSK 175	GC/FID	Ethane
Water	RSK 175	GC/FID	Ethene
Air	(CAS S.O.P.) VOA-EPA3C	GC/TCD	Hydrogen
Air	(CAS S.O.P.) VOA-EPA3C	GC/TCD	Oxygen
Air	(CAS S.O.P.) VOA-EPA3C	GC/TCD	Nitrogen
Air	(CAS S.O.P.) VOA-EPA3C	GC/TCD	Methane
Air	(CAS S.O.P.) VOA-EPA3C	GC/TCD	Carbon Dioxide
Air	(CAS S.O.P.) VOA-EPA3C	GC/TCD	Carbon Monoxide
Air	(CAS S.O.P) VOA-TPHG_TO3	GC/FID	Total Petroleum Hydrocarbons Gasoline (TPHG)
Air	(CAS S.O.P) VOA-TPHG_TO3	GC/FID	JP-4
Air	(CAS S.O.P) VOA-TO3C1C6	GC/FID	Total Volatile Petroleum Hydrocarbons (TVPH) as Hexane
Air	(CAS S.O.P) VOA-TO3C1C6	GC/FID	C1 - C6+
Air	EPA TO-15	GC/MS	1,1,1-Trichloroethane
Air	EPA TO-15	GC/MS	1,1,2,2-Tetrachloroethane
Air	EPA TO-15	GC/MS	1,1,2-Trichloroethane
Air	EPA TO-15	GC/MS	1,1-Dichloroethane
Air	EPA TO-15	GC/MS	1,1-Dichloroethene
Air	EPA TO-15	GC/MS	1,2,3-Trimethylbenzene
Air	EPA TO-15	GC/MS	1,2,4-Trichlorobenzene
Air	EPA TO-15	GC/MS	1,2,4-Trimethylbenzene
Air	EPA TO-15	GC/MS	1,2,Dibromo-3-Chloropropane
Air	EPA TO-15	GC/MS	1,2-Dibromoethane
Air	EPA TO-15	GC/MS	1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)
Air	EPA TO-15	GC/MS	1,2-Dichlorobenzene
Air	EPA TO-15	GC/MS	1,2-Dichloroethane
Air	EPA TO-15	GC/MS	1,2-Dichloropropane
Air	EPA TO-15	GC/MS	1,3,5-Trimethylbenzene
Air	EPA TO-15	GC/MS	1,3-Butadiene
Air	EPA TO-15	GC/MS	1,3-Dichlorobenzene
Air	EPA TO-15	GC/MS	1,4-Dichlorobenzene
Air	EPA TO-15	GC/MS	1,4-Dioxane
Air	EPA TO-15	GC/MS	1-Butanol

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Columbia Analytical Services, Inc.
2655 Park Center Drive, Suite A
Simi Valley, CA 93065

Accreditation is granted to this facility to perform the following testing:

Matrix	Standard / Method	Technology	Analyte
Air	EPA TO-15	GC/MS	2-Butanone (MEK)
Air	EPA TO-15	GC/MS	2-Ethyltoluene
Air	EPA TO-15	GC/MS	2-Hexanone
Air	EPA TO-15	GC/MS	3-Ethyltoluene
Air	EPA TO-15	GC/MS	4-Ethyltoluene
Air	EPA TO-15	GC/MS	4-Methyl-2-Pentanone
Air	EPA TO-15	GC/MS	Acetone
Air	EPA TO-15	GC/MS	Acetonitrile
Air	EPA TO-15	GC/MS	Acrolein
Air	EPA TO-15	GC/MS	Acrylonitrile
Air	EPA TO-15	GC/MS	Allyl Chloride
Air	EPA TO-15	GC/MS	alpha-Methylstyrene
Air	EPA TO-15	GC/MS	alpha-Pinene
Air	EPA TO-15	GC/MS	Benzene
Air	EPA TO-15	GC/MS	Benzyl Chloride
Air	EPA TO-15	GC/MS	Bromodichloromethane
Air	EPA TO-15	GC/MS	Bromoform
Air	EPA TO-15	GC/MS	Bromomethane
Air	EPA TO-15	GC/MS	Carbon Disulfide
Air	EPA TO-15	GC/MS	Carbon Tetrachloride
Air	EPA TO-15	GC/MS	Chlorobenzene
Air	EPA TO-15	GC/MS	Chloroethane
Air	EPA TO-15	GC/MS	Chloroform
Air	EPA TO-15	GC/MS	Chloromethane
Air	EPA TO-15	GC/MS	cis-1,2-Dichloroethene
Air	EPA TO-15	GC/MS	cis-1,3-Dichloropropene
Air	EPA TO-15	GC/MS	Cumene
Air	EPA TO-15	GC/MS	Cyclohexane
Air	EPA TO-15	GC/MS	Cyclohexanone
Air	EPA TO-15	GC/MS	Dibromochloromethane
Air	EPA TO-15	GC/MS	Dichlorodifluoromethane
Air	EPA TO-15	GC/MS	Dichlorodifluoromethane (CFC 12)
Air	EPA TO-15	GC/MS	Diisopropyl Ether
Air	EPA TO-15	GC/MS	d-Limonene

Certificate of Accreditation: Supplement

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Simi Valley, CA 93065

Accreditation is granted to this facility to perform the following testing:

Matrix	Standard / Method	Technology	Analyte
Air	EPA TO-15	GC/MS	Ethanol
Air	EPA TO-15	GC/MS	Ethyl Acetate
Air	EPA TO-15	GC/MS	Ethyl tert-Butyl Ether
Air	EPA TO-15	GC/MS	Ethylbenzene
Air	EPA TO-15	GC/MS	Hexachlorobutadiene
Air	EPA TO-15	GC/MS	Isooctane
Air	EPA TO-15	GC/MS	Isopropyl acetate
Air	EPA TO-15	GC/MS	Isopropyl Alcohol
Air	EPA TO-15	GC/MS	m-&, p-Xylenes
Air	EPA TO-15	GC/MS	Methyl Methacrylate
Air	EPA TO-15	GC/MS	Methyl tert-Butyl Ether
Air	EPA TO-15	GC/MS	Methylene Chloride
Air	EPA TO-15	GC/MS	Naphthalene
Air	EPA TO-15	GC/MS	n-Butyl Acetate
Air	EPA TO-15	GC/MS	n-Butylbenzene
Air	EPA TO-15	GC/MS	n-Decane
Air	EPA TO-15	GC/MS	n-Dodecane
Air	EPA TO-15	GC/MS	n-Heptane
Air	EPA TO-15	GC/MS	n-Hexane
Air	EPA TO-15	GC/MS	n-Nonane
Air	EPA TO-15	GC/MS	n-Octane
Air	EPA TO-15	GC/MS	n-Propylbenzene
Air	EPA TO-15	GC/MS	n-Undecane
Air	EPA TO-15	GC/MS	o-Xylene
Air	EPA TO-15	GC/MS	p-Isopropyltoluene
Air	EPA TO-15	GC/MS	Propene
Air	EPA TO-15	GC/MS	sec-Butylbenzene
Air	EPA TO-15	GC/MS	Styrene
Air	EPA TO-15	GC/MS	tert-Amyl Methyl Ether
Air	EPA TO-15	GC/MS	tert-Butanol
Air	EPA TO-15	GC/MS	tert-Butylbenzene
Air	EPA TO-15	GC/MS	Tetrachloroethene
Air	EPA TO-15	GC/MS	Tetrahydrofuran

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2655 Park Center Drive, Suite A
Simi Valley, CA 93065

Accreditation is granted to this facility to perform the following testing:

Matrix	Standard / Method	Technology	Analyte
Air	EPA TO-15	GC/MS	Toluene
Air	EPA TO-15	GC/MS	trans-1,2-Dichloroethene
Air	EPA TO-15	GC/MS	trans-1,3-Dichloropropene
Air	EPA TO-15	GC/MS	Trichloroethene
Air	EPA TO-15	GC/MS	Trichlorofluoromethane
Air	EPA TO-15	GC/MS	Trichlorotrifluoroethane
Air	EPA TO-15	GC/MS	Vinyl Acetate
Air	EPA TO-15	GC/MS	Vinyl Chloride